Tungsten Clustering (for MySQL) 5.4 Manual

Continuent Ltd

Tungsten Clustering (for MySQL) 5.4 Manual

Continuent Ltd
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Abstract

This manual documents Tungsten Clustering (for MySQL), a high performance, High Availability and Disaster Recovery for MySQL clustering.

This manual includes information for 5.4, up to and including 5.4.1.

Build date: 2024-04-03 (65a56d5c)

Up to date builds of this document: Tungsten Clustering (for MySQL) 5.4 Manual (Online), Tungsten Clustering (for MySQL) 5.4 Manual (PDF)

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Preface

This manual documents Tungsten Cluster 5.4 up to and including 5.4.1 build 41. Differences between minor versions are highlighted stating the explicit minor release version, such as 5.4.1.

For other versions and products, please use the appropriate manual.

1. Legal Notice

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2. Conventions

This documentation uses a number of text and style conventions to indicate and differentiate between different types of information:

- *Text in this style* is used to show an important element or piece of information. It may be used and combined with other text styles as appropriate to the context.
- Text in this style is used to show a section heading, table heading, or particularly important emphasis of some kind.
- Program or configuration options are formatted using `this style`. Options are also automatically linked to their respective documentation page when this is known. For example, tpm and `--hosts` [450] both link automatically to the corresponding reference page.
- Parameters or information explicitly used to set values to commands or options is formatted using *`this style`*.
- Option values, for example on the command-line are marked up using this format: `--help`. Where possible, all option values are directly linked to the reference information for that option.
- Commands, including sub-commands to a command-line tool are formatted using Text in this style. Commands are also automatically linked to their respective documentation page when this is known. For example, tpm links automatically to the corresponding reference page.
- `Text in this style` indicates literal or character sequence text used to show a specific value.
- Filenames, directories or paths are shown like this `/etc/passwd`. Filenames and paths are automatically linked to the corresponding reference page if available.

Bulleted lists are used to show lists, or detailed information for a list of items. Where this information is optional, a magnifying glass symbol enables you to expand, or collapse, the detailed instructions.

Code listings are used to show sample programs, code, configuration files and other elements. These can include both user input and replaceable values:

```
shell> cd /opt/continuent/software
shell> ar zxvf tungsten-clustering-5.4.1-41.tar.gz
```

In the above example command-lines to be entered into a shell are prefixed using `shell`. This shell is typically sh, ksh, or bash on Linux and Unix platforms.

If commands are to be executed using administrator privileges, each line will be prefixed with root-shell, for example:

```
root-shell> vi /etc/passwd
```

To make the selection of text easier for copy/pasting, ignorable text, such as `shell>` are ignored during selection. This allows multi-line instructions to be copied without modification, for example:

```
mysql> create database test_selection;
mysql> drop database test_selection;
```

Lines prefixed with `mysql>` should be entered within the mysql command-line.

If a command-line or program listing entry contains lines that are two wide to be displayed within the documentation, they are marked using the » character:

```
the first line has been extended by using a »
    continuation line
```

They should be adjusted to be entered on a single line.

Text marked up with **`this style`** is information that is entered by the user (as opposed to generated by the system). Text formatted using *`this style`* should be replaced with the appropriate file, version number or other variable information according to the operation being performed.

In the HTML versions of the manual, blocks or examples that can be userinput can be easily copied from the program listing. Where there are multiple entries or steps, use the 'Show copy-friendly text' link at the end of each section. This provides a copy of all the user-enterable text.

3. Quickstart Guide

- Are you planning on completing your first installation?
  - Do you know the Section 2.2, “Requirements”?
  - Have you followed the Appendix B, *Prerequisites*?
  - Have you decided which installation method you will use? INI or Staging?
  - Have you chosen your deployment type from Chapter 2, *Deployment*? Is this a Primary/Replica deployment?
- Would you like to understand the different types of installation?

  There are two installation methods available in tpm, INI and Staging. A comparison of the two methods is at

  Section 10.1, “Comparing Staging and INI tpm Methods”.
- Do you want to upgrade to the latest version?

  See Section 10.5.16, “tpm update Command”.
- Are you trying to update or change the configuration of your system?

  See Section 10.5.16, “tpm update Command”.
- Has your system suffered a failure?

  For recovery methods and instructions, see Section 6.6, “Datasource Recovery Steps”.
- Would you like to perform database or operating system maintenance?

  See Section 6.14, “Performing Database or OS Maintenance”.
- Do you need to backup or restore your system?

  For backup instructions, see Section 6.9, “Creating a Backup”, and to restore a previously made backup, see Section 6.10, “Restoring a Backup”.

Chapter 1. Introduction

Tungsten Clustering™ provides a suite of tools to aid the deployment of database clusters using MySQL. A Tungsten Cluster™ consists of three primary tools:

- Tungsten Replicator

  Tungsten Replicator supports replication between different databases. Tungsten Replicator acts as a direct replacement for the native MySQL replication, in addition to supporting connectivity to Oracle, MongoDB, Vertica and others.

- Tungsten Manager

  The Tungsten Manager is responsible for monitoring and managing a Tungsten Cluster dataservice. The manager has a number of control and supervisory roles for the operation of the cluster, and acts both as a control and a central information source for the status and health of the dataservice as a whole.

- Tungsten Connector (or Tungsten Proxy)

  The Tungsten Connector is a service that sits between your application server and your MySQL database. The connector routes connections from your application servers to the datasources within the cluster, automatically distributing and redirecting queries to each datasource according to load balancing and availability requirements.

While there is no specific SLA because every customer's environment is different, we strive to deliver a very low RTO and a very high RPO. For example, a cluster failover normally takes around 30 seconds depending on load, so the RTO is typically under 1 minute. Additionally, the RPO is 100%, since we keep copies of the database on Replica nodes, so that a failover happens with zero data loss under the vast majority of conditions.

Tungsten Cluster uses key terminology for different components in the system. These are used to distinguish specific elements of the overall system at the different levels of operations.

Table 1.1. Key Terminology

Continuent Term	Traditional Term	Description
composite dataservice	Multi-Site Cluster	A configured Tungsten Cluster service consisting of multiple dataservices, typically at different physical locations.
dataservice	Cluster	The collection of machines that make up a single Tungsten Dataservice. Individual hosts within the dataservice are called datasources. Each dataservice is identified by a unique name, and multiple dataservices can be managed from one server.
dataserver	Database	The database on a host.
datasource	Host or Node	One member of a dataservice and the associated Tungsten components.
staging host	-	The machine (and directory) from which Tungsten Cluster™ is installed and configured. The machine does not need to be the same as any of the existing hosts in the dataservice.
active witness	-	A machine in the dataservice that runs the manager process but is not running a database server. This server will be used to establish quorum in the event that a datasource becomes unavailable.
passive witness	-	A witness host is a host that can be contacted using the ping protocol to act as a network check for the other nodes of the cluster. Witness hosts should be on the same network and segment as the other nodes in the dataservice.
coordinator		The datasource or active witness in a dataservice that is responsible for making decisions on the state of the dataservice. The coordinator is usually the member that has been running the longest. It will not always be the Primary. When the manager process on the coordinator is stopped, or no longer available, a new coordinator will be chosen from the remaining members.

1.1. Tungsten Replicator

Tungsten Replicator is a high performance replication engine that works with a number of different source and target databases to provide high-performance and improved replication functionality over the native solution. With MySQL replication, for example, the enhanced functionality and information provided by Tungsten Replicator allows for global transaction IDs, advanced topology support such as Composite Active/Active, star, and fan-in, and enhanced latency identification.

In addition to providing enhanced functionality Tungsten Replicator is also capable of heterogeneous replication by enabling the replicated information to be transformed after it has been read from the data server to match the functionality or structure in the target server. This functionality allows for replication between MySQL and a variety of heterogeneous targets.

Understanding how Tungsten Replicator works requires looking at the overall replicator structure. There are three major components in the system that provide the core of the replication functionality:

- Extractor

  The extractor component reads data from a MysQL data server and writes that information into the Transaction History Log (THL). The role of the extractor is to read the information from a suitable source of change information and write it into the THL in the native or defined format, either as SQL statements or row-based information.

  Information is always extracted from a source database and recorded within the THL in the form of a complete transaction. The full transaction information is recorded and logged against a single, unique, transaction ID used internally within the replicator to identify the data.

- Applier

  Appliers within Tungsten Replicator convert the THL information and apply it to a destination data server. The role of the applier is to read the THL information and apply that to the data server.

  The applier works with a number of different target databases, and is responsible for writing the information to the database. Because the transactional data in the THL is stored either as SQL statements or row-based information, the applier has the flexibility to reformat the information to match the target data server. Row-based data can be reconstructed to match different database formats, for example, converting row-based information into an Oracle-specific table row, or a MongoDB document.

- Transaction History Log (THL)

  The THL contains the information extracted from a data server. Information within the THL is divided up by transactions, either implied or explicit, based on the data extracted from the data server. The THL structure, format, and content provides a significant proportion of the functionality and operational flexibility within Tungsten Replicator.

  As the THL data is stored additional information, such as the metadata and options in place when the statement or row data was extracted are recorded. Each transaction is also recorded with an incremental global transaction ID. This ID enables individual transactions within the THL to be identified, for example to retrieve their content, or to determine whether different appliers within a replication topology have written a specific transaction to a data server.

These components will be examined in more detail as different aspects of the system are described with respect to the different systems, features, and functionality that each system provides.

From this basic overview and structure of Tungsten Replicator, the replicator allows for a number of different topologies and solutions that replicate information between different services. Straightforward replication topologies, such as Primary/Replica are easy to understand with the basic concepts described above. More complex topologies use the same core components. For example, Composite Active/Active topologies make use of the global transaction ID to prevent the same statement or row data being applied to a data server multiple times. Fan-in topologies allow the data from multiple data servers to be combined into one data server.

1.1.1. Transaction History Log (THL)

Tungsten Replicator operates by reading information from the source database and transferring that information to the *Transaction History Log (THL)*.

Each transaction within the THL includes the SQL statement or the row-based data written to the database. The information also includes, where possible, transaction specific options and metadata, such as character set data, SQL modes and other information that may affect how the information is written when the data is applied. The combination of the metadata and the global transaction ID also enable more complex data replication scenarios to be supported, such as Composite Active/Active, without fear of duplicating statement or row data application because the source and global transaction ID can be compared.

In addition to all this information, the THL also includes a timestamp and a record of when the information was written into the database before the change was extracted. Using a combination of the global transaction ID and this timing information provides information on the latency and how up to date a dataserver is compared to the original datasource.

Depending on the underlying storage of the data, the information can be reformatted and applied to different data servers. When dealing with row-based data, this can be applied to a different type of data server, or completely reformatted and applied to non-table based services such as MongoDB.

THL information is stored for each replicator service, and can also be exchanged over the network between different replicator instances. This enables transaction data to be exchanged between different hosts within the same network or across wide-area-networks.

1.2. Tungsten Manager

The Tungsten Manager is responsible for monitoring and managing a Tungsten Cluster dataservice. The manager has a number of control and supervisory roles for the operation of the cluster, and acts both as a control and a central information source for the status and health of the dataservice as a whole.

Primarily, the Tungsten Manager handles the following tasks:

- Monitors the replication status of each datasource (node) within the cluster.
- Communicates and updates Tungsten Connector with information about the status of each datasource. In the event of a change of status, Tungsten Connectors are notified so that queries can be redirected accordingly.
- Manages all the individual components of the system. Using the Java JMX system the manager is able to directly control the different components to change status, control the replication process, and
- Checks to determine the availability of datasources by using either the Echo TCP/IP protocol on port 7 (default), or using the system ping protocol to determine whether a host is available. The configuration of the protocol to be used can be made by adjusting the manager properties. For more information, see Section B.2.2.3, “Host Availability Checks”.
- Includes an advanced rules engine. The rule engine is used to respond to different events within the cluster and perform the necessary operations to keep the dataservice in optimal working state. During any change in status, whether user-selected or automatically triggered due to a failure, the rules are used to make decisions about whether to restart services, swap Primaries, or reconfigure connectors.

Please see the Tungsten Manager documentation section Chapter 8, *Tungsten Manager* for more information.

1.3. Tungsten Connector

The Tungsten Connector (or Tungsten Proxy) is a service that sits between your application server and your MySQL database. The connector routes connections from your application servers to the datasources within the cluster, automatically distributing and redirecting queries to each datasource according to load balancing and availability requirements.

The primary goal of Tungsten Connector is to effectively route and redirect queries between the Primary and Replica datasources within the cluster. Client applications talk to the connector, while the connector determines where the packets should really go, depending on the scaling and availability. Using a connector in this way effectively hides the complexities of the cluster size and configuration, allowing your cluster to grow and shrink without interrupting your client application connectivity. Client applications remain connected even though the number, configuration and orientation of the Replicas within the cluster may change.

During failover or system maintenance Tungsten Connector takes information from Tungsten Manager to determine which hosts are up and available, and redirects queries only to those servers that are online within the cluster.

For load balancing, Tungsten Connector supports a number of different solutions for redirecting queries to the different datasources within the network. Solutions are either based on explicit routing, or an implied or automatic read/write splitting mode where data is automatically distributed between Primary hosts (writes) and Replica hosts (reads).

Basic read/write splitting uses packet inspection to determine whether a query is a read operation (`SELECT`) or a write (`INSERT`, `UPDATE`, `DELETE`). The actual selection mechanism can be fine tuned using the different modes according to your application requirements.

The supported modes are:

- *Port Based Routing*

  Port based routing employs a second port on the connector host. All connections to this port are sent to an available Replica.

- *Direct Reads*

  Direct reads uses the read/write splitting model, but directs read queries to dedicated read-only connections on the Replica. No attempt is made to determine which host may have the most up to date version of the data. Connections are pooled between the connector and datasources, and this results in very fast execution.

- *SmartScale*

  With SmartScale, data is automatically distributed among the datasources using read/write splitting. Where possible, the connector selects read queries by determining how up to date the Replica is, and using a specific session model to determine which host is up to date according to the session and replication status information. Session identification can be through predefined session types or user-defined session strings.

- *Host Based Routing*

  Explicit host based routing uses different IP addresses on datasources to identify whether the operation should be directed to a Primary or a Replica. Each connector is configured with two IP addresses, connecting to one IP address triggers the connection to be routed to the current Primary, while connecting to the second IP routes queries to a Replica.

- *SQL Based Routing*

  SQL based routing employs packet inspection to identify key strings within the query to determine where the packets should be routed.

These core read/write splitting modes can also be explicitly overridden at a user or host level to allow your application maximum flexibility.

Internally, Tungsten Connector supports the native MySQL protocol, and accepts the raw packet data from the client and sends those packets directly to the datasource. Because it is the native network packets that are being forwarded between hosts the performance is kept high, without requiring any additional overhead or intelligence within the application.

The connector handles the distribution of packets between datasources, allowing clients to remain connected to Tungsten Connector even while the underlying datasources may become disconnected, or expanded as new datasources are added to the cluster.

Chapter 2. Deployment

Creating a Tungsten Clustering (for MySQL) Dataservice using Tungsten Cluster requires careful preparation and configuration of the required components. This section provides guidance on these core operations, preparation and information such as licensing and best practice that should be used for all installations.

2.1. Host Types

Before covering the basics of creating different dataservice types, there are some key terms that will be used throughout the setup and installation process that identify different components of the system. these are summarised in Table 2.1, "Key Terminology".

Table 2.1. Key Terminology

Tungsten Term	Traditional Term	Description
composite dataservice	Multi-Site Cluster	A configured Tungsten Cluster service consisting of multiple dataservices, typically at different physical locations.
dataservice	Cluster	A configured Tungsten Cluster service consisting of dataservers, datasources and connectors.
dataserver	Database	The database on a host. Datasources include MySQL, PostgreSQL or Oracle.
datasource	Host or Node	One member of a dataservice and the associated Tungsten components.
staging host	-	The machine from which Tungsten Cluster is installed and configured. The machine does not need to be the same as any of the existing hosts in the cluster.
staging directory	-	The directory where the installation files are located and the installer is executed. Further configuration and updates must be performed from this directory.
connector	-	A connector is a routing service that provides management for connectivity between application services and the underlying dataserver.
Witness host	-	A witness host is a host that can be contacted using the ping protocol to act as a network check for the other nodes of the cluster. Witness hosts should be on the same network and segment as the other nodes in the dataservice.

2.1.1. Manager Hosts

The manager plays a key role within any dataservice, communicating between the replicator, connector and datasources to understand the current status, and controlling these components to handle failures, maintenance, and service availability.

The primary role of the manager is to monitor each of the services, identify problems, and react to those problems in the most effective way to keep the dataservice active. For example, in the case of a datasource failure, the datasource is temporarily removed from the cluster, the connector is updated to route queries to another available datasource, and the replication is disabled.

These decisions are driven by a rule-based system, which checks current status values, and performs different operations to achieve the correct result and return the dataservice to operational status.

In terms of control and management, the manager is capable of performing backup and restore information, automatically recovering from failure (including re-provisioning from backups), and is also able to individually control the configuration, service startup and shutdown, and overall control of the system.

Within a typical Tungsten Cluster deployment there are multiple managers and these keep in constant contact with each other, and the other services. When a failure occurs, multiple managers are involved in decisions. For example, if a host is no longer visible to one manager, it does not make the decision to disable the service on it's own; only when a majority of managers identify the same result is the decision made. For this reason, there should be an odd number of managers (to prevent deadlock), or managers can be augmented through the use of witness hosts.

One manager is automatically installed for each configured datasource; that is, in a three-node system with a Primary and two Replicas, three managers will be installed.

Checks to determine the availability of hosts are performed by using either the system ping protocol or the Echo TCP/IP protocol on port 7 to determine whether a host is available. The configuration of the protocol to be used can be made by adjusting the manager properties. For more information, see Section B.2.2.3, "Host Availability Checks".

2.1.2. Connector (Router) Hosts

Connectors (known as routers within the dataservice) provide a routing mechanism between client applications and the dataservice. The Tungsten Connector component automatically routes database operations to the Primary or Replica, and takes account of the current cluster

status as communicated to it by the Tungsten Manager. This functionality solves three primary issues that might normally need to be handled by the client application layer:

- Datasource role redirection (i.e. Primary and Replica). This includes read/write splitting, and the ability to read data from a Replica that is up to date with a corresponding write.
- Datasource failure (high-availability), including the ability to redirect client requests in the event of a failure or failover. This includes maintenance operations.
- Dataservice topology changes, for example when expanding the number of datasources within a dataservice

The primary role of the connector is to act as the connection point for applications that can remain open and active, while simultaneously supporting connectivity to the datasources. This allows for changes to the topology and active role of individual datasources without interrupting the client application. Because the operation is through one or more static connectors, the application also does not need to be modified or changed when the number of datasources is expanded or altered.

Depending on the deployment environment and client application requirements, the connector can be installed either on the client application servers, the database servers, or independent hosts. For more information, see Section 7.3, "Clients and Deployment".

Connectors can also be installed independently on specific hosts. The list of enabled connectors is defined by the `--connectors` [440] option to tpm. A Tungsten Cluster dataservice can be installed with more connector servers than datasources or managers.

2.1.3. Replicator Hosts

Tungsten Replicator provides the core replication of information between datasources and, in composite deployment, between dataservices. The replicator operates by extracting data from the 'Primary' datasource (for example, using the MySQL binary log), and then applies the data to one or more target datasources.

Different deployments use different replicators and configurations, but in a typical Tungsten Cluster deployment a Primary/Replica or active/active deployment model is used. For Tungsten Cluster deployments there will be one replicator instance installed on each datasource host.

Within the dataservice, the manager controls each replicator service and it able to alter the replicator operation and role, for example by switching between Primary and Replica roles. The replicator also provides information to the manager about the latency of the replication operation, and uses this with the connectors to control client connectivity into the dataservice.

Replication within Tungsten Cluster is supported by Tungsten Replicator™ and this supports a wide range of additional deployment topologies, and heterogeneous deployments including MongoDB, Vertica, and Oracle. Replication to and from a dataservice are supported. For more information on replicating out of an existing dataservice, see:

- Section 3.7, "Replicating Data Out of a Cluster"
- Section 3.8, "Replicating from a Cluster to a Datawarehouse"

Replicators are automatically configured according to the datasources and topology specified when the dataservice is created.

2.1.4. Witness Hosts

Tungsten Cluster operates through the rules built into the manager that make decisions about different configuration and status settings for all the services within the cluster. In the event of a communication failure within the system it is vital for the manager, in automatic policy mode, to perform a switch from a failed or unavailable Primary.

Within the network, the managers communicate with each other, in addition to the connectors and dataservers to determine their availability. The managers compare states and network connectivity. In the event of an issue, managers 'vote' on whether a failover or switch should occur.

The rules are designed to prevent unnecessary switches and failovers. Managers vote, and an odd number of managers helps to ensure that prevent split-brain scenarios when invalid failover decisions have been made.

Two types of witness are supported:

- *Active Witness* — an active witness is an instance of Tungsten Manager running on a host that is otherwise not part of the dataservice. An active witness has full voting rights within the managers and can therefore make informed decisions about the dataservice state in the event of a failure. Active witnesses can only be a member of one cluster at a time.
- *Passive Witness* — a passive witness is checked by the managers using a network ping to determine if the host is available. The witness host or hosts are used only as check to verify whether a failed host or failed network is the root cause.

  Passive Witness hosts are deprecated as of v6.1.0 and support will be removed in v7.0.0

Use Active Witness hosts instead.

All managers are active witnesses, and active witnesses are the recommended solution for deployments where network availability is less certain (i.e. cloud environments), and where you have two-node deployments.

Tungsten Cluster Quorum Requirements

- There should be at least three managers (including any active witnesses)
- There should be, in total, an odd number of managers and witnesses, to prevent deadlocks.
- If the dataservice contains only two hosts, at least one active witness must be installed.
- Dataservices may contain either *passive* or *active* witnesses, but not both.

These rules apply for all Tungsten Cluster installations and must be adhered to. Deployment will fail if these conditions are not met.

The rules for witness selection are as follows:

- Active witnesses can be located beyond or across network segments, but all active witnesses must have clear communication channel to each other, and other managers. Difficulties in contacting other managers and services in the network could cause unwanted failover or shunning of datasources.
- Passive witnesses must be on the same network segment the managers. To prevent issues where a network switch or router failure would cause the managers to falsely identify a network failure, the managers must be able to connect to each other without having to route across networks or network segments.

To enable active witnesses, the `--enable-active-witnesses=true` [446] option must be specified and the hosts that will act as active witnesses must be added to the list of hosts provided to `--members` [455]. This enables all specified witnesses to be enabled as active witnesses:

```
shell> ./tools/tpm install alpha --enable-active-witnesses=true \
      --witnesses=hostC \
       --members=hostA,hostB,hostC
  ...
```

2.2. Requirements

2.2.1. Operating Systems Support

The following Operating Systems are supported for installation of the various Tungsten components and are part of our regular QA testing processes. Other variants of Linux may work at your own risk, but use of them in production should be avoided and any issues that arise may not be supported; if in doubt we recommend that you contact Continuent Support for clarification. Windows/MAC OS is NOT supported, however appropriate Virtual Environments running any of the supported distributions listed would be supported, although only recommended for Development/Testing environments.

Virtual Environments running any of the supported distributions listed are supported, although only recommended for Development/Testing environments.

The list below also includes EOL dates published by the providers and should be taken into consideration when configuring your deployment

Table 2.2. Tungsten OS Support

Distribtion	Published EOL	Notes
Amazon Linux 2	30th June 2024	
CentOS 7	30th June 2024	
Debian GNU/Linux 10 (Buster)	June 2024	
Debian GNU/Linux 11 (Bullseye)	June 2026	
Oracle Linux 8.4	July 2029	
RHEL 7	30th June 2024	
RHEL 8.4.0	31st May 2029	
Rocky Linux 8	31st May 2029	

Distribtion	Published EOL	Notes
Rocky Linux 9	31st May 2032	
SUSE Linux Enterprise Server 15	21st June 2028	
Ubuntu 20.04 LTS (Focal Fossa)	April 2025	
Ubuntu 22.04 LTS (Canonical)	April 2027	

2.2.2. Database Support

Unless stated, MySQL refers to the following variants:

- MySQL Community Edition
- MySQL Enterprise Edition
- Percona MySQL

Version Support Matrix

Table 2.3. MySQL/Tungsten Version Support

Database	MySQL Version	Tungsten Version	Notes
MySQL	5.7	All non-EOL Versions	Full Support
MySQL	8.0.0-8.0.34	6.1.0-6.1.3	Supported, but does not support Partitioned Tables or the use of `binlog-transaction-compression=ON` introduced in 8.0.20
MySQL	8.0.0-8.0.34	6.1.4 onwards	Fully Supported.
MariaDB	10.0, 10.1	All non-EOL Versions	Full Support
MariaDB	10.2, 10.3	6.1.13-6.1.20	Partial Support. See note below.
MariaDB	10.2, 10.3	7.x	Full Support

Known Issue affecting use of MySQL 8.0.21

In MySQL release 8.0.21 the behavior of `CREATE TABLE ... AS SELECT ...` has changed, resulting in the transactions being logged differenly in the binary log. This change in behavior will cause the replicators to fail.

Until a fix is implemented within the replicator, the workaround for this will be to split the action into separate `CREATE TABLE ...` followed by `INSERT INTO ... SELECT FROM...` statements.

If this is not possible, then you will need to manually create the table on all nodes, and then skip the resulting error in the replicator, allowing the subsequent loading of the data to continue.

MariaDB 10.3+ Support

Full support for MariaDB version 10.3 has been certified in v7.0.0 onwards of the Tungsten products.

Version 6.1.13 onwards of Tungsten will also work, however should you choose to deploy these versions, you do so at your own risk. There are a number of issues noted below that are all resolved from v7.0.0 onwards, therefore if you choose to use an earlier release, you should do so with the following limitations acknowledged:

- tungsten_find_orphaned may fail, introducing the risk of data loss (Fixed in v6.1.13 onwards)
- SSL from Tungsten Components TO the MariaDB is not supported.
- Geometry data type is not supported.
- Tungsten backup tools will fail as they rely on xtrabackup, which will not work with newer release of MariaDB.
- tpm might fail to find correct mysql configuration file. (Fixed in 6.1.13 onwards)
- MariaDB specific event types trigger lots of warnings in the replicator log file.

MySQL "Innovation" Releases

In 2023, Oracle announced a new MySQL version schema that introduced "Innovation" releases. From this point on, patch releases would only contain bug fixes and these would be, for example, the various 8.0.x releases, whereas new features would only be introduced in the "Innovation" releases, such as 8.1, 8.2 etc (Along with Bug Fixes)

"Innovation" releases will be released quartlery, and Oracle aim to make an LTS release every two years which will bundle all of the new features, behavior changes and bug fixes from all the previous "Innovation" releases.

Oracle do not advise the use of the "Innovation" releases in a production enviornment where a known behavior is expected to ensure system stability. We have chosen to follow this advice and as such we do not certify any release of Tungsten against "Innovation" releases for use in Production. We will naturally test against these releases in our QA environment so that we are able to certify and support the LTS release as soon as is practical. Any modifications needed to support an LTS release will not be backported to older Tungsten releases.

For more information on Oracles release policy, please read their blogpost here

2.2.3. RAM Requirements

RAM requirements are dependent on the workload being used and applied, but the following provide some guidance on the basic RAM requirements:

- Tungsten Replicator requires 2GB of VM space for the Java execution, including the shared libraries, with approximate 1GB of Java VM heapspace. This can be adjusted as required, for example, to handle larger transactions or bigger commit blocks and large packets.

  Performance can be improved within the Tungsten Replicator if there is a 2-3GB available in the OS Page Cache. Replicators work best when pages written to replicator log files remain memory-resident for a period of time, so that there is no file system I/O required to read that data back within the replicator. This is the biggest potential point of contention between replicators and DBMS servers.

- Tungsten Manager requires approximately 500MB of VM space for execution.

2.2.4. Disk Requirements

Disk space usage is based on the space used by the core application, the staging directory used for installation, and the space used for the THL files:

- The staging directory containing the core installation is approximately 150MB. When performing a staging-directory based installation, this space requirement will be used once. When using a INI-file based deployment, this space will be required on each server. For more information on the different methods, see Section 10.1, “Comparing Staging and `INI` tpm Methods”.

- Deployment of a live installation also requires approximately 150MB.

- The THL files required for installation are based on the size of the binary logs generated by MySQL. THL size is typically twice the size of the binary log. This space will be required on each machine in the cluster. The retention times and rotation of THL data can be controlled, see Section D.1.5, “The `thl` Directory” for more information, including how to change the retention time and move files during operation.

A dedicated partition for THL and/or Tungsten Software is recommended to ensure that a full disk does not impact your OS or DBMS. Local disk, SAN, iSCSI and AWS EBS are suitable for storing THL. NFS is NOT recommended.

Because the replicator reads and writes information using buffered I/O in a serial fashion, there is no random-access or seeking.

2.2.5. Java Requirements

All components of Tungsten are certified with Java using the following versions:

- Oracle JRE 8
-
- OpenJDK 8
-
-

Important

There are a number of known issues in earlier Java revisions that may cause performance degradation, high CPU, and/or component hangs, specifically when SSL is enabled. It is strongly advised that you ensure your Java version is one of the following MINIMUM releases:

- Oracle JRE 8 Build 261
- OpenJDK 8 Build 222

All versions from 8u265, excluding version 13 onwards, contain a bug that can trigger unusually high CPU and/or system timeouts and hangs within the SSL protocol. To avoid this, you should add the following entry to the `wrapper.conf` file for all relevant components. This will be included by default from version 6.1.15 onwards of all Tungsten products.

`wrapper.conf` can be found in the following path *`{INSTALLDIR}`*/tungsten/tungsten-*`component`*/conf, for example: `/opt/continuent/tungsten/tungsten-manager/conf`

```
wrapper.java.additional.{next available number}=-Djdk.tls.acknowledgeCloseNotify=true
```

For example:

```
wrapper.java.additional.16=-Djdk.tls.acknowledgeCloseNotify=true
```

After editing the file, each component will need restarting

2.2.6. Cloud Deployment Requirements

Cloud deployments require a different set of considerations over and above the general requirements. The following is a guide only, and where specific cloud environment requirements are known, they are explicitly included:

Instance Types/Configuration

Attribute	Guidance	Amazon Example
Instance Type	Instance sizes and types are dependent on the workload, but larger instances are recommended for transactional databases.	`m4.xlarge` or better
Instance Boot Volume	Use block, not ephemeral storage.	EBS
Instance Deployment	Use standard Linux distributions and bases. For ease of deployment and configuration, the use of Ansible, Puppet or other script based solutions could be used.	Amazon Linux AMIs

Development/QA nodes should always match the expected production environment.

AWS/EC2 Deployments

- Use Virtual Private Cloud (VPC) deployments, as these provide consistent IP address support.
- When using Active Witnesses, a `micro` instance can be used for a single cluster. For composite clusters, an instance size larger than `micro` must be used.
- Multiple EBS-optimized volumes for data, using Provisioned IOPS for the EBS volumes depending on workload:

Parameter	tpm Option	tpm Value	MySQL `my.cnf` Option	MySQL Value
`/` (root)				
MySQL Data	`datasource-mysql-data-directory` [443]	`/volumes/mysql/data`	`datadir`	`/volumes/mysql/data`
MySQL Binary Logs	`datasource-log-directory` [442]	`/volumes/mysql/binlogs`	`log-bin`	`/volumes/mysql/binlogs/mysql-bin`
Transaction History Logs (THL)	`thl-directory` [469]	`/volumes/mysql/thl`		

Recommended Replication Formats

- `MIXED` is recommended for MySQL Primary/Replica topologies (e.g., either single clusters or primary/data-recovery setups).
- `ROW` is strongly recommended for Composite Active/Active setups. Without `ROW`, data drift is a possible problem when using `MIXED` or `STATEMENT`. Even with `ROW` there are still cases where drift is possible but the window is far smaller.

2.2.7. Docker Support Policy

2.2.7.1. Overview

Continuent has traditionally had a relaxed policy about Linux platform support for customers using our products.

While it is possible to install and run Continuent Tungsten products (i.e. Clustering/Replicator/etc.) inside Docker containers, there are many reasons why this is not a good idea.

2.2.7.2. Background

As background, every database node in a Tungsten Cluster runs at least three (3) layers or services:

- MySQL Server (i.e. MySQL Community or Enterprise, MariaDB or Percona Server)
- Tungsten Manager, which handles health-checking, signaling and failover decisions (Java-based)
- Tungsten Replicator, which handles the movement of events from the MySQL Primary server binary logs to the Replica databases nodes (Java-based)

Optionally, a fourth service, the Tungsten Connector (Java-based), may be installed as well, and often is.

2.2.7.3. Current State

As such, this means that the Docker container would also need to support these 3 or 4 layers and all the resources needed to run them.

This is not what containers were designed to do. In a proper containerized architecture, each container would contain one single layer of the operation, so there would be 3-4 containers per "node". This sort of architecture is best managed by some underlying technology like Swarm, Kubernetes, or Mesos.

More reasons to avoid using Docker containers with Continuent Tungsten solutions:

- Our product is designed to run on a full Linux OS. By design Docker does not have a full init system like SystemD, SysV init, Upstart, etc... This means that if we have a process (Replicator, Manager, Connector, etc...) that process will run as PID 1. If this process dies the container will die. There are some solutions that let a Docker container to have a 'full init' system so the container can start more processes like ssh, replicator, manager, ... all at once. However this is almost a heavyweight VM kind of behavior, and Docker wasn't designed this way.
- Requires a mutable container – to use Tungsten Clustering inside a Docker container, the Docker container must be launched as a mutable Linux instance, which is not the classic, nor proper way to use containers.
- Our services are not designed as "serverless". Serverless containers are totally stateless. Tungsten Cluster and Tungsten Replicator do not support this type of operation.
- Until we make the necessary changes to our software, using Docker as a cluster node results in a minimum 1.2GB docker image.
- Once Tungsten Cluster and Tungsten Replicator have been refactored using a microservices-based architecture, it will be much easier to scale our solution using containers.
- A Docker container would need to allow for updates in order for the Tungsten Cluster and Tungsten Replicator software to be re-configured as needed. Otherwise, a new Docker container would need to be launched every time a config change was required.
- There are known i/o and resource constraints for Docker containers, and therefore must be carefully deployed to avoid those pitfalls.
- We test on CentOS-derived Linux platforms.

2.2.7.4. Summary

In closing, Continuent's position on container support is as follows:

- Unsupported at this time for all products (i.e. Clustering/Replicator/etc.)
- Use at your own risk

2.3. Deployment Sources

Tungsten Cluster is available in a number of different distribution types, and the methods for configuration available for these different packages differs. See Section 10.1, "Comparing Staging and INI tpm Methods" for more information on the available installation methods.

Deployment Type/Package	TAR/GZip	RPM
Staging Installation	Yes	No
INI File Configuration	Yes	Yes
Deploy Entire Cluster	Yes	No
Deploy Per Machine	Yes	Yes

Two primary deployment sources are available:

- Tar/GZip

  Using the TAR/GZip package creates a local directory that enables you to perform installs and updates from the extracted 'staging' directory, or use the INI file format.

- RPM Packages

  Using the RPM package format is more suited to using the INI file format, as hosts can be installed and upgraded to the latest RPM package independently of each other.

All packages are named according to the product, version number, build release and extension. For example:

```
tungsten-clustering-5.4.1-41.tar.gz
```

The version number is `5.4.1` and build number `41`. Build numbers indicate which build a particular release version is based on, and may be useful when installing patches provided by support.

2.3.1. Using the TAR/GZipped files

To use the TAR/GZipped packages, download the files to your machine and unpack them:

```
shell> cd /opt/continuent/software
shell> tar zxf tungsten-clustering-5.4.1-41.tar.gz
```

This will create a directory matching the downloaded package name, version, and build number from which you can perform an install using either the INI file or command-line configuration. To use, you will need to use the tpm command within the `tools` directory of the extracted package:

```
shell> cd tungsten-clustering-5.4.1-41
```

2.3.2. Using the RPM package files

The RPM packages can be used for installation, but are primarily designed to be in combination with the INI configuration file.

Installation

Installing the RPM package will do the following:

1. Create the `tungsten` system user if it doesn't exist
2. Make the `tungsten` system user part of the `mysql` group if it exists
3. Create the `/opt/continuent/software` directory
4. Unpack the software into `/opt/continuent/software`
5. Define the `$CONTINUENT_PROFILES` and `$REPLICATOR_PROFILES` environment variables
6. Update the profile script to include the `/opt/continuent/share/env.sh` script
7. Create the `/etc/tungsten` directory
8. Run tpm install if the `/etc/tungsten.ini` or `/etc/tungsten/tungsten.ini` file exists

Although the RPM packages complete a number of the pre-requisite steps required to configure your cluster, there are additional steps, such as configuring ssh, that you still need to complete. For more information, see Appendix B, *Prerequisites*.

By using the package files you are able to setup a new server by creating the `/etc/tungsten.ini` file and then installing the package. Any output from the tpm command will go to `/opt/continuent/service_logs/rpm.output`.

> **Note**
>
> If you download the package files directly, you may need to add the signing key to your environment before the package will load properly.
>
> For yum platforms (RHEL/CentOS/Amazon Linux), the rpm command is used :
>
> ```
> root-shell> rpm --import http://www.continuent.com/RPM-GPG-KEY-continuent
> ```
>
> For Ubuntu/Debian platforms, the gpg command is used :

```
root-shell> gpg --keyserver keyserver.ubuntu.com --recv-key 7206c924
```

Upgrades

If you upgrade to a new version of the RPM package it will do the following:

1. Unpack the software into `/opt/continuent/software`
2. Run tpm update if the `/etc/tungsten.ini` or `/etc/tungsten/tungsten.ini` file exists

The tpm update will restart all Continuent Tungsten services so you do not need to do anything after upgrading the package file.

2.4. Common tpm Options During Deployment

There are a variety of tpm options that can be used to alter some aspect of the deployment during configuration. Although they might not be provided within the example deployments, they may be used or required for different installation environments. These include options such as altering the ports used by different components, or the commands and utilities used to monitor or manage the installation once deployment has been completed. Some of the most common options are included within this section.

Changes to the configuration should be made with tpm update. This continues the procedure of using tpm install during installation. See Section 10.5.16, “tpm update Command” for more information on using tpm update.

- `--datasource-systemctl-service` [443]

  On some platforms and environments the command used to manage and control the MySQL or MariaDB service is handled by a tool other than the services or /etc/init.d/mysql commands.

  Depending on the system or environment other commands using the same basic structure may be used. For example, within CentOS 7, the command is systemctl. You can explicitly set the command to be used by using the `--datasource-systemctl-service` [443] to specify the name of the tool.

  The format of the corresponding command that will be used is expected to follow the same format as previous commands, for example to start the database service::

  ```
  shell> systemctl mysql stop
  ```

  Different commands must follow the same basic structure, the command configured by `--datasource-systemctl-service` [443], the service-name, and the status (i.e. `stop`).

2.5. Best Practices

A successful deployment depends on being mindful during deployment, operations and ongoing maintenance.

2.5.1. Best Practices: Deployment

- Identify the best deployment method for your environment and use that in production and testing. See Section 10.1, “Comparing Staging and INI tpm Methods”.
- Standardize the OS and database prerequisites. There are Ansible modules available for immediate use within AWS, or as a template for modifications.

  More information on the Ansible method is available in this blog article.
- Ensure that the output of the `hostname`command and the nodename entries in the Tungsten configuration match exactly prior to installing Tungsten.

  The configuration keys that define nodenames are: `--slaves` [466], `--dataservice-slaves` [466], `--members` [455], `--master` [454], `--dataservice-master-host` [454], `--masters` [454] and `--relay` [454]
- For security purposes you should ensure that you secure the following areas of your deployment:
  - Ensure that you create a unique installation and deployment user, such as tungsten, and set the correct file permissions on installed directories. See Section B.2.3, “Directory Locations and Configuration”.
  - When using ssh and/or SSL, ensure that the ssh key or certificates are suitably protected. See Section B.2.2.2, “SSH Configuration”.
  - Use a firewall, such as iptables to protect the network ports that you need to use. The best solution is to ensure that only known hosts can connect to the required ports for Tungsten Cluster. For more information on the network ports required for Tungsten Cluster operation, see Section B.2.2.1, “Network Ports”.

- If possible, use authentication and SSL connectivity between hosts to protext your data and authorisation for the tools used in your deployment.

  See Chapter 5, *Deployment: Security* for more information.

- Choose your topology from the deployment section and verify the configuration matches the basic settings. Additional settings may be included for custom features but the basics are needed to ensure proper operation. If your configuration is not listed or does not match our documented settings; we cannot guarantee correct operation.
- If there are an even number of database servers in the cluster, configure the cluster with a witness host. An active witness is preferred but a passive one will ensure stability. See Section 2.1.4, "Witness Hosts" for an explanation of the differences and how to configure them.
- If you are using `ROW` replication, any triggers that run additional `INSERT`/`UPDATE`/`DELETE` operations must be updated so they do not run on the Replica servers.
- Make sure you know the structure of the Tungsten Cluster home directory and how to initialize your environment for administration. See Section 6.1, "The Home Directory" and Section 6.2, "Establishing the Shell Environment".
- Prior to migrating applications to Tungsten Cluster test failover and recovery procedures from Chapter 6, *Operations Guide*. Be sure to try recovering a failed Primary and reprovisioning failed Replicas.
- When deciding on the Service Name for your configurations, keep them simple and short and only use alphanumerics [Aa-Zz,0-9] and underscores [_].

2.5.2. Best Practices: Upgrade

In this section we identify the best practices for performing a Tungsten Software upgrade.

- Identify the deployment method chosen for your environment, Staging or INI. See Section 10.1, "Comparing Staging and `INI` tpm Methods".
- The best practice for Tungsten software is to upgrade All-at-Once, performing zero Primary switches.
- The Staging deployment method automatically does an All-at-Once upgrade - this is the basic design of the Staging method.
- For an INI upgrade, there are two possible ways, One-at-a-Time [with at least one Primary switch], and All-at-Once [no switches at all].
- See Section 10.4.3, "Upgrades with an INI File" for more information.
- Here is the sequence of events for a proper Tungsten upgrade on a 3-node cluster with the INI deployment method:
  - Login to the Customer Downloads Portal and get the latest version of the software.
  - Copy the file [i.e. `tungsten-clustering-7.0.2-161.tar.gz`] to each host that runs a Tungsten component.
  - Set the cluster to policy `MAINTENANCE`
  - On every host:
    - Extract the tarball under /opt/continuent/software/ [i.e. create `/opt/continuent/software/tungsten-clustering-7.0.2-161`]
    - cd to the newly extracted directory
    - Run the Tungsten Package Manager tool, tools/tpm update --replace-release
  - For example, here are the steps in order:

```
On ONE database node:
shell> cctrl
cctrl> set policy maintenance
cctrl> exit

On EVERY Tungsten host at the same time:
shell> cd /opt/continuent/software
shell> tar xvzf tungsten-clustering-7.0.2-161.tar.gz
shell> cd tungsten-clustering-7.0.2-161

To perform the upgrade and restart the Connectors gracefully at the same time:
shell> tools/tpm update --replace-release

To perform the upgrade and delay the restart of the Connectors to a later time:
shell> tools/tpm update --replace-release --no-connectors
When it is time for the Connector to be promoted to the new version, perhaps after taking it out of the load balancer:
shell> tpm promote-connector
```

```
When all nodes are done, on ONE database node:
shell> cctrl
cctrl> set policy automatic
cctrl> exit
```

WHY is it ok to upgrade and restart everything all at once?

Let's look at each component to examine what happens during the upgrade, starting with the Manager layer.

Once the cluster is in Maintenance mode, the Managers cease to make changes to the cluster, and therefore Connectors will not reroute traffic either.

Since Manager control of the cluster is passive in Maintenance mode, it is safe to stop and restart all Managers - there will be zero impact to the cluster operations.

The Replicators function independently of client MySQL requests (which come through the Connectors and go to the MySQL database server), so even if the Replicators are stopped and restarted, there should be only a small window of delay while the replicas catch up with the Primary once upgraded. If the Connectors are reading from the Replicas, they may briefly get stale data if not using SmartScale.

Finally, when the Connectors are upgraded they must be restarted so the new version can take over. As discussed in this blog post, Zero-Downtime Upgrades, the Tungsten Cluster software upgrade process will do two key things to help keep traffic flowing during the Connector upgrade promote step:

- Execute `connector graceful-stop 30`to gracefully drain existing connections and prevent new connections.
- Using the new software version, initiate the start/retry feature which launches a new connector process while another one is still bound to the server socket. The new Connector process will wait for the socket to become available by retrying binding every 200ms by default (which is tunable), drastically reducing the window for application connection failures.

2.5.3. Best Practices: Operations

- Setup proper monitoring for all servers as described in Section 6.16, "Monitoring Tungsten Cluster".
- Configure the Tungsten Cluster services to startup and shutdown along with the server. See Section 4.3, "Configuring Startup on Boot".
- Schedule the Section 9.8, "The cluster_backup Command" tool on each database server at least each night. The script will take a backup of at least one server. Skip this step if you have another backup method scheduled that takes consistent snapshots of your server.

2.5.4. Best Practices: Maintenance

- Your license allows for a testing cluster. Deploy a cluster that matches your production cluster and test all operations and maintenance operations there.
- Schedule regular tests for local and DR failover. This should at least include switching the Primary server to another host in the local cluster. If possible, the DR cluster should be tested once per quarter.
- Disable any automatic operating system patching processes. The use of automatic patching will cause issues when all database servers automatically restart without coordination. See Section 6.14.3, "Performing Maintenance on an Entire Dataservice".
- Regularly check for maintenance releases and upgrade your environment. Every version includes stability and usability fixes to ease the administrative process.

Chapter 3. Deployment: MySQL Topologies

Creating a Tungsten Clustering (for MySQL) Dataservice using Tungsten Cluster combines a number of different components, systems, and functionality, to support a running database dataservice that is capable of handling database failures, complex replication topologies, and management of the client/database connection for both load balancing and failover scenarios.

How you choose to deploy depends on your requirements and environment. All deployments operate through the tpm command. tpm operates in two different modes:

- tpm staging configuration — a tpm configuration is created by defining the command-line arguments that define the deployment type, structure and any additional parameters. tpm then installs all the software on all the required hosts by using ssh to distribute Tungsten Cluster and the configuration, and optionally automatically starts the services on each host. tpm manages the entire deployment, configuration and upgrade procedure.

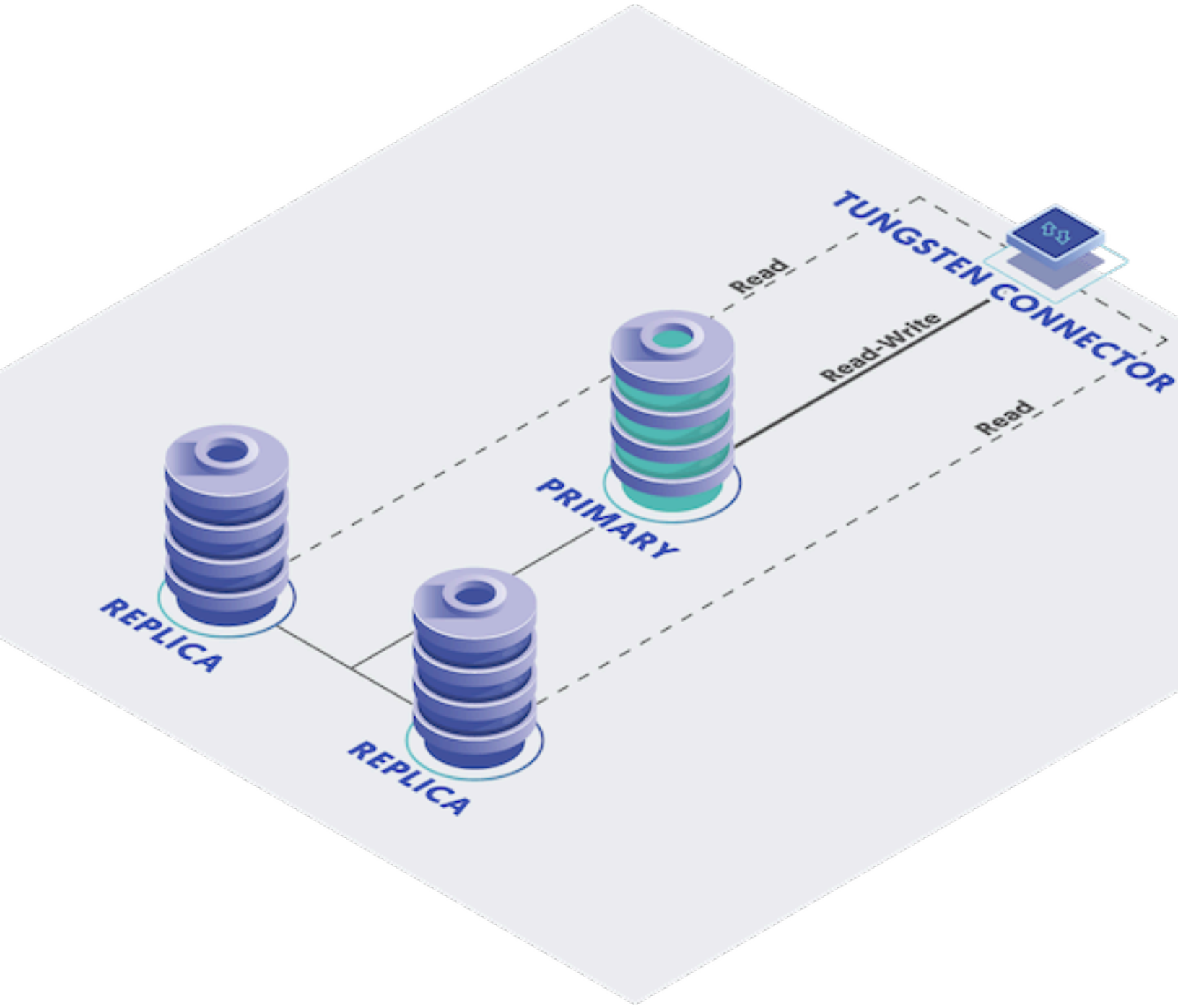
- tpm `INI` configuration — tpm uses an `INI` to configure the service on the local host. The `INI` file must be create on each host that will be part of the cluster. tpm only manages the services on the local host; in a multi-host deployment, upgrades, updates, and configuration must be handled separately on each host.

The following sections provide guidance and instructions for creating a number of different deployment scenarios using Tungsten Cluster.

3.1. Deploying Standalone HA Clusters

Within a Primary/Replica service, there is a single Primary which replicates data to the Replicas. The Tungsten Connector handles connectivity by the application and distributes the load to the datasources in the dataservice.

Figure 3.1. Topologies: Standalone HA Cluster



3.1.1. Prepare: Standalone HA Cluster

Before continuing with deployment you will need the following:

1. The name to use for the cluster.
2. The list of datasources in the cluster. These are the servers which will be running MySQL.
3. The list of servers that will run the connector.
4. The username and password of the MySQL replication user.

5. The username and password of the first application user. You may add more users after installation.

All servers must be prepared with the proper prerequisites. See Appendix B, *Prerequisites* for additional details.

3.1.2. Install: Standalone HA Cluster

1. Install the Tungsten Cluster package or download the Tungsten Cluster tarball, and unpack it:

```
shell> cd /opt/continuent/software
shell> tar zxf tungsten-clustering-5.4.1-41.tar.gz
```

2. Change to the Tungsten Cluster directory:

```
shell> cd tungsten-clustering-5.4.1-41
```

3. Run tpm to perform the installation, using either the staging method or the INI method. Review Section 10.1, "Comparing Staging and INI tpm Methods" for more details on these two methods.

   Click the link below to switch examples between Staging and INI methods

   Show Staging

   Show INI

```
shell> ./tools/tpm configure defaults \
    --reset \
    --user=tungsten \
    --install-directory=/opt/continuent \
    --profile-script=~/.bash_profile \
    --replication-user=tungsten \
    --replication-password=password \
    --replication-port=13306 \
    --application-user=app_user \
    --application-password=secret \
    --application-port=3306 \
    --rest-api-admin-user=apiuser \
    --rest-api-admin-pass=secret

shell> ./tools/tpm configure alpha \
    --topology=clustered \
    --master=host1 \
    --members=host1,host2,host3 \
    --connectors=host4
```

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[defaults]
user=tungsten
install-directory=/opt/continuent
profile-script=~/.bash_profile
replication-user=tungsten
replication-password=password
replication-port=13306
application-user=app_user
application-password=secret
application-port=3306
rest-api-admin-user=apiuser
rest-api-admin-pass=secret

[alpha]
topology=clustered
master=host1
members=host1,host2,host3
connectors=host4
```

   Configuration group **defaults**

   The description of each of the options is shown below; click the icon to hide this detail:

   Click the icon to show a detailed description of each argument.

   - `--reset` [464]

     `reset` [464]

     For staging configurations, deletes all pre-existing configuration information between updating with the new configuration values.

   - `--user=tungsten` [471]

`user=tungsten` [471]

System User

- `--install-directory=/opt/continuent` [450]

  `install-directory=/opt/continuent` [450]

  Path to the directory where the active deployment will be installed. The configured directory will contain the software, THL and relay log information unless configured otherwise.

- `--profile-script=~/.bash_profile` [461]

  `profile-script=~/.bash_profile` [461]

  Append commands to include env.sh in this profile script

- `--replication-user=tungsten` [464]

  `replication-user=tungsten` [464]

  For databases that required authentication, the username to use when connecting to the database using the corresponding connection method (native, JDBC, etc.).

- `--replication-password=password` [463]

  `replication-password=password` [463]

  The password to be used when connecting to the database using the corresponding `--replication-user` [464].

- `--replication-port=13306` [463]

  `replication-port=13306` [463]

  The network port used to connect to the database server. The default port used depends on the database being configured.

- `--application-user=app_user` [433]

  `application-user=app_user` [433]

  Database username for the connector

- `--application-password=secret` [432]

  `application-password=secret` [432]

  Database password for the connector

- `--application-port=3306` [432]

  `application-port=3306` [432]

  Port for the connector to listen on

- `--rest-api-admin-user=apiuser`

  `rest-api-admin-user=apiuser`
  Optional: Must be specified along with rest-api-admin-pass if you wish to access the full API features and use the Dashboard GUI for cluster installations.

- `--rest-api-admin-pass=secret`

  `rest-api-admin-pass=secret`
  Optional: Must be specified along with rest-api-admin-user if you wish to access the full API features.

Configuration group **`alpha`**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--topology=clustered` [470]

`topology=clustered` [470]

Replication topology for the dataservice.

- `--master=host1` [454]

  `master=host1` [454]

  The hostname of the primary (extractor) within the current service.

- `--members=host1,host2,host3` [455]

  `members=host1,host2,host3` [455]

  Hostnames for the dataservice members

- `--connectors=host4` [440]

  `connectors=host4` [440]

  Hostnames for the dataservice connectors

Run tpm to install the software with the configuration.

```
shell > ./tools/tpm install
```

During the startup and installation, tpm will notify you of any problems that need to be fixed before the service can be correctly installed and started. If the service starts correctly, you should see the configuration and current status of the service.

4. Initialize your `PATH` and environment.

```
shell > source /opt/continuent/share/env.sh
```

> **Important**
>
> Do not include `start-and-report` [466] if you are taking over for MySQL native replication. See Section 3.9.1, “Migrating from MySQL Native Replication 'In-Place'” for next steps after completing installation.

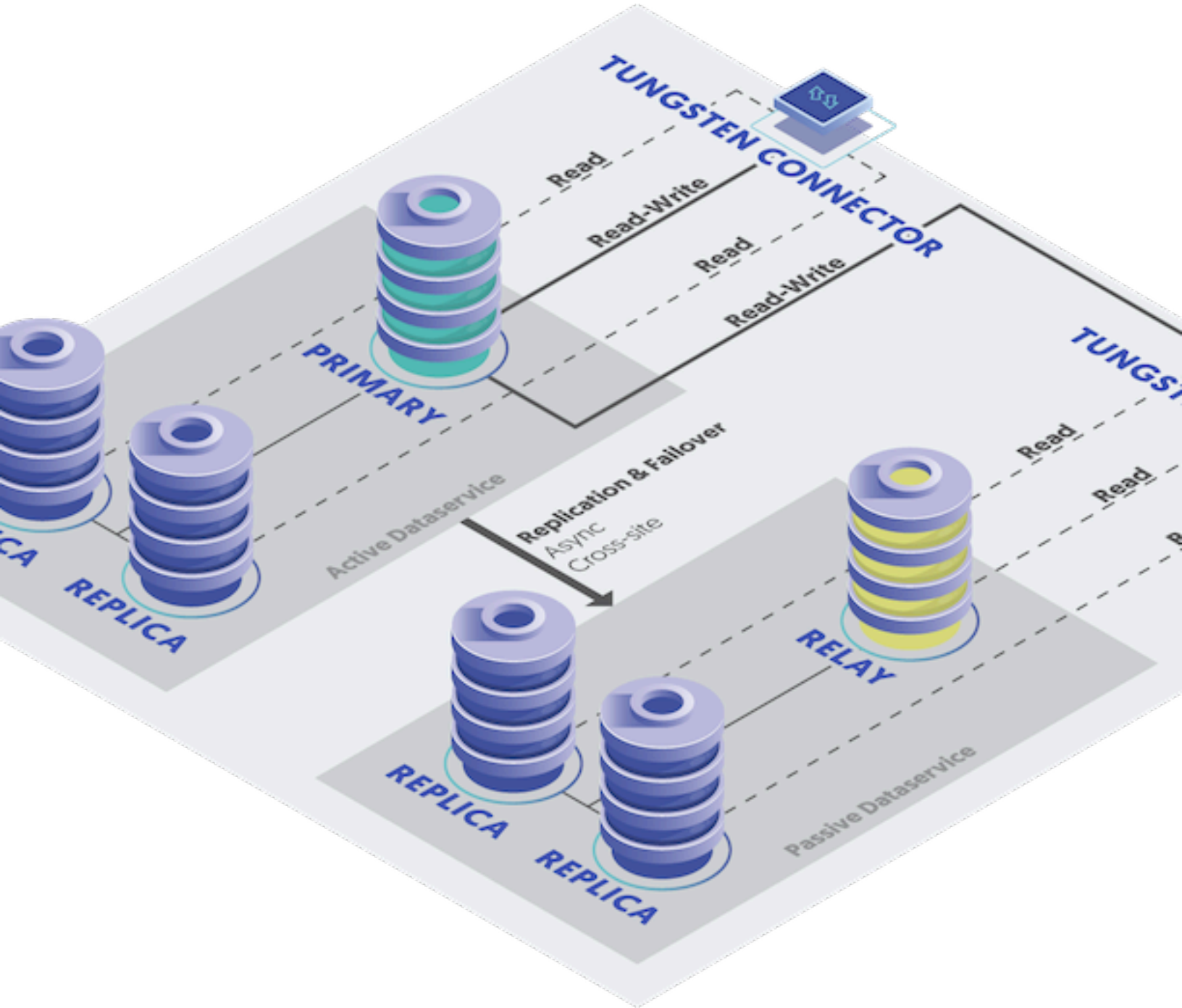
3.1.3. Best Practices: Standalone HA Cluster

Follow the guidelines in Section 2.5, “Best Practices”.

3.2. Deploying Composite Active/Passive Clustering

Tungsten Cluster supports the creation of composite clusters. This includes multiple active/passive dataservices tied together. One of the dataservices is identified as the active, containing the Primary node and all other dataservices (passive) replicate from it.

Figure 3.2. Topologies: Composite Active/Passive Cluster



3.2.1. Prepare: Composite Active/Passive Cluster

Before continuing with deployment you will need the following:

1. The cluster name for each Active/Passive Cluster and a Composite cluster name to group them.
2. The list of datasources in each cluster. These are the servers which will be running MySQL.
3. The list of servers that will run the connector. Each connector will be associated with a preferred cluster but will have access to the Primary regardless of location.

4. The username and password of the MySQL replication user.
5. The username and password of the first application user. You may add more users after installation.

All servers must be prepared with the proper prerequisites. See Appendix B, *Prerequisites* for additional details.

3.2.2. Install: Composite Active/Passive Cluster

1. Install the Tungsten Cluster package or download the Tungsten Cluster tarball, and unpack it:

```
shell> cd /opt/continuent/software
shell> tar zxf tungsten-clustering-5.4.1-41.tar.gz
```

2. Change to the Tungsten Cluster directory:

```
shell> cd tungsten-clustering-5.4.1-41
```

3. Run tpm to perform the installation. This method assumes you are using the Section 10.3, "tpm Staging Configuration" method:

   Click the link below to switch examples between Staging and INI methods

   Show Staging

   Show INI

```
shell> ./tools/tpm configure defaults \
    --reset \
    --user=tungsten \
    --install-directory=/opt/continuent \
    --profile-script=~/.bash_profile \
    --replication-user=tungsten \
    --replication-password=secret \
    --replication-port=13306 \
    --application-user=app_user \
    --application-password=secret \
    --application-port=3306 \
    --rest-api-admin-user=apiuser \
    --rest-api-admin-pass=secret

shell> ./tools/tpm configure alpha \
    --topology=clustered \
    --master=host1.alpha \
    --members=host1.alpha,host2.alpha,host3.alpha \
    --connectors=host1.alpha,host2.alpha,host3.alpha

shell> ./tools/tpm configure beta \
    --topology=clustered \
    --relay=host1.beta \
    --members=host1.beta,host2.beta,host3.beta \
    --connectors=host1.beta,host2.beta,host3.beta \
    --relay-source=alpha

shell> ./tools/tpm configure gamma \
    --composite-datasources=alpha,beta
```

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[defaults]
user=tungsten
install-directory=/opt/continuent
profile-script=~/.bash_profile
replication-user=tungsten
replication-password=secret
replication-port=13306
application-user=app_user
application-password=secret
application-port=3306
rest-api-admin-user=apiuser
rest-api-admin-pass=secret

[alpha]
topology=clustered
master=host1.alpha
members=host1.alpha,host2.alpha,host3.alpha
connectors=host1.alpha,host2.alpha,host3.alpha

[beta]
topology=clustered
relay=host1.beta
members=host1.beta,host2.beta,host3.beta
connectors=host1.beta,host2.beta,host3.beta
```

```
relay-source=alpha

[gamma]
composite-datasources=alpha,beta
```

Configuration group `defaults`

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--reset` [464]

  `reset` [464]

  For staging configurations, deletes all pre-existing configuration information between updating with the new configuration values.

- `--user=tungsten` [471]

  `user=tungsten` [471]

  System User

- `--install-directory=/opt/continuent` [450]

  `install-directory=/opt/continuent` [450]

  Path to the directory where the active deployment will be installed. The configured directory will contain the software, THL and relay log information unless configured otherwise.

- `--profile-script=~/.bash_profile` [461]

  `profile-script=~/.bash_profile` [461]

  Append commands to include env.sh in this profile script

- `--replication-user=tungsten` [464]

  `replication-user=tungsten` [464]

  For databases that required authentication, the username to use when connecting to the database using the corresponding connection method (native, JDBC, etc.).

- `--replication-password=secret` [463]

  `replication-password=secret` [463]

  The password to be used when connecting to the database using the corresponding `--replication-user` [464].

- `--replication-port=13306` [463]

  `replication-port=13306` [463]

  The network port used to connect to the database server. The default port used depends on the database being configured.

- `--application-user=app_user` [433]

  `application-user=app_user` [433]

  Database username for the connector

- `--application-password=secret` [432]

  `application-password=secret` [432]

  Database password for the connector

- `--application-port=3306` [432]

  `application-port=3306` [432]

  Port for the connector to listen on

- `--rest-api-admin-user=apiuser`

  `rest-api-admin-user=apiuser`
  Optional: Must be specified along with rest-api-admin-pass if you wish to access the full API features and use the Dashboard GUI for cluster installations.

- `--rest-api-admin-pass=secret`

  `rest-api-admin-pass=secret`
  Optional: Must be specified along with rest-api-admin-user if you wish to access the full API features.

Configuration group **`alpha`**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--topology=clustered` [470]

  `topology=clustered` [470]

  Replication topology for the dataservice.

- `--master=host1.alpha` [454]

  `master=host1.alpha` [454]

  The hostname of the primary (extractor) within the current service.

- `--members=host1.alpha,host2.alpha,host3.alpha` [455]

  `members=host1.alpha,host2.alpha,host3.alpha` [455]

  Hostnames for the dataservice members

- `--connectors=host1.alpha,host2.alpha,host3.alpha` [440]

  `connectors=host1.alpha,host2.alpha,host3.alpha` [440]

  Hostnames for the dataservice connectors

Configuration group **`beta`**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--topology=clustered` [470]

  `topology=clustered` [470]

  Replication topology for the dataservice.

- `--relay=host1.beta` [454]

  `relay=host1.beta` [454]

  The hostname of the primary (extractor) within the current service.

- `--members=host1.beta,host2.beta,host3.beta` [455]

  `members=host1.beta,host2.beta,host3.beta` [455]

  Hostnames for the dataservice members

- `--connectors=host1.beta,host2.beta,host3.beta` [440]

  `connectors=host1.beta,host2.beta,host3.beta` [440]

  Hostnames for the dataservice connectors

- `--relay-source=alpha` [463]

`relay-source=alpha` [463]

Dataservice name to use as a relay source

Configuration group `gamma`

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--composite-datasources=alpha,beta` [436]

  `composite-datasources=alpha,beta` [436]

  Data services that should be added to this composite data service

Run tpm to install the software with the configuration.

```
shell > ./tools/tpm install
```

During the startup and installation, tpm will notify you of any problems that need to be fixed before the service can be correctly installed and started. If the service starts correctly, you should see the configuration and current status of the service.

4. Initialize your `PATH` and environment.

```
shell > source /opt/continuent/share/env.sh
```

The Composite Active/Passive Cluster should be installed and ready to use.

3.2.3. Best Practices: Composite Active/Passive Cluster

Follow the guidelines in Section 2.5, “Best Practices”.

3.2.4. Adding a remote Composite Cluster

Adding an entire new cluster provides significant level of availability and capacity. The new cluster nodes that form the cluster will be fully aware of the original cluster(s) and communicate with existing managers and datasources within the cluster.

The following steps guide you through updating the configuration to include the new hosts and services you are adding.

1. On the new host(s), ensure the Appendix B, *Prerequisites* have been followed.

2. Let's assume that we have a composite cluster dataservice called `global` with two clusters, `east` and `west`, with three nodes each.

   In this worked exmple, we show how to add an additional cluster service called `north` with three new nodes.

3. Set the cluster to maintenance mode using cctrl:

```
shell> cctrl
[LOGICAL] / > use global
[LOGICAL] /global > set policy maintenance
```

4. Using the following as an example, update the configuration to include the new cluster and update the additional composite service block. If using an INI installation copy the ini file to all the new nodes in the new cluster.

   Click the link to switch between staging or ini examples

   Show Staging

   Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
```

```
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure north \
    --connectors=db7,db8,db9 \
    --relay-source=east \
    --relay=db7 \
    --slaves=db8,db9 \
    --topology=clustered

shell> ./tools/tpm configure global \
    --composite-datasources=east,west,north
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update --no-connectors --replace-release
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[north]
...
connectors=db7,db8,db9
relay-source=east
relay=db7
slaves=db8,db9
topology=clustered

[global]
...
composite-datasources=east,west,north
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update --no-connectors --replace-release
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

5. Using the `--no-connectors` [459] option updates the current deployment without restarting the existing connectors.

6. If installed via INI, on all nodes in the new cluster, download and unpack the software, and install

```
shell> cd /opt/continunent/software
shell> tar zxvf tungsten-clustering-5.4.1-41.tar.gz
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> tools/tpm install
```

7. On every node in the original clusters, make sure all replicators are online:

```
shell> trepctl online; trepctl services
```

8. On all nodes in the new cluster start the software

```
shell> startall
```

9. The next steps will involve provisioning the new cluster nodes. An alternative approach to using this method would be to take a backup of a Replica from the existing cluster, and manually restoring it to ALL nodes in the new cluster PRIOR to issuing the install step above. If you take this approach then you can skip the next two re-provision steps.

10. Go to the relay (Primary) node of the new cluster (i.e. db7) and provision it from any Replica in the original cluster (i.e. db2):

```
shell> tungsten_provision_slave --source db2
```

11. Go to a Replica node of the new cluster (i.e. db8) and provision it from the relay node of the new cluster (i.e. db7):

```
shell> tungsten_provision_slave --source db7
```

12. Repeat the process for the renamining Replicas nodes in the new cluster.

13. Set the composite cluster to automatic mode using cctrl:

```
shell> cctrl
[LOGICAL] / > use global
[LOGICAL] /global > set policy automatic
```

14. During a period when it is safe to restart the connectors:

```
shell> ./tools/tpm promote-connector
```

3.3. Deploying Multi-Site/Active-Active Clustering

Note

The procedures in this section are designed for the Multi-Site/Active-Active topology ONLY. Do NOT use these procedures for Composite Active/Active Clustering using v6 onwards.

For version 6.x onwards, Composite Active/Active Clustering, please refer to Deploying Composite Active/Active Clustering.

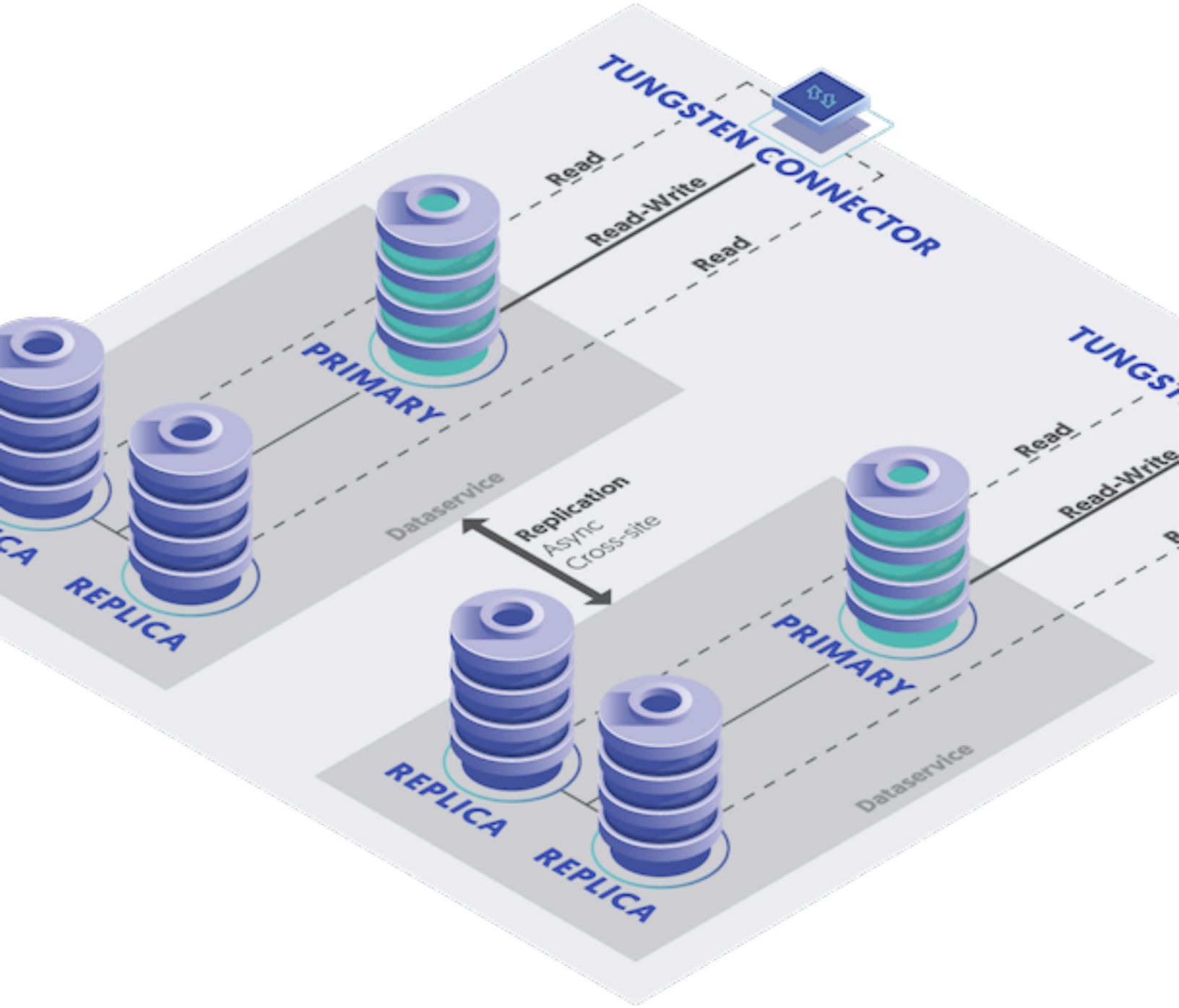
A Multi-Site/Active-Active topology provides all the benefits of a typical dataservice at a single location, but with the benefit of also replicating the information to another site. The underlying configuration within Tungsten Cluster uses the Tungsten Replicator which enables operation between the two sites.

The configuration is in two separate parts:

- Tungsten Cluster dataservice that operates the main dataservice service within each site.
- Tungsten Replicator dataservice that provides replication between the two sites; one to replicate from site1 to site2, and one for site2 to site1.

A sample display of how this operates is provided in Figure 3.3, “Topologies: Multi-Site/Active-Active Clusters”.

Figure 3.3. Topologies: Multi-Site/Active-Active Clusters



The service can be described as follows:

- Tungsten Cluster Service: east

  Replicates data between east1, east2 and east3 (not shown).

- Tungsten Cluster Service: west

  Replicates data between west1, west2 and west3 (not shown).

- Tungsten Replicator Service: east

Defines the replication of data within east as a replicator service using Tungsten Replicator. This service reads from all the hosts within the Tungsten Cluster service `east` and writes to `west1`, `west2`, and `west3`. The service name is the same to ensure that we do not duplicate writes from the clustered service already running.

Data is read from the `east` Tungsten Cluster and replicated to the `west` Tungsten Cluster dataservice. The configuration allows for changes in the Tungsten Cluster dataservice (such as a switch or failover) without upsetting the site-to-site replication.

- Tungsten Replicator Service: west

  Defines the replication of data within west as a replicator service using Tungsten Replicator. This service reads from all the hosts within the Tungsten Cluster service `west` and writes to `east1`, `east2`, and `east3`. The service name is the same to ensure that we do not duplicate writes from the clustered service already running.

  Data is read from the `west` Tungsten Cluster and replicated to the `east` Tungsten Cluster dataservice. The configuration allows for changes in the Tungsten Cluster dataservice (such as a switch or failover) without upsetting the site-to-site replication.

- Tungsten Replicator Service: east_west

  Replicates data from East to West, using Tungsten Replicator. This is a service alias that defines the reading from the dataservice (as an trext;) to other servers within the destination cluster.

- Tungsten Replicator Service: west_east

  Replicates data from West to East, using Tungsten Replicator. This is a service alias that defines the reading from the dataservice (as an trext;) to other servers within the destination cluster.

Requirements. Recommended releases for Multi-Site/Active-Active deployments are Tungsten Cluster 5.4.x and Tungsten Replicator 5.4.x however this topology can also be installed with the later v6+ releases.

3.3.1. Prepare: Multi-Site/Active-Active Clusters

Some considerations must be taken into account for any active/active scenario:

- For tables that use auto-increment, collisions are possible if two hosts select the same `auto-increment` number. You can reduce the effects by configuring each MySQL host with a different auto-increment settings, changing the offset and the increment values. For example, adding the following lines to your `my.cnf` file:

  ```
  auto-increment-offset = 1
  auto-increment-increment = 4
  ```

  In this way, the increments can be staggered on each machine and collisions are unlikely to occur.

- Use row-based replication. Update your configuration file to explicitly use row-based replication by adding the following to your `my.cnf` file:

  ```
  binlog-format = row
  ```

- Beware of triggers. Triggers can cause problems during replication because if they are applied on the Replica as well as the Primary you can get data corruption and invalid data. Tungsten Cluster cannot prevent triggers from executing on a Replica, and in an active/active topology there is no sensible way to disable triggers. Instead, check at the trigger level whether you are executing on a Primary or Replica. For more information, see Section C.4.1, “Triggers”.

3.3.2. Install: Multi-Site/Active-Active Clusters

Note

The procedures in this section are designed for the Multi-Site/Active-Active topology ONLY. Do NOT use these procedures for Composite Active/Active Clustering using v6 onwards.

For version 6.x onwards, Composite Active/Active Clustering, please refer to Deploying Composite Active/Active Clustering.

Creating the configuration requires two distinct steps, the first to create the two Tungsten Cluster deployments, and a second that creates the Tungsten Replicator configurations on different network ports, and different install directories.

1. Install the Tungsten Cluster and Tungsten Replicator packages or download the tarballs, and unpack them:

   ```
   shell> cd /opt/continuent/software
   shell> tar zxf tungsten-clustering-5.4.1-41.tar.gz
   shell> tar zxf tungsten-replicator-5.4.1-41.tar.gz
   ```

2. Change to the Tungsten Cluster directory:

```
shell> cd tungsten-clustering-5.4.1-41
```

3. Run tpm to configure the installation. This method assumes you are using the Section 10.3, “tpm Staging Configuration” method:

   Click the link below to switch examples between Staging and INI methods

   For ini install, the ini file contains all the configuration for both the cluster deployment and the replicator deployment.

   For a staging install, you first use the cluster configuration show below and then configure the replicator as a separate process. These additional steps are outlined below

   Show Staging

   Show INI

```
shell> ./tools/tpm configure defaults \
    --reset \
    --user=tungsten \
    --install-directory=/opt/continuent \
    --replication-user=tungsten \
    --replication-password=secret \
    --replication-port=3306 \
    --profile-script=~/.bashrc \
    --application-user=app_user \
    --application-password=secret \
    --skip-validation-check=MySQLPermissionsCheck \
    --rest-api-admin-user=apiuser \
    --rest-api-admin-pass=secret


shell> ./tools/tpm configure east \
    --topology=clustered \
    --connectors=east1,east2,east3 \
    --master=east1 \
    --members=east1,east2,east3

shell> ./tools/tpm configure west \
    --topology=clustered \
    --connectors=west1,west2,west3 \
    --master=west1 \
    --members=west1,west2,west3
```

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[defaults]
user=tungsten
install-directory=/opt/continuent
replication-user=tungsten
replication-password=secret
replication-port=3306
profile-script=~/.bashrc
application-user=app_user
application-password=secret
skip-validation-check=MySQLPermissionsCheck
rest-api-admin-user=apiuser
rest-api-admin-pass=secret

[defaults.replicator]
home-directory=/opt/replicator
rmi-port=10002
executable-prefix=mm

[east]
topology=clustered
connectors=east1,east2,east3
master=east1
members=east1,east2,east3

[west]
topology=clustered
connectors=west1,west2,west3
master=west1
members=west1,west2,west3

[east_west]
topology=cluster-slave
master-dataservice=east
slave-dataservice=west
thl-port=2113

[west_east]
```

```
topology=cluster-slave
master-dataservice=west
slave-dataservice=east
thl-port=2115
```

Configuration group `defaults`

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--reset` [464]

  `reset` [464]

  For staging configurations, deletes all pre-existing configuration information between updating with the new configuration values.

- `--user=tungsten` [471]

  `user=tungsten` [471]

  System User

- `--install-directory=/opt/continuent` [450]

  `install-directory=/opt/continuent` [450]

  Path to the directory where the active deployment will be installed. The configured directory will contain the software, THL and relay log information unless configured otherwise.

- `--replication-user=tungsten` [464]

  `replication-user=tungsten` [464]

  For databases that required authentication, the username to use when connecting to the database using the corresponding connection method (native, JDBC, etc.).

- `--replication-password=secret` [463]

  `replication-password=secret` [463]

  The password to be used when connecting to the database using the corresponding `--replication-user` [464].

- `--replication-port=3306` [463]

  `replication-port=3306` [463]

  The network port used to connect to the database server. The default port used depends on the database being configured.

- `--profile-script=~/.bashrc` [461]

  `profile-script=~/.bashrc` [461]

  Append commands to include env.sh in this profile script

- `--application-user=app_user` [433]

  `application-user=app_user` [433]

  Database username for the connector

- `--application-password=secret` [432]

  `application-password=secret` [432]

  Database password for the connector

- `--skip-validation-check=MySQLPermissionsCheck` [406]

  `skip-validation-check=MySQLPermissionsCheck` [406]

  The `--skip-validation-check` [406] disables a given validation check. If any validation check fails, the installation, validation or configuration will automatically stop.

Warning

Using this option enables you to bypass the specified check, although skipping a check may lead to an invalid or non-working configuration.

You can identify a given check if an error or warning has been raised during configuration. For example, the default table type check:

```
...
ERROR >> centos >> The datasource root@centos:3306 (WITH PASSWORD) »
 uses MyISAM as the default storage engine (MySQLDefaultTableTypeCheck)
...
```

The check in this case is `MySQLDefaultTableTypeCheck` [416], and could be ignored using `--skip-validation-check=MySQLDefaultTableTypeCheck` [406].

Setting both `--skip-validation-check` [406] and `--enable-validation-check` [404] is equivalent to explicitly disabling the specified check.

- `--rest-api-admin-user=apiuser`

  `rest-api-admin-user=apiuser`
  Optional: Must be specified along with rest-api-admin-pass if you wish to access the full API features and use the Dashboard GUI for cluster installations.

- `--rest-api-admin-pass=secret`

  `rest-api-admin-pass=secret`
  Optional: Must be specified along with rest-api-admin-user if you wish to access the full API features.

Configuration group **`defaults.replicator`**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--home-directory=/opt/replicator` [450]

  `home-directory=/opt/replicator` [450]

  Path to the directory where the active deployment will be installed. The configured directory will contain the software, THL and relay log information unless configured otherwise.

- `--rmi-port=10002` [464]

  `rmi-port=10002` [464]

  Replication RMI listen port

- `--executable-prefix=mm` [449]

  `executable-prefix=mm` [449]

  When enabled, the supplied prefix is added to each command alias that is generated for a given installation. This enables multiple installations to co-exist and and be accessible through a unique alias. For example, if the executable prefix is configured as `east`, then an alias for the installation to trepctl will be created as east_trepctl.

  Alias information for executable prefix data is stored within the `$CONTINUENT_ROOT/share/aliases.sh` file for each installation.

Configuration group **`east`**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--topology=clustered` [470]

  `topology=clustered` [470]

  Replication topology for the dataservice.

- `--connectors=east1,east2,east3` [440]

  `connectors=east1,east2,east3` [440]

Hostnames for the dataservice connectors

- `--master=east1` [454]

  `master=east1` [454]

  The hostname of the primary (extractor) within the current service.

- `--members=east1,east2,east3` [455]

  `members=east1,east2,east3` [455]

  Hostnames for the dataservice members

Configuration group **`west`**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--topology=clustered` [470]

  `topology=clustered` [470]

  Replication topology for the dataservice.

- `--connectors=west1,west2,west3` [440]

  `connectors=west1,west2,west3` [440]

  Hostnames for the dataservice connectors

- `--master=west1` [454]

  `master=west1` [454]

  The hostname of the primary (extractor) within the current service.

- `--members=west1,west2,west3` [455]

  `members=west1,west2,west3` [455]

  Hostnames for the dataservice members

Configuration group **`east_west`**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--topology=cluster-slave` [470]

  `topology=cluster-slave` [470]

  Replication topology for the dataservice.

- `--master-dataservice=east` [463]

  `master-dataservice=east` [463]

  Dataservice name to use as a relay source

- `--slave-dataservice=west` [468]

  `slave-dataservice=west` [468]

  Dataservice to use to determine the value of host configuration

- `--thl-port=2113` [470]

  `thl-port=2113` [470]

Port to use for THL Operations

Configuration group `west_east`

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--topology=cluster-slave` [470]

  `topology=cluster-slave` [470]

  Replication topology for the dataservice.

- `--master-dataservice=west` [463]

  `master-dataservice=west` [463]

  Dataservice name to use as a relay source

- `--slave-dataservice=east` [468]

  `slave-dataservice=east` [468]

  Dataservice to use to determine the value of host configuration

- `--thl-port=2115` [470]

  `thl-port=2115` [470]

  Port to use for THL Operations

Run tpm to install the software with the configuration.

```
shell > ./tools/tpm install
```

During the startup and installation, tpm will notify you of any problems that need to be fixed before the service can be correctly installed and started. If the service starts correctly, you should see the configuration and current status of the service.

4. Change to the Tungsten Replicator directory:

```
shell> cd tungsten-replicator-5.4.1-41
```

5. Run tpm to configure the installation. This method assumes you are using the Section 10.3, “tpm Staging Configuration” method:

6. If you are running a staging install, first configure the replicator using the following example, if configuring using an ini file, skip straight to the install step below

```
shell> ./tools/tpm configure defaults \
    --reset \
    --user=tungsten \
    --install-directory=/opt/replicator \
    --replication-user=tungsten \
    --replication-password=secret \
    --replication-port=3306 \
    --profile-script=~/.bashrc \
    --application-user=app_user \
    --application-password=secret \
    --skip-validation-check=MySQLPermissionsCheck \
    --rmi-port=10002 \
    --executable-prefix=mm \
    --thl-port=2113 \
    --rest-api-admin-user=apiuser \
    --rest-api-admin-pass=secret

shell> ./tools/tpm configure east \
    --topology=clustered \
    --connectors=east1,east2,east3 \
    --master=east1 \
    --members=east1,east2,east3

shell> ./tools/tpm configure west \
    --topology=clustered \
    --connectors=west1,west2,west3 \
    --master=west1 \
    --members=west1,west2,west3
```

```
shell> ./tools/tpm configure east_west \
    --topology=cluster-slave \
    --master-dataservice=east \
    --slave-dataservice=west \
    --thl-port=2113

shell> ./tools/tpm configure west_east \
    --topology=cluster-slave \
    --master-dataservice=west \
    --slave-dataservice=east \
    --thl-port=2115
```

7. Run tpm to install the software with the configuration.

```
shell > ./tools/tpm install
```

   During the startup and installation, tpm will notify you of any problems that need to be fixed before the service can be correctly installed and started. If the service starts correctly, you should see the configuration and current status of the service.

8. Initialize your PATH and environment.

```
shell> source /opt/continuent/share/env.sh
shell> source /opt/replicator/share/env.sh
```

The Multi-Site/Active-Active clustering should be installed and ready to use.

3.3.3. Best Practices: Multi-Site/Active-Active Clusters

> **Note**
>
> The procedures in this section are designed for the Multi-Site/Active-Active topology ONLY. Do NOT use these procedures for Composite Active/Active Clustering uing v6 onwards.
>
> For version 6.x onwards, Composite Active/Active Clustering, please refer to Deploying Composite Active/Active Clustering.

> **Note**
>
> In addition to this information, follow the guidelines in Section 2.5, “Best Practices”.

- Running a Multi-Site/Active-Active service uses many different components to keep data updated on all servers. Monitoring the dataservice is divided into monitoring the two different clusters. Be mindful when using commands that you have the correct path. You should either use the full path to the command under `/opt/continuent` and `/opt/replicator`, or use the aliases created by setting the `--executable-prefix=mm` [449] option. Calling trepctl would become mm_trepctl.
- Configure your database servers with distinct `auto_increment_increment` and `auto_increment_offset` settings. Each location that may accept writes should have a unique offset value.

Using cctrl gives you the dataservice status individually for the `east` and `west` dataservice. For example, the `east` dataservice is shown below:

```
Continuent Tungsten 5.4.1 build 41
east: session established
[LOGICAL] /east > ls

COORDINATOR[east1:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@east1[17951](ONLINE, created=0, active=0)                         |
|connector@east2[17939](ONLINE, created=0, active=0)                         |
|connector@east3[17961](ONLINE, created=0, active=0)                         |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|east1(master:ONLINE, progress=29, THL latency=0.739)                        |
|STATUS [OK] [2013/11/25 11:24:35 AM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=master, state=ONLINE)                                     |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|east2(slave:ONLINE, progress=29, latency=0.721)                             |
|STATUS [OK] [2013/11/25 11:24:39 AM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
```

```
|  REPLICATOR(role=slave, master=east1, state=ONLINE)                     |
|  DATASERVER(state=ONLINE)                                               |
|  CONNECTIONS(created=0, active=0)                                       |
+-------------------------------------------------------------------------+

+-------------------------------------------------------------------------+
|east3(slave:ONLINE, progress=29, latency=1.143)                          |
|STATUS [OK] [2013/11/25 11:24:38 AM GMT]                                 |
+-------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                  |
|  REPLICATOR(role=slave, master=east1, state=ONLINE)                     |
|  DATASERVER(state=ONLINE)                                               |
|  CONNECTIONS(created=0, active=0)                                       |
+-------------------------------------------------------------------------+
```

When checking the current status, it is import to compare the sequence numbers from each service correctly. There are *four* services to monitor, the Tungsten Cluster service `east`, and a Tungsten Replicator service `east` that reads data from the `west` Tungsten Cluster service. A corresponding `west` Tungsten Cluster and `west` Tungsten Replicator service.

- When data is inserted on the Primary within the `east` Tungsten Cluster, use cctrl to determine the cluster status. Sequence numbers within the Tungsten Cluster `east` should match, and latency between hosts in the Tungsten Cluster service are relative to each other.
- When data is inserted on `east`, the sequence number of the `east` Tungsten Cluster service and `east` Tungsten Replicator service (on `west{1,2,3}`) should be compared.
- When data is inserted on the Primary within the `east` Tungsten Cluster, use cctrl to determine the cluster status. Sequence numbers within the Tungsten Cluster `east` should match, and latency between hosts in the Tungsten Cluster service are relative to each other.
- When data is inserted on `west`, the sequence number of the `west` Tungsten Cluster service and `west` Tungsten Replicator service (on `east{1,2,3}`) should be compared.

	Tungsten Cluster Service Seqno		Tungsten Replicator Service Seqno	
Operation	**east**	**west**	**east**	**west**
Insert/update data on `east`	Seqno Increment		Seqno Increment	
Insert/update data on `west`		Seqno Increment		Seqno Increment

Within each cluster, cctrl can be used to monitor the current status. For more information on checking the status and controlling operations, see Section 6.3, “Checking Dataservice Status”.

Note

For convenience, the shell PATH can be updated with the tools and configuration. With two separate services, both environments must be updated. To update the shell with the Tungsten Cluster service and tools:

```
shell> source /opt/continuent/share/env.sh
```

To update the shell with the Tungsten Replicator service and tools:

```
shell> source /opt/replicator/share/env.sh
```

To monitor all services and the current status, you can also use the multi_trepctl command (part of the Tungsten Replicator installation). This generates a unified status report for all the hosts and services configured:

```
shell> multi_trepctl --by-service
| host  | servicename | role   | state  | appliedlastseqno | appliedlatency |
| east1 | east        | master | ONLINE |               53 |        120.161 |
| east3 | east        | master | ONLINE |               44 |          0.697 |
| east2 | east        | slave  | ONLINE |               53 |        119.961 |
| west1 | east        | slave  | ONLINE |               53 |        119.834 |
| west2 | east        | slave  | ONLINE |               53 |        181.128 |
| west3 | east        | slave  | ONLINE |               53 |        204.790 |
| west1 | west        | master | ONLINE |           294327 |          0.285 |
| west2 | west        | master | ONLINE |           231595 |          0.316 |
| east1 | west        | slave  | ONLINE |           294327 |          0.879 |
| east2 | west        | slave  | ONLINE |           294327 |          0.567 |
| east3 | west        | slave  | ONLINE |           294327 |          1.046 |
| west3 | west        | slave  | ONLINE |           231595 |         22.895 |
```

In the above example, it can be seen that the `west` services have a much higher applied last sequence number than the `east` services, this is because all the writes have been applied within the `west` cluster.

To monitor individual servers and/or services, use trepctl, using the correct port number and servicename. For example, on `east1` to check the status of the replicator within the Tungsten Cluster service:

```
shell> trepctl status
```

To check the Tungsten Replicator service, explicitly specify the port and service:

```
shell> mm_trepctl -service west status
```

3.3.4. Configuring Startup on Boot

Note

The procedures in this section are designed for the Multi-Site/Active-Active topology ONLY. Do NOT use these procedures for Composite Active/Active Clustering uing v6 onwards.

For version 6.x onwards, Composite Active/Active Clustering, please refer to Deploying Composite Active/Active Clustering.

Because there are two different Continuent services running, each must be individually configured to startup on boot:

- For the Tungsten Cluster service, use Section 4.3, “Configuring Startup on Boot”.
- For the Tungsten Replicator service, a custom startup script must be created, otherwise the replicator will be unable to start as it has been configured in a different directory.

1. Create a link from the Tungsten Replicator service startup script in the operating system startup directory (`/etc/init.d`):

   ```
   shell> sudo ln -s /opt/replicator/tungsten/tungsten-replicator/bin/replicator /etc/init.d/mmreplicator
   ```

2. Modify the `APP_NAME` variable within the startup script (`/etc/init.d/mmreplicator`) to mmreplicator:

   ```
   APP_NAME="mmreplicator"
   ```

3. Update the operating system startup configuration to use the updated script.

   On Debian/Ubuntu:

   ```
   shell> sudo update-rc.d mmreplicator defaults
   ```

   On RedHat/CentOS:

   ```
   shell> sudo checkconfig --add mmreplicator
   ```

3.3.5. Resetting a single dataservice

Note

The procedures in this section are designed for the Multi-Site/Active-Active topology ONLY. Do NOT use these procedures for Composite Active/Active Clustering uing v6 onwards.

For version 6.x onwards, Composite Active/Active Clustering, please refer to Deploying Composite Active/Active Clustering.

Under certain conditions, dataservices in an active/active configuration may drift and/or become inconsistent with the data in another dataservice. If this occurs, you may need to re-provision the data on one or more of the dataservices after first determining the definitive source of the information.

In the following example the `west` service has been determined to be the definitive copy of the data. To fix the issue, all the datasources in the `east` service will be reprovisioned from one of the datasources in the `west` service.

The following is a guide to the steps that should be followed. In the example procedure it is the *`east`* service that has failed:

1. Put the dataservice into *`MAINTENANCE`* mode. This ensures that Tungsten Cluster will not attempt to automatically recover the service.

   ```
   cctrl [east]> set policy maintenance
   ```

2. On the `east`, failed, Tungsten Cluster service, put each Tungsten Connector offline:

   ```
   cctrl [east]> router * offline
   ```

3. Reset the failed Tungsten Replicator service on all servers connected to the failed Tungsten Cluster service. For example, on `west{1,2,3}` reset the `east` Tungsten Replicator service:

   ```
   shell west> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service east offline
   shell west> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service east reset -all -y
   ```

4. Reset the Tungsten Cluster service on each server within the failed region (`east{1,2,3}`):

   ```
   shell east> /opt/continuent/tungsten/tungsten-replicator/bin/replicator stop
   shell east> /opt/continuent/tungsten/tools/tpm reset east
   ```

```
shell east> /opt/continuent/tungsten/tungsten-replicator/bin/replicator start
```

5. Restore a backup on each host (`east{1,2,3}`) in the failed `east` service from a host in the `west` service:

```
shell east> /opt/continuent/tungsten/tungsten-replicator/scripts/tungsten_provision_slave \
    --direct --source=west1
```

```
shell east> /opt/continuent/tungsten/tungsten-replicator/scripts/tungsten_provision_slave \
    --direct --source=west1
```

6. Place all the Tungsten Replicator services on `west{1,2,3}` back online:

```
shell west> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service east online
```

7. On the `east`, failed, Tungsten Cluster service, put each Tungsten Connector online:

```
cctrl [east]> router * online
```

8. Set the policy back to automatic:

```
cctrl> set policy automatic
```

3.3.6. Resetting all dataservices

> **Note**
>
> The procedures in this section are designed for the Multi-Site/Active-Active topology ONLY. Do NOT use these procedures for Composite Active/Active Clustering uing v6 onwards.
>
> For version 6.x onwards, Composite Active/Active Clustering, please refer to Deploying Composite Active/Active Clustering.

To reset all of the dataservices and restart the Tungsten Cluster and Tungsten Replicator services:

On all hosts (e.g. `east{1,2,3}` and `west{1,2,3}`):

```
shell> /opt/replicator/tungsten/tungsten-replicator/bin/replicator stop
shell> /opt/replicator/tungsten/tools/tpm reset
shell> /opt/continuent/tungsten/tools/tpm reset
shell> /opt/replicator/tungsten/tungsten-replicator/bin/replicator start
```

3.3.7. Provisioning during live operations

> **Note**
>
> The procedures in this section are designed for the Multi-Site/Active-Active topology ONLY. Do NOT use these procedures for Composite Active/Active Clustering uing v6 onwards.
>
> For version 6.x onwards, Composite Active/Active Clustering, please refer to Deploying Composite Active/Active Clustering.

In the event of a failure within one host in the service where you need to reprovision the host from another running Replica:

- Identify the servers that are failed. All servers that are not the Primary for their region can be re-provisioned using a backup/restore of the Primary (see Section 6.9, “Creating a Backup” or using the tungsten_provision_slave script.
- To re-provision an entire region, follow the steps below. The `east` region is used in the example statements below:

  1. To prevent application servers from reading and writing to the failed service, place the Tungsten Connector offline within the failed region:

```
cctrl [east]> router * offline
```

  2. On all servers in other regions (`west{1,2,3}`):

```
shell> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service east offline
shell> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service east reset -all -y
```

  3. On all servers in the failed region (`east{1,2,3}`):

```
shell> /opt/replicator/tungsten/tungsten-replicator/bin/replicator stop
shell> /opt/replicator/tungsten/tools/tpm reset
shell> /opt/continuent/tungsten/tungsten-replicator/scripts/tungsten_provision_slave \
    --direct --source=west1
```

  4. Check that Tungsten Cluster is working correctly and all hosts are up to date:

```
cctrl [east]> ls
```

5. Restart the Tungsten Replicator service:

```
shell> /opt/replicator/tungsten/tungsten-replicator/bin/replicator start
```

6. On all servers in other regions (`west{1,2,3}`):

```
shell> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service east online
```

3.3.8. Adding a new Cluster/Dataservice

> **Note**
>
> The procedures in this section are designed for the Multi-Site/Active-Active topology ONLY. Do NOT use these procedures for Composite Active/Active Clustering uing v6 onwards.
>
> For version 6.x onwards, Composite Active/Active Clustering, please refer to Deploying Composite Active/Active Clustering.

To add an entirely new cluster (dataservice) to the mesh, follow the below simple procedure.

> **Note**
>
> There is no need to set the Replicator starting points, and no downtime/maintenance window is required!

1. Choose a cluster to take a node backup from:
   - Choose a cluster and Replica node to take a backup from.
   - Enable maintenance mode for the cluster:

```
shell> cctrl
cctrl> set policy maintenance
```

   - Shun the selected Replica node and stop both local and cross-site replicator services:

```
shell> cctrl
cctrl> datasource {replica_hostname_here} shun
replica shell> trepctl offline
replica shell> replicator stop
replica shell> mm_trepctl offline
replica; shell> mm_replicator stop
```

   - Take a backup of the shunned node, then copy to/restore on all nodes in the new cluster.
   - Recover the Replica node and put cluster back into automatic mode:

```
replica shell> replicator start
replica shell> trepctl online
replica shell> mm_replicator start
replica shell> mm_trepctl online
shell> cctrl
cctrl> datasource {replica_hostname_here} online
cctrl> set policy automatic
```

2. On ALL nodes in all three (3) clusters, ensure the `/etc/tungsten/tungsten.ini` has all three clusters defined and all the correct cross-site combinations.
3. Install the Tungsten Clustering software on new cluster nodes to create a single standalone cluster and check the cctrl command to be sure the new cluster is fully online.
4. Install the Tungsten Replicator software on all new cluster nodes and start it.

   Replication will now be flowing INTO the new cluster from the original two.
5. On the original two clusters, run tools/tpm update from the cross-site replicator staging software path:

```
shell> mm_tpm query staging
shell> cd {replicator_staging_directory}
shell> tools/tpm update --replace-release
shell> mm_trepctl online
shell> mm_trepctl services
```

   Check the output from the mm_trepctl services command output above to confirm the new service appears and is online.

> **Note**
>
> There is no need to set the cross-site replicators at a starting position because:
>
> - Replicator feeds from the new cluster to the old clusters start at seqno 0.
> - The tungsten_olda and tungsten_oldb database schemas will contain the correct starting points for the INBOUND feed into the new cluster, so when the cross-site replicators are started and brought online they will read from the tracking table and carry on correctly from the stored position.

3.3.9. Enabling SSL for Replicators Only

> **Note**
>
> The procedures in this section are designed for the Multi-Site/Active-Active topology ONLY. Do NOT use these procedures for Composite Active/Active Clustering uing v6 onwards.
>
> For version 6.x onwards, Composite Active/Active Clustering, please refer to Deploying Composite Active/Active Clustering.

It is possible to enable secure communications for just the Replicator layer in a Multi-Site/Active-Active topology. This would include both the Cluster Replicators and the Cross-Site Replicators because they cannot be SSL-enabled independently.

1. Create a certificate and load it into a java keystore, and then load it into a truststore and place all files into the `/etc/tungsten/` directory. For detailed instructions, see Chapter 5, *Deployment: Security*

2. Update `/etc/tungsten/tungsten.ini` to include these additional lines in the both the `defaults` section and the `defaults.replicator` section:

```
[defaults]
...
java-keystore-path=/etc/tungsten/keystore.jks
java-keystore-password=secret
java-truststore-path=/etc/tungsten/truststore.ts
java-truststore-password=secret
thl-ssl=true

[defaults.replicator]
...
java-keystore-path=/etc/tungsten/keystore.jks
java-keystore-password=secret
java-truststore-path=/etc/tungsten/truststore.ts
java-truststore-password=secret
thl-ssl=true
```

3. Put all clusters into maintenance mode.

```
shell> cctrl
cctrl> set policy maintenance
```

4. On all hosts, update the cluster configuration:

```
shell> tpm query staging
shell> cd {cluster_staging_directory}
shell> tools/tpm update
shell> trepctl online
shell> trepctl status | grep thl
```

   On all hosts, update the cross-site replicator configuration:

```
shell> mm_tpm query staging
shell> cd {replicator_staging_directory}
shell> tools/tpm update
shell> mm_trepctl online
shell> mm_trepctl status | grep thl
```

   > **Important**
   >
   > Please note that all replication will effectively be down until all nodes/services are SSL-enabled and online.

5. Once all the updates are done and the Replicators are back up and running, use the various commands to check that secure communications have been enabled.

   Each datasource will show `[SSL]` when enabled:

```
shell> cctrl
cctrl> ls
```

```
DATASOURCES:
+--------------------------------------------------------------------------+
|db1(master:ONLINE, progress=208950063, THL latency=0.895)                 |
|STATUS [OK] [2018/04/10 11:47:57 AM UTC][SSL]                             |
+--------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                   |
|  REPLICATOR(role=master, state=ONLINE)                                   |
|  DATASERVER(state=ONLINE)                                                |
|  CONNECTIONS(created=15307, active=2)                                    |
+--------------------------------------------------------------------------+

+--------------------------------------------------------------------------+
|db2(slave:ONLINE, progress=208950061, latency=0.920)                      |
|STATUS [OK] [2018/04/19 11:18:21 PM UTC][SSL]                             |
+--------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                   |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                |
|  CONNECTIONS(created=0, active=0)                                        |
+--------------------------------------------------------------------------+

+--------------------------------------------------------------------------+
|db3(slave:ONLINE, progress=208950063, latency=0.939)                      |
|STATUS [OK] [2018/04/25 12:17:20 PM UTC][SSL]                             |
+--------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                   |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                |
|  CONNECTIONS(created=0, active=0)                                        |
+--------------------------------------------------------------------------+
```

Both the local cluster replicator status command trepctl status and the cross-site replicator status command mm_trepctl status will show `thls` instead of `thl` in the values for *masterConnectUri*, *masterListenUri* and *pipelineSource*.

```
shell> trepctl status | grep thl

masterConnectUri       : thls://db1:2112/
masterListenUri        : thls://db5:2112/
pipelineSource         : thls://db1:2112/
```

3.3.10. Dataserver maintenance

Note

The procedures in this section are designed for the Multi-Site/Active-Active topology ONLY. Do NOT use these procedures for Composite Active/Active Clustering uing v6 onwards.

For version 6.x onwards, Composite Active/Active Clustering, please refer to Deploying Composite Active/Active Clustering.

To perform maintenance on the dataservice, for example to update the MySQL configuration file, can be achieved in a similar sequence to that shown in Section 6.14, “Performing Database or OS Maintenance”, except that you must also restart the corresponding Tungsten Replicator service after the main Tungsten Cluster service has been placed back online.

For example, to perform maintenance on the `east` service:

1. Put the dataservice into *MAINTENANCE* mode. This ensures that Tungsten Cluster will not attempt to automatically recover the service.

   ```
   cctrl [east]> set policy maintenance
   ```

2. Shun the first Replica datasource so that maintenance can be performed on the host.

   ```
   cctrl [east]> datasource east1 shun
   ```

3. Perform the updates, such as updating `my.cnf`, changing schemas, or performing other maintenance.

4. If MySQL configuration has been modified, restart the MySQL service:

   ```
   cctrl [east]> service host/mysql restart
   ```

5. Bring the host back into the dataservice:

   ```
   cctrl [east]> datasource host recover
   ```

6. Perform a switch so that the Primary becomes a Replica and can then be shunned and have the necessary maintenance performed:

   ```
   cctrl [east]> switch
   ```

7. Repeat the previous steps to shun the host, perform maintenance, and then switch again until all the hosts have been updated.

8. Set the policy back to automatic:

```
cctrl> set policy automatic
```

9. On each host in the other region, manually restart the Tungsten Replicator service, which will have gone offline when MySQL was restarted:

```
shell> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -host host -service east online
```

3.3.10.1. Fixing Replication Errors

In the event of a replication fault, the standard cctrl, trepctl and other utility commands in Chapter 9, *Command-line Tools* can be used to bring the dataservice back into operation. All the tools are safe to use.

If you have to perform any updates or modifications to the stored MySQL data, ensure binary logging has been disabled using:

```
mysql> SET SESSION SQL_LOG_BIN=0;
```

Before running any commands. This prevents statements and operations reaching the binary log so that the operations will not be replicated to other hosts.

3.4. Deploying Tungsten Connector Only

An independent Tungsten Connector installation can be useful when you want to create a connector service that provides HA and load balancing, but which operates independently of the main cluster. Specifically, this solution is used within disaster recovery and multi-site operations where the connector may be operating across site-boundaries independently of the dataservice at each site.

The independent nature is in terms of the configuration of the overall service through tpm; an independent connector configured to communicate with existing cluster hosts will be managed by the managers of the cluster. But, the connector will not be updated when performing a tpm update operation within the configured cluster. This allows the connector to work through upgrade procedures to minimize downtime.

To create an independent connector, tpm is used to create a definition for a cluster including the datasources, and specifying only a single connector host, then installing Tungsten Cluster on only the connector host. Failure to configure in this way, and tpm will install a full Tungsten Cluster service across all the implied members of the cluster.

1. Install the Tungsten Cluster package or download the Tungsten Cluster tarball, and unpack it:

```
shell> cd /opt/continuent/software
shell> tar zxf tungsten-clustering-5.4.1-41.tar.gz
```

2. Change to the Tungsten Cluster directory:

```
shell> cd tungsten-clustering-5.4.1-41
```

3. Run tpm to perform the installation, using either the staging method or the INI method. Review Section 10.1, "Comparing Staging and INI tpm Methods" for more details on these two methods.

   Click the link below to switch examples between Staging and INI methods

   Show Staging

   Show INI

```
shell> ./tools/tpm configure defaults \
    --reset \
    --user=tungsten \
    --profile-script=~/.bashrc \
    --application-user=app-_user \
    --application-password=secret \
    --application-port=3306 \
    --replication-port=13306 \
    --install-directory=/opt/continuent

shell> ./tools/tpm configure alpha \
    --connectors=connectorhost1 \
    --master=host1 \
    --members=host1,host2,host3
```

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[defaults]
user=tungsten
profile-script=~/.bashrc
application-user=app-_user
application-password=secret
application-port=3306
```

```
replication-port=13306
install-directory=/opt/continuent

[alpha]
connectors=connectorhost1
master=host1
members=host1,host2,host3
```

Configuration group **defaults**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- --reset [464]

  reset [464]

  For staging configurations, deletes all pre-existing configuration information between updating with the new configuration values.

- --user=tungsten [471]

  user=tungsten [471]

  System User

- --profile-script=~/.bashrc [461]

  profile-script=~/.bashrc [461]

  Append commands to include env.sh in this profile script

- --application-user=app-_user [433]

  application-user=app-_user [433]

  Database username for the connector

- --application-password=secret [432]

  application-password=secret [432]

  Database password for the connector

- --application-port=3306 [432]

  application-port=3306 [432]

  Port for the connector to listen on

- --replication-port=13306 [463]

  replication-port=13306 [463]

  The network port used to connect to the database server. The default port used depends on the database being configured.

- --install-directory=/opt/continuent [450]

  install-directory=/opt/continuent [450]

  Path to the directory where the active deployment will be installed. The configured directory will contain the software, THL and relay log information unless configured otherwise.

Configuration group **alpha**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- --connectors=connectorhost1 [440]

  connectors=connectorhost1 [440]

  Hostnames for the dataservice connectors

- `--master=host1` [454]

  `master=host1` [454]

  The hostname of the primary (extractor) within the current service.

- `--members=host1,host2,host3` [455]

  `members=host1,host2,host3` [455]

  Hostnames for the dataservice members

The above creates a configuration specifying the datasources, `host{1,2,3}`, and a single connector host based on the hostname of the installation host. Note that the application and datasource port configuration are the same as required by a typical Tungsten Cluster configuration. The values above are identical to those used in Section 3.1, "Deploying Standalone HA Clusters" deployment.

4. Run tpm to install the software with the configuration.

```
shell > ./tools/tpm install
```

   During the startup and installation, tpm will notify you of any problems that need to be fixed before the service can be correctly installed and started. If the service starts correctly, you should see the configuration and current status of the service.

5. Initialize your `PATH` and environment.

```
shell > source /opt/continuent/share/env.sh
```

6. Start the connector service:

```
shell> connector start
```

Once started:

- The connector will appear, and be managed by, any manager host using the cctrl tool. For example:

```
[LOGICAL] /dsone > ls

COORDINATOR[host1:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@connector2[16019](ONLINE, created=0, active=0)                    |
|connector@host1[18450](ONLINE, created=19638, active=0)                     |
|connector@host2[1995](ONLINE, created=0, active=0)                          |
|connector@host3[8895](ONLINE, created=0, active=0)                          |
+----------------------------------------------------------------------------+
...
```

- The active status of the connector can be monitored using cctrl as normal.
- Updates to the main cluster will not update the Tungsten Cluster of the standalone connector. The standalone must be updated independently of the remainder of the Tungsten Cluster dataservice.
- Connector can be accessed using the connector host and specified port:

```
shell> mysql -utungsten -p -hconnector -P3306
```

- The `user.map` authorization file must be created and managed separately on standalone connectors. For more information, see Section 7.6, "User Authentication"

3.5. Deploying Additional Datasources, Managers, or Connectors

3.5.1. Adding Datasources to an Existing Deployment

1. Ensure the new host that is being added has been configured following the Appendix B, *Prerequisites*.
2. Update the configuration using tpm, adding the new host to the list of `--members` [455], `--hosts` [450], and `--connectors` [440], if applicable.

   If using the staging method of deployment, you can use `+=`, which appends the host to the existing deployment as shown in the example below. Click the link to switch between staging and ini type deployment examples.

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --members+=host4 \
    --hosts+=host4 \
    --connectors+=host4 \
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update --no-connectors
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
members=host1,host2,host3,host4
hosts=host1,host2,host3,host4
connectors=host1,host2,host3,host4
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update --no-connectors
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

3. Using the `--no-connectors` [459] option updates the current deployment without restarting the existing connectors.

4. Initially, the newly added host will attempt to read the information from the existing THL. If the full THL is not available from the Primary, the new Replica will need to be reprovisioned:

   a. Log into the new host.

   b. Execute tungsten_provision_slave to read the information from an existing Replica and overwrite the data within the new host:

   ```
   shell> tungsten_provision_slave --source=host2
   NOTE >>Put alpha replication service offline
   NOTE >>Create a mysqldump backup of host2 in /opt/continuent/backups/provision_mysqldump_2019-01-17_17-27_96
   NOTE >>host2>>Create mysqldump in /opt/continuent/backups/provision_mysqldump_2019-01-17_17-27_96/provision.sql.gz
   NOTE >>Load the mysqldump file
   NOTE >>Put the alpha replication service online
   NOTE >>Clear THL and relay logs for the alpha replication service
   ```

Once the new host has been added and re-provision, check the status in cctrl:

```
[LOGICAL] /alpha > ls

COORDINATOR[host1:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@host1[11401](ONLINE, created=0, active=0)                         |
```

```
|connector@host2[8756](ONLINE, created=0, active=0)                          |
|connector@host3[21673](ONLINE, created=0, active=0)                         |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|host1(master:ONLINE, progress=219, THL latency=1.047)                       |
|STATUS [OK] [2018/12/13 04:16:17 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=master, state=ONLINE)                                     |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host2(slave:ONLINE, progress=219, latency=1.588)                            |
|STATUS [OK] [2018/12/13 04:16:17 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=host1, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host3(slave:ONLINE, progress=219, latency=2.021)                            |
|STATUS [OK] [2018/12/13 04:16:18 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=host1, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host4(slave:ONLINE, progress=219, latency=1.000)                            |
|STATUS [OK] [2019/01/17 05:28:54 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=host1, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+
```

If the host has not come up, or the progress does not match the Primary, check Section 6.6, “Datasource Recovery Steps” for more information on determining the exact status and what steps to take to enable the host operation.

3.5.2. Adding Active Witnesses to an Existing Deployment

To add active witnesses to an Existing Deployment, use tpm to update the configuration, adding the list of active witnesses and the list of all members within the updated dataservice configuration.

Active Witness hosts must have been prepared using the notes provided in Appendix B, *Prerequisites*. Active witnesses must be ble to resolve the hostnames of the other managers and hosts in the dataservice. Installation will fail if prerequisities and host availability and stability cannot be confirmed.

Update the configuration using tpm, adding the new host to the list of `members` [455]

If using the staging method of deployment, you can use `+=`, which appends the host to the existing deployment as shown in the example below. Click the link to switch between staging and ini type deployment examples.

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
```

```
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --members+=host4 \
    --witnesses=host4 \
    --enable-active-witnesses=true \
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update --no-connectors
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
members=host1,host2,host3,host4
witnesses=host4
enable-active-witnesses=true
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update --no-connectors
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

Using the `--no-connectors` [459] option updates the current deployment without restarting the existing connectors.

Once installation has completed successfully, and the manager service has started on each configured active witness, the status can be determined using ls within cctrl:

```
[LOGICAL] /alpha > ls

COORDINATOR[host1:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@host1[20446](ONLINE, created=0, active=0)                         |
|connector@host2[21698](ONLINE, created=0, active=0)                         |
|connector@host3[30354](ONLINE, created=0, active=0)                         |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|host1(slave:ONLINE, progress=8946, latency=0.000)                           |
|STATUS [OK] [2018/12/05 04:27:47 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=host3, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host2(slave:ONLINE, progress=8946, latency=0.334)                           |
|STATUS [OK] [2018/12/05 04:06:59 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=host3, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host3(master:ONLINE, progress=8946, THL latency=0.331)                      |
|STATUS [OK] [2018/11/20 05:39:14 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=master, state=ONLINE)                                     |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+
```

```
WITNESSES:
+---------------------------------------------------------------------------+
|host4(witness:ONLINE)                                                      |
+---------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
+---------------------------------------------------------------------------+
```

Validation of the cluster with the new witnesses can be verified by using the cluster validate command within cctrl.

3.5.3. Replacing an Active Witness as a Full Cluster Node

This section explains the simple process for converting an Active Witness into a full cluster node. This process can be used to either convert the existig node or replace the witness with a new node.

1. First, place the cluster into `MAINTENANCE` mode.

   ```
   shell> cctrl
   cctrl> set policy maintenance
   ```

2. Stop the software on the existing Witness node

   ```
   shell> stopall
   ```

3. Whether you are converting this host, or adding a new host, ensure any additional pre-requisities that are needed for a full cluster node are in place, for example MySQL has been installed.

4. INI Install

   If you are using an ini file for configuration, update the ini on all nodes (including connectors) removing the witness properties and placing the new host as part of the cluster configuration, example below. Skip to Staging Install further down for Staging steps.

   Before:

   ```
   [defaults]
   user=tungsten
   home-directory=/opt/continuent
   application-user=app_user
   application-password=secret
   application-port=3306
   profile-script=~/.bash_profile
   replication-user=tungsten
   replication-password=secret
   replication-port=13306
   mysql-allow-intensive-checks=true

   [nyc]
   enable-active-witnesses=true
   topology=clustered
   master=db1
   members=db1,db2,db3
   witnesses=db3
   connectors=db1,db2,db3
   ```

   After:

   ```
   [defaults]
   user=tungsten
   home-directory=/opt/continuent
   application-user=app_user
   application-password=secret
   application-port=3306
   profile-script=~/.bash_profile
   replication-user=tungsten
   replication-password=secret
   replication-port=13306
   mysql-allow-intensive-checks=true

   [nyc]
   topology=clustered
   master=db1
   members=db1,db2,db3
   connectors=db1,db2,db3
   ```

5. Update the software on the existing cluster nodes and connector nodes (If separate). Include `--no-connectors` if connectors you want to manually restart them when convenient.

   ```
   shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
   ```

```
shell> tools/tpm update --replace-release
```

6. Either install on the new host or update on the previous Witness host:

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> tools/tpm install
```

or:

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> tools/tpm update --replace-release -f
```

7. Staging Install

If you are using a staging configuration, update the configuration from the staging host, example below:

```
shell> cd {STAGING_DIRECTORY}

./tools/tpm configure defaults \
--reset \
--user=tungsten \
--home-directory=/opt/continuent \
--application-user=app_user \
--application-password=secret \
--application-port=3306 \
--profile-script=~/.bash_profile \
--replication-user=tungsten \
--replication-password=secret \
--replication-port=13306 \
--mysql-allow-intensive-checks=true

./tools/tpm configure nyc \
--topology=clustered \
--master=db1 \
--members=db1,db2,db3 \
--connectors=db1,db2,db3
```

8. Update the software on the existing cluster nodes. Include `--no-connectors` if connectors co-exist on database nodes and you want to manually restart them when convenient.

```
shell> cd {STAGING_DIRECTORY}
shell> tools/tpm update --replace-release --hosts=db1,db2
```

9. Either install on the new host or update on the previous Witness host:

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> tools/tpm install --hosts=db3
```

or:

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> tools/tpm update --replace-release -f --hosts=db3
```

10. Once the software has been installed you now need to restore a backup of the database onto the node, or provision the database using the provided scripts. Either restore a backup, create and restore a new backup or use tungsten_provision_slave to restore the database on the host.

11. Start the software on the new node/old witness node

```
shell> startall
```

12. If you issued `--no-connectors` during the update, restart the connectors when convenient

```
shell> connector restart
```

13. Check within cctrl from one of the existing database nodes to check that the status returns the exptected output, if it does, return the cluster to `AUTOMATIC` and the process is complete. If the output is not correct, this is usually due to metadata files not updating, therefore on every node, issue the following:

```
shell> tungsten_reset_manager
```

This will clean the metadata files and stop the manager process. Once the script has completed on all nodes, restart the manager process on each node, one-by-one, starting with the Primary node first, followed by the Replicas

```
shell> manager start
```

Finally, return the cluster to `AUTOMATIC`. If the reset process above was performed, it may take a minute or two for the ls output of cctrl to update whilst the metadata files are refreshed.

3.5.4. Replacing a Full Cluster Node as an Active Witness

This section explains the simple process for converting a full cluster node into an Active Witness.

1. First, place the cluster into `MAINTENANCE` mode.

```
shell> cctrl
cctrl> set policy maintenance
```

2. Stop the software on the existing cluster node

```
shell> stopall
```

3. Stop MySQL on the existing cluster node (Syntax is an example and may differ in your environment)

```
shell> systemctl stop mysqld
```

4. INI Install

   If you are using an ini file for configuration, update the ini on all nodes (including connectors) changind the reference to the node to be a witness node, example below. Skip to Staging Install further down for Staging steps.

   Before:

```
[defaults]
user=tungsten
home-directory=/opt/continuent
application-user=app_user
application-password=secret
application-port=3306
profile-script=~/.bash_profile
replication-user=tungsten
replication-password=secret
replication-port=13306
mysql-allow-intensive-checks=true

[nyc]
topology=clustered
master=db1
members=db1,db2,db3
connectors=db1,db2,db3
```

   After:

```
[defaults]
user=tungsten
home-directory=/opt/continuent
application-user=app_user
application-password=secret
application-port=3306
profile-script=~/.bash_profile
replication-user=tungsten
replication-password=secret
replication-port=13306
mysql-allow-intensive-checks=true

[nyc]
enable-active-witnesses=true
topology=clustered
master=db1
members=db1,db2,db3
witnesses=db3
connectors=db1,db2,db3
```

5. Update the software on the existing cluster nodes and connector nodes (If separate). Include `--no-connectors` if connectors you want to manually restart them when convenient.

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> tools/tpm update --replace-release
```

6. Update on the host you are converting:

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> tools/tpm update --replace-release -f
```

7. Staging Install

   If you are using a staging configuration, update the configuration from the staging host, example below:

```
shell> cd {STAGING_DIRECTORY}

./tools/tpm configure defaults \
--reset \
--user=tungsten \
--home-directory=/opt/continuent \
--application-user=app_user \
--application-password=secret \
--application-port=3306 \
--profile-script=~/.bash_profile \
--replication-user=tungsten \
--replication-password=secret \
--replication-port=13306 \
--mysql-allow-intensive-checks=true

./tools/tpm configure nyc \
--enable-active-witnesses=true \
--topology=clustered \
--master=db1 \
--members=db1,db2,db3 \
--witnesses=db3 \
--connectors=db1,db2,db3
```

8. Update the software on the existing cluster nodes. Include `--no-connectors` if connectors co-exist on database nodes and you want to manually restart them when convenient.

```
shell> cd {STAGING_DIRECTORY}
shell> tools/tpm update --replace-release --hosts=db1,db2
```

9. Update on the host you are converting:

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> tools/tpm update --replace-release -f --hosts=db3
```

10. Once the updates have been complete, you should then run the tungsten_reset_manager command on each node in the entire cluster. This will ensure the metadata is clean and reference to the node is reflected to be a witness, rather than a full cluter node. On each node, simply execute the command and follow the on screen prompts:

```
shell> tungsten_reset_manager
```

11. Restart the managers on the nodes you have not converted:

```
shell> manager start
```

12. Start the software on the node that you converted:

```
shell> startall
```

13. If you issued `--no-connectors` during the update, restart the connectors when convenient

```
shell> connector restart
```

14. Check within cctrl from one of the existing database nodes to check that the status returns the exptected output, and then return the cluster to `AUTOMATIC` and the process is complete.

3.5.5. Adding Passive Witnesses to an Existing Deployment

To add passive witness to an existing installation, use tpm to update the active configuration.

> Passive Witness hosts are deprecated as of v6.1.0
>
> Use Active Witness hosts instead
>
> Passive Witness support will be removed in v7.0.0

> **Note**
>
> Continuent recommend that active witnesses, rather than passive witnesses are used for all installations. For more information on differences, see Section 2.1, “Host Types”

Show Staging

Show INI

```
shell> tpm query staging
```

```
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --witnesses=host4
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update --no-connectors
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
witnesses=host4
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update --no-connectors
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

Using the `--no-connectors` [459] option updates the current deployment without restarting the existing connectors.

Once the update process has been completed, the current status will be displayed using cctrl. The current configuration of the cluster can be verified by using the cluster validate command within cctrl.

3.5.6. Adding Connectors to an Existing Deployment

Adding more connectors to an existing installation allows for increased routing capacity. The new connectors will form part of the cluster and be fully aware and communicate with existing managers and datasources within the cluster.

To add more connectors to an existing deployment:

1. On the new host, ensure the Appendix B, *Prerequisites* have been followed.
2. Update the configuration using tpm, adding the new host to the list of `connectors` [440]

   If using the staging method of deployment, you can use `+=`, which appends the host to the existing deployment as shown in the example below. Click the link to switch between staging and ini type deployment examples.

   Show Staging

   Show INI

   ```
   shell> tpm query staging
   tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

   shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
   The staging USER is tungsten

   shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
   The staging HOST is db1

   shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
   ```

```
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --connectors+=host4 \
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update --no-connectors
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, "Configuration Changes from a Staging Directory".

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
connectors=host4
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update --no-connectors
```

For information about making updates when using an INI file, please see Section 10.4.4, "Configuration Changes with an INI file".

3. Using the `--no-connectors` [459] option updates the current deployment without restarting the existing connectors.

4. During a period when it is safe to restart the connectors:

```
shell> ./tools/tpm promote-connector
```

The status of all the connectors can be monitored using cctrl:

```
[LOGICAL] /alpha > ls

COORDINATOR[host1:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@host1[8616](ONLINE, created=0, active=0)                          |
|connector@host2[12381](ONLINE, created=0, active=0)                         |
|connector@host3[19708](ONLINE, created=0, active=0)                         |
|connector@host4[5085](ONLINE, created=0, active=0)                          |
+----------------------------------------------------------------------------+
```

3.5.7. Converting from a single cluster to a composite cluster

There are two possible scenarios for converting from a single standalone cluster to a composite cluster. The two following sections will guide you through examples of each of these.

3.5.7.1. Convert and add new nodes as a new service

The following steps guide you through updating the configuration to include the new hosts as a new service and convert to a Composite Cluster.

For the purpose of this worked example, we have a single cluster dataservice called `east` with three nodes, defined as db1, db2 and db3 with db1 as the Primary.

Our goal is to create a new cluster dataservice called `west` with three nodes, defined as db4, db5 and db6 with db4 as the relay.

We will configure a new composite dataservice called `global`

1. On the new host[s], ensure the Appendix B, *Prerequisites* have been followed.

   If configuring via the Staging Installation method, skip straight to Step 4:

2. On the new host(s), ensure the `tungsten.ini` contains the correct service blocks for both the existing cluster and the new cluster.

3. On the new host(s), install the proper version of clustering software, ensuring that the version being installed matches the version currently installed on the existing hosts.

   > **Important**
   >
   > Ensure `--start-and-report` [466] is set to `false` in the configuration for the new hosts.

4. Set the existing cluster to maintenance mode using cctrl:

```
shell> cctrl
[LOGICAL] / > set policy maintenance
```

5. Add the definition for the new Replica cluster service `west` and composite service `global` to the existing configuration on the existing host(s):

   Click the link to switch between staging or ini examples

   Show Staging

   Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure west \
    --connectors=db4,db5,db6 \
    --relay-source=east \
    --relay=db4 \
    --slaves=db5,db6 \
    --topology=clustered

shell> ./tools/tpm configure global \
    --composite-datasources=east,west
```

   Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update --no-connectors --replace-release
```

   For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[west]
...
connectors=db4,db5,db6
relay-source=east
relay=db4
slaves=db5,db6
topology=clustered

[global]
...
composite-datasources=east,west
```

   Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm update --no-connectors --replace-release
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

> **Note**
>
> Using the optional `--no-connectors` [459] option updates the current deployment without restarting the existing connectors.

> **Note**
>
> Using the `--replace-release` option ensures the metadata files for the cluster are correctly rebuilt. This parameter MUST be supplied.

6. On every node in the original cluster, make sure all replicators are online:

```
shell> trepctl online; trepctl services
```

7. On all the new hosts in the new cluster, start the manager processes only

```
shell> manager start
```

8. From the original cluster, use cctrl to check that the new dataservice and composite dataservice have been created, and place the new dataserive into maintenance mode

```
shell> cctrl -multi
cctrl> ls
cctrl> use global
cctrl> ls
cctrl> datasource east online
cctrl> set policy maintenance
```

```
tungsten@db1:~  $ cctrl -multi
Tungsten Clustering 6.1.1 build 129
east: session established, encryption=false, authentication=false

[LOGICAL] / > ls
global
  east
  west

[LOGICAL] / > use global
[LOGICAL] /global > ls
COORDINATOR[db3:MIXED:ONLINE]
   east:COORDINATOR[db3:MAINTENANCE:ONLINE]
   west:COORDINATOR[db5:AUTOMATIC:ONLINE]

ROUTERS:
+---------------------------------------------------------------------------+
|connector@db1[9493](ONLINE, created=0, active=0)                           |
|connector@db2[9341](ONLINE, created=0, active=0)                           |
|connector@db3[10675](ONLINE, created=0, active=0)                          |
+---------------------------------------------------------------------------+

DATASOURCES:
+---------------------------------------------------------------------------+
|east(composite master:OFFLINE)                                             |
|STATUS [OK] [2019/12/09 11:04:17 AM UTC]                                   |
+---------------------------------------------------------------------------+
+---------------------------------------------------------------------------+
|west(composite slave:OFFLINE)                                              |
|STATUS [OK] [2019/12/09 11:04:17 AM UTC]                                   |
+---------------------------------------------------------------------------+

REASON FOR MAINTENANCE MODE: MANUAL OPERATION

[LOGICAL] /global > datasource east online
composite data source 'east@global' is now ONLINE

[LOGICAL] /global > set policy maintenance
policy mode is now MAINTENANCE
```

9. Start the replicators in the new cluster ensuring they start as OFFLINE:

```
shell> replicator start offline
```

10. Go to the relay (Primary) node of the new cluster (i.e. db4) and provision it from a Replica of the original cluster (i.e. db2):

```
db4-shell> tungsten_provision_slave --source db2
```

11. Go to each Replica node of the new cluster and provision from the relay node of the new cluster (i.e. db4):

```
db5-shell> tungsten_provision_slave --source db4
```

12. Bring the replicators in the new cluster online:

```
shell> trepctl online
```

13. From a node in the original cluster (e.g. db1), using cctrl, set the composite cluster online and return both clusters to automatic:

```
shell> cctrl -multi
[LOGICAL] / > use global
[LOGICAL] / > datasource west online
[LOGICAL] / > set policy automatic
```

14. Start the connectors associated with the new cluster hosts in `west`:

```
shell> connector start
```

15. If `--no-connectors` [459] was issued during the update, then during a period when it is safe, restart the connectors associated with the original cluster:

```
shell> ./tools/tpm promote-connector
```

3.5.7.2. Convert and move nodes to a new service

This method of conversion is a little more complicated and the only safe way to accomplish this would require downtime for the replication on all nodes.

To achieve this without downtime to your applications, it is recommended that all application activity be isolated to the Primary host only. Following the conversion, all activity will then be replicated to the Replica nodes

Our example starting cluster has 5 nodes (1 Primary and 4 Replicas) and uses service name `alpha`. Our target cluster will have 6 nodes (3 per cluster) in 2 member clusters `alpha_east` and `alpha_west` in composite service `alpha`.

This means that we will reuse the existing service name `alpha` as the name of the new composite service, and create two new service names, one for each cluster (`alpha_east` and `alpha_west`).

To convert the above configuration, follow the steps below:

1. On the new host, ensure the Appendix B, *Prerequisites* have been followed.
2. Ensure the cluster is in MAINTENANCE mode. This will prevent the managers from performing any unexpected recovery or failovers during the process.

```
cctrl> set policy maintenance
```

3. Next, you must stop all services on all existing nodes.

```
shell> stopall
```

4. If configuring via the INI Installation Method, update tungsten.ini on all original 5 nodes, then copy the file to the new node.

   You will need to create two new services for each cluster, and change the original service stanza to represent the composite service. An example of how the complete configuration would look is below. Click the link the switch between ini and staging configurations.

   Show Staging

   Show INI

```
shell> ./tools/tpm configure defaults \
    --reset \
    --user=tungsten \
    --install-directory=/opt/continuent \
    --profile-script=~/.bash_profile \
    --replication-user=tungsten \
    --replication-password=secret \
    --replication-port=13306 \
    --application-user=app_user \
    --application-password=secret \
    --application-port=3306 \
    --rest-api-admin-user=apiuser \
    --rest-api-admin-pass=secret

shell> ./tools/tpm configure alpha_east \
    --topology=clustered \
    --master=db1 \
    --members=db1,db2,db3 \
```

```
    --connectors=db1,db2,db3

shell> ./tools/tpm configure alpha_west \
    --topology=clustered \
    --relay=db4 \
    --members=db4,db5,db6 \
    --connectors=db4,db5,db6 \
    --relay-source=alpha_east

shell> ./tools/tpm configure alpha \
    --composite-datasources=alpha_east,alpha_west
```

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[defaults]
user=tungsten
install-directory=/opt/continuent
profile-script=~/.bash_profile
replication-user=tungsten
replication-password=secret
replication-port=13306
application-user=app_user
application-password=secret
application-port=3306
rest-api-admin-user=apiuser
rest-api-admin-pass=secret

[alpha_east]
topology=clustered
master=db1
members=db1,db2,db3
connectors=db1,db2,db3

[alpha_west]
topology=clustered
relay=db4
members=db4,db5,db6
connectors=db4,db5,db6
relay-source=alpha_east

[alpha]
composite-datasources=alpha_east,alpha_west
```

5. Using you preferred backup/restore method, take a backup of the MySQL database on one of the original nodes and restore this to the new node

   If preferred, this step can be skipped, and the provision of the new node completed via the use of the supplied provisioning scripts, explained in Step 10 below.

6. Invoke the conversion using the tpm command from the software extraction directory.

   If installation configured via the INI method, this command should be run on all 5 original nodes. If configured via Staging method, this command should be run on the staging host only.

```
shell> tpm query staging
shell> cd {software_staging_dir_from_tpm_query}
shell> ./tools/tpm update --replace-release --force
shell> rm /opt/continuent/tungsten/cluster-home/conf/cluster/*/datasource/*
```

   Note

   The use of the `--force` [395] option is required to force the override of the old properties

7. Only if installation configured via the INI method, then proceed to install the software using the tpm command from the software extraction directory on the new node:

```
shell> cd {software_staging_dir}
shell> ./tools/tpm install
```

   Note

   Ensure you install the same version of software on the new node that matches exactly, the version on the existing 5 nodes

8. Start all services on all existing nodes.

```
shell> startall
```

9. Bring the clusters back into AUTOMATIC mode:

```
shell> cctrl -multi
cctrl> use alpha
cctrl> set policy automatic
cctrl> exit
```

10. If you skipped the backup/restore step above, you now need to provision the database on the new node. To do this, use the tungsten_provision_slave script to provision the database from one of the existing nodes, for example db5

```
shell> tungsten_provision_slave --source db5
```

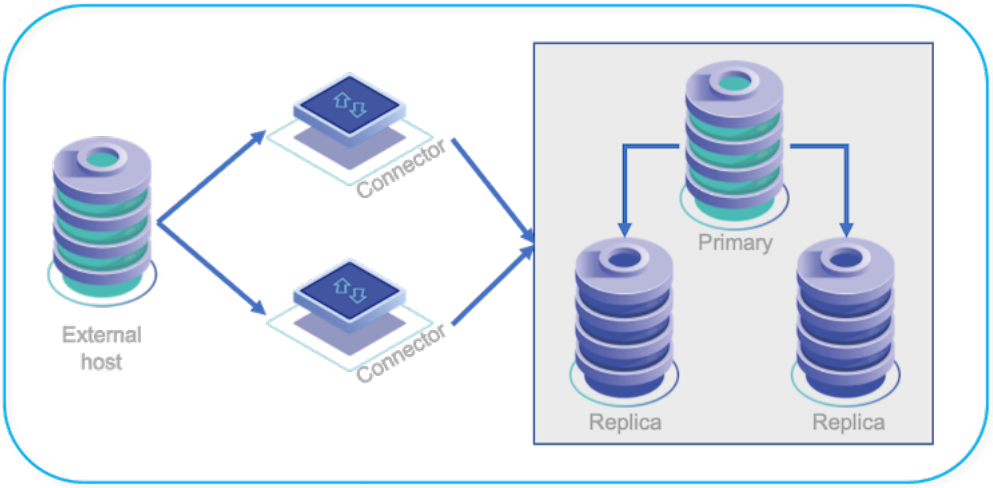
3.6. Replicating Data Into an Existing Dataservice

If you have an existing dataservice, data can be replicated from a standalone MySQL server into the service. The replication is configured by creating a service that reads from the standalone MySQL server and writes into the cluster through a connector attached to your dataservice. By writing through the connector, changes to the underlying dataservice topology can be handled.

Additionally, using a replicator that writes data into an existing data service can be used when migrating from an existing service into a new Tungsten Cluster service.

For more information on initially provisioning the data for this type of operation, see Section 6.11.2, "Migrating from MySQL Native Replication Using a New Service".

Figure 3.4. Topologies: Replicating into a Dataservice



In order to configure this deployment, there are two steps:

1. Create a new replicator on the source server that extracts the data.
2. Create a new replicator that reads the binary logs directly from the external MySQL service through the connector

There are also the following requirements:

- The host on which you want to replicate to must have Tungsten Replicator 5.3.0 or later.
- Hosts on both the replicator and cluster must be able to communicate with each other.
- The replication user on the source host must have the `RELOAD`, `REPLICATION SLAVE`, and `REPLICATION CLIENT GRANT` privileges.
- Replicator must be able to connect as the `tungsten` user to the databases within the cluster.
- When writing into the Primary through the connector, the user must be given the correct privileges to write and update the MySQL server. For this reason, the easiest method is to use the `tungsten` user, and ensure that that user has been added to the `user.map`:

```
tungsten secret alpha
```

Install the Tungsten Replicator package (see Section 2.3.2, "Using the RPM package files"), or download the compressed tarball and unpack it on `host1`:

```
shell> cd /opt/replicator/software
shell> tar zxf tungsten-replicator-5.4.1-41.tar.gz
```

Change to the Tungsten Replicator staging directory:

```
shell> cd tungsten-replicator-5.4.1-41
```

Configure the replicator on host1

First we configure the defaults and a cluster alias that points to the Primaries and Replicas within the current Tungsten Cluster service that you are replicating from:

Click the link below to switch examples between Staging and INI methods

Show Staging

Show INI

```
shell> ./tools/tpm configure alpha \
    --master=host1 \
    --install-directory=/opt/continuent \
    --replication-user=tungsten \
    --replication-password=password \
    --enable-batch-service=true
```

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
master=host1
install-directory=/opt/continuent
replication-user=tungsten
replication-password=password
enable-batch-service=true
```

Configuration group **alpha**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- --master=host1 [454]

  master=host1 [454]

  The hostname of the primary (extractor) within the current service.

- --install-directory=/opt/continuent [450]

  install-directory=/opt/continuent [450]

  Path to the directory where the active deployment will be installed. The configured directory will contain the software, THL and relay log information unless configured otherwise.

- --replication-user=tungsten [464]

  replication-user=tungsten [464]

  For databases that required authentication, the username to use when connecting to the database using the corresponding connection method (native, JDBC, etc.).

- --replication-password=password [463]

  replication-password=password [463]

  The password to be used when connecting to the database using the corresponding --replication-user [464].

- --enable-batch-service=true

  enable-batch-service=true

  This option enables batch mode for a service, which ensures that replication services that are writing to a target database using batch mode in heterogeneous deployments (for example Hadoop, Amazon Redshift or Vertica). Setting this option enables the following settings on each host:

  - On a Primary
    - mysql-use-bytes-for-string [459] is set to false.
    - colnames filter is enabled (in the binlog-to-q stage to add column names to the THL information.
    - pkey filter is enabled (in the binlog-to-q and q-to-dbms stage), with the *addPkeyToInserts* and *addColumnsToDeletes* filter options set to true. This ensures that rows have the right primary key information.

- `enumtostring` filter is enabled (in the `q-to-thl` stage), to translate `ENUM` values to their string equivalents.
- `settostring` filter is enabled (in the `q-to-thl` stage), to translate `SET` values to their string equivalents.

- On a Replica
  - `mysql-use-bytes-for-string` [459] is set to true.
  - `pkey` filter is enabled (`q-to-dbms` stage).

This creates a configuration that specifies that the topology should read directly from the source host, `host3`, writing directly to `host1`. An alternative THL port is provided to ensure that the THL listener is not operating on the same network port as the original.

Now install the service, which will create the replicator reading direct from `host3` into `host1`:

```
shell> ./tools/tpm install
```

If the installation process fails, check the output of the `/tmp/tungsten-configure.log` file for more information about the root cause.

Once the installation has been completed, you must update the position of the replicator so that it points to the correct position within the source database to prevent errors during replication. If the replication is being created as part of a migration process, determine the position of the binary log from the external replicator service used when the backup was taken. For example:

```
mysql> show master status;
*************************** 1. row ***************************
            File: mysql-bin.000026
        Position: 1311
    Binlog_Do_DB:
Binlog_Ignore_DB:
1 row in set (0.00 sec)
```

Use dsctl set to update the replicator position to point to the Primary log position:

```
shell> /opt/replicator/tungsten/tungsten-replicator/bin/dsctl -service beta set \
    -reset -seqno 0 -epoch 0 \
    -source-id host3 -event-id mysql-bin.000026:1311
```

Now start the replicator:

```
shell> /opt/replicator/tungsten/tungsten-replicator/bin/replicator start
```

Replication status should be checked by explicitly using the servicename and/or RMI port:

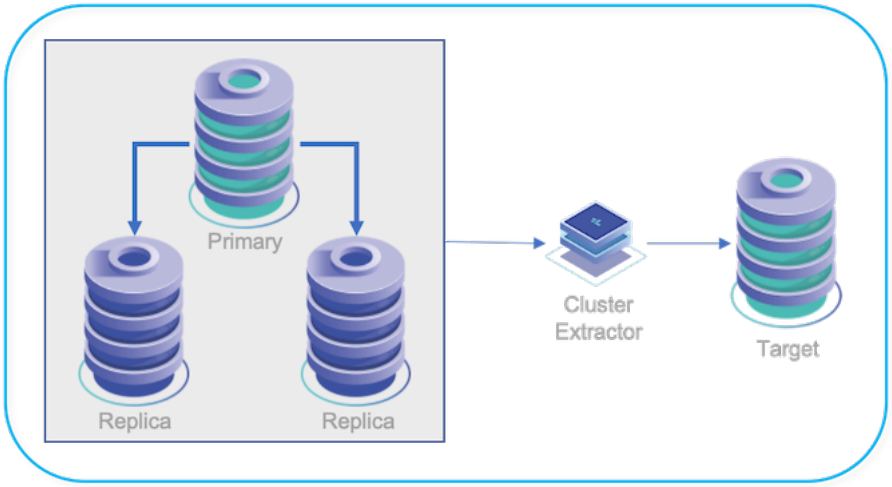
```
shell> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service beta status
Processing status command...
NAME                     VALUE
----                     -----
appliedLastEventId     : mysql-bin.000026:0000000000001311;1252
appliedLastSeqno       : 5
appliedLatency         : 0.748
channels               : 1
clusterName            : beta
currentEventId         : mysql-bin.000026:0000000000001311
currentTimeMillis      : 1390410611881
dataServerHost         : host1
extensions             :
host                   : host3
latestEpochNumber      : 1
masterConnectUri       : thl://host3:2112/
masterListenUri        : thl://host1:2113/
maximumStoredSeqNo     : 5
minimumStoredSeqNo     : 0
offlineRequests        : NONE
pendingError           : NONE
pendingErrorCode       : NONE
pendingErrorEventId    : NONE
pendingErrorSeqno      : -1
pendingExceptionMessage: NONE
pipelineSource         : jdbc:mysql:thin://host3:13306/
relativeLatency        : 8408.881
resourcePrecedence     : 99
rmiPort                : 10000
role                   : master
seqnoType              : java.lang.Long
serviceName            : beta
serviceType            : local
simpleServiceName      : beta
siteName               : default
sourceId               : host3
state                  : ONLINE
timeInStateSeconds     : 8408.21
```

```
transitioningTo        :
uptimeSeconds          : 8409.88
useSSLConnection       : false
version                : Tungsten Replicator 5.4.1 build 41
Finished status command...
```

3.7. Replicating Data Out of a Cluster

If you have an existing cluster and you want to replicate the data out to a separate standalone server using Tungsten Replicator then you can create a cluster alias, and use a Primary/Replica topology to replicate from the cluster. This allows for THL events from the cluster to be applied to a separate server for the purposes of backup or separate analysis.

Figure 3.5. Topologies: Replicating Data Out of a Cluster



During the installation process a `cluster-alias` and `cluster-slave` are declared. The `cluster-alias` describes all of the servers in the cluster and how they may be reached. The `cluster-slave` defines one or more servers that will replicate from the cluster.

The Tungsten Replicator will be installed on the Cluster-Extractor server. That server will download THL data and apply them to the local server. If the Cluster-Extractor has more than one server; one of them will be declared the relay (or Primary). The other members of the Cluster-Extractor may also download THL data from that server.

If the relay for the Cluster-Extractor fails; the other nodes will automatically start downloading THL data from a server in the cluster. If a non-relay server fails; it will not have any impact on the other members.

3.7.1. Prepare: Replicating Data Out of a Cluster

1. Identify the cluster to replicate from. You will need the Primary, Replicas and THL port (if specified). Use tpm reverse from a cluster member to find the correct values.
2. If you are replicating to a non-MySQL server. Update the configuration of the cluster to include the following properties prior to beginning.

   ```
   svc-extractor-filters=colnames,pkey
   property=replicator.filter.pkey.addColumnsToDeletes=true
   property=replicator.filter.pkey.addPkeyToInserts=true
   ```
3. Identify all servers that will replicate from the cluster. If there is more than one, a relay server should be identified to replicate from the cluster and provide THL data to other servers.
4. Prepare each server according to the prerequisites for the DBMS platform it is serving. If you are working with multiple DBMS platforms; treat each platform as a different Cluster-Extractor during deployment.
5. Make sure the THL port for the cluster is open between all servers.

3.7.2. Deploy: Replicating Data Out of a Cluster

1. Install the Tungsten Replicator package or download the Tungsten Replicator tarball, and unpack it:

   ```
   shell> cd /opt/continuent/software
   shell> tar zxf tungsten-replicator-5.4.1-41.tar.gz
   ```
2. Change to the unpackaged directory:

```
shell> cd tungsten-replicator-5.4.1-41
```

3. Configure the replicator

   Click the link below to switch examples between Staging and INI methods

   Show Staging

   Show INI

```
shell> ./tools/tpm configure defaults \
    --install-directory=/opt/continuent \
    --profile-script=~/.bash_profile \
    --replication-password=secret \
    --replication-port=13306 \
    --replication-user=tungsten \
    --user=tungsten \
    --rest-api-admin-user=apiuser \
    --rest-api-admin-pass=secret

shell> ./tools/tpm configure alpha \
    --master=host1 \
    --slaves=host2,host3 \
    --thl-port=2112 \
    --topology=cluster-alias

shell> ./tools/tpm configure beta \
    --relay=host6 \
    --relay-source=alpha \
    --topology=cluster-slave
```

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[defaults]
install-directory=/opt/continuent
profile-script=~/.bash_profile
replication-password=secret
replication-port=13306
replication-user=tungsten
user=tungsten
rest-api-admin-user=apiuser
rest-api-admin-pass=secret

[alpha]
master=host1
slaves=host2,host3
thl-port=2112
topology=cluster-alias

[beta]
relay=host6
relay-source=alpha
topology=cluster-slave
```

   Configuration group **defaults**

   The description of each of the options is shown below; click the icon to hide this detail:

   Click the icon to show a detailed description of each argument.

   - `--install-directory=/opt/continuent` [450]

     `install-directory=/opt/continuent` [450]

     Path to the directory where the active deployment will be installed. The configured directory will contain the software, THL and relay log information unless configured otherwise.

   - `--profile-script=~/.bash_profile` [461]

     `profile-script=~/.bash_profile` [461]

     Append commands to include env.sh in this profile script

   - `--replication-password=secret` [463]

     `replication-password=secret` [463]

     The password to be used when connecting to the database using the corresponding `--replication-user` [464].

- `--replication-port=13306` [463]

  `replication-port=13306` [463]

  The network port used to connect to the database server. The default port used depends on the database being configured.

- `--replication-user=tungsten` [464]

  `replication-user=tungsten` [464]

  For databases that required authentication, the username to use when connecting to the database using the corresponding connection method (native, JDBC, etc.).

- `--user=tungsten` [471]

  `user=tungsten` [471]

  System User

- `--rest-api-admin-user=apiuser`

  `rest-api-admin-user=apiuser`
  Optional: Must be specified along with rest-api-admin-pass if you wish to access the full API features and use the Dashboard GUI for cluster installations.

- `--rest-api-admin-pass=secret`

  `rest-api-admin-pass=secret`
  Optional: Must be specified along with rest-api-admin-user if you wish to access the full API features.

Configuration group **`alpha`**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--master=host1` [454]

  `master=host1` [454]

  The hostname of the primary (extractor) within the current service.

- `--slaves=host2,host3` [466]

  `slaves=host2,host3` [466]

  What are the Replicas for this dataservice?

- `--thl-port=2112` [470]

  `thl-port=2112` [470]

  Port to use for THL Operations

- `--topology=cluster-alias` [470]

  `topology=cluster-alias` [470]

  Replication topology for the dataservice.

Configuration group **`beta`**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--relay=host6` [454]

  `relay=host6` [454]

  The hostname of the primary (extractor) within the current service.

- `--relay-source=alpha` [463]

  `relay-source=alpha` [463]

  Dataservice name to use as a relay source

- `--topology=cluster-slave` [470]

  `topology=cluster-slave` [470]

  Replication topology for the dataservice.

  Important

  If you are replicating to a non-MySQL server. Include the following steps in your configuration.

  ```
  shell> mkdir -p /opt/continuent/share/
  shell> cp tungsten-replicator/support/filters-config/convertstringfrommysql.json »
     /opt/continuent/share/
  ```

  Then, include the following parameters in the configuration

  ```
  property=replicator.stage.remote-to-thl.filters=convertstringfrommysql
  property=replicator.filter.convertstringfrommysql.definitionsFile= »
     /opt/continuent/share/convertstringfrommysql.json
  ```

  Important

  This dataservice `cluster-alias` name MUST be the same as the cluster dataservice name that you are replicating from.

  Note

  Do not include `start-and-report=true` [466] if you are taking over for MySQL native replication. See Section 6.11.1, “Migrating from MySQL Native Replication 'In-Place'” for next steps after completing installation.

4. Once the configuration has been completed, you can perform the installation to set up the services using this configuration:

   ```
   shell> ./tools/tpm install
   ```

During the installation and startup, tpm will notify you of any problems that need to be fixed before the service can be correctly installed and started. If the service starts correctly, you should see the configuration and current status of the service.

If the installation process fails, check the output of the `/tmp/tungsten-configure.log` file for more information about the root cause.

The cluster should be installed and ready to use.

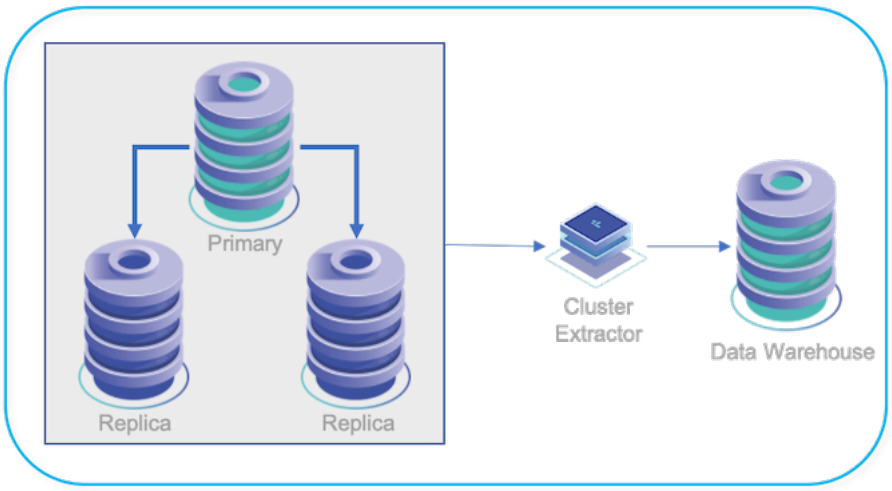
3.8. Replicating from a Cluster to a Datawarehouse

You can replicate data from an existing cluster to a datawarehouse such as Hadoop or Vertica. A replication applier node handles the datawarehouse loading by obtaining THL from the cluster. The configuration of the cluster needs to be changed to be compatible with the required target applier format.

The Cluster-Extractor deployment works by configuring the cluster replication service in heterogeneous mode, and then replicating out to the Appliers that writes into the datawarehouse by using a cluster alias. This ensures that changes to the cluster topology (i.e. Primary switches during a failover or maintenance) still allow replication to continue effectively to your chosen datawarehouse.

The datawarehouse may be installed and running on the same host as the replicator, "Onboard", or on a different host entirely, "Offboard".

Figure 3.6. Topologies: Replication from a Cluster to an Offboard Datawarehouse



Below is a summary of the steps needed to configure the Cluster-Extractor topology, with links to the actual procedures included:

1. Install or update a cluster, configured to operate in heterogeneous mode.

   In our example, the cluster configuration file `/etc/tungsten/tungsten.ini` would contain two stanzas:

   - `[defaults]` - contains configuration values used by all services.
   - `[alpha]` - contains cluster configuration parameters, and will use `topology=clustered` [470] to indicate to the tpm command that nodes listed in this stanza are to be acted upon during installation and update operations.

   For more details about installing the source cluster, please see Section 3.8.2, "Replicating from a Cluster to a Datawarehouse - Configuring the Cluster Nodes".

2. Potentially seed the initial data. For more information about various ways to provision the initial data into the target warehouse, please see Section 3.9, "Migrating and Seeding Data".

3. Install the Extractor replicator:

   In our example, the Extractor configuration file `/etc/tungsten/tungsten.ini` would contain three stanzas:

   - `[defaults]` - contains configuration values used by all services.
   - `[alpha]` - contains the list of cluster nodes for use by the applier service as a source list. This stanza will use `topology=cluster-alias` [470] to ensure that no installation or update action will ever be taken on the listed nodes by the tpm command.
   - `[omega]` - defines a replicator Applier service that uses `topology=cluster-slave` [470]. This service will extract THL from the cluster nodes defined in the relay source cluster-alias definition `[alpha]` and write the events into your chosen datawarehouse.

   For more details about installing the replicator, please see Section 3.8.3, "Replicating from a Cluster to a Datawarehouse - Configuring the Cluster-Extractor".

3.8.1. Replicating from a Cluster to a Datawarehouse - Prerequisites

There are the prerequisite requirements for Cluster-Extractor operations::

- The Tungsten Cluster and Tungsten Replicator must be version 5.2.0 or later.
- Hosts on both the replicator and cluster must be able to communicate with each other.
- Replicator must be able to connect as the `tungsten` user to the databases within the cluster

3.8.2. Replicating from a Cluster to a Datawarehouse - Configuring the Cluster Nodes

There are the steps to configure a cluster to act as the source for a Cluster-Extractor replicator writing into a datawarehouse:

- Enable MySQL ROW-based Binary Logging

  All MySQL databases running in clusters replicating to non-MySQL targets must operate in ROW-based replication mode to prevent data drift.

  This is required because replication to the datawarehouse environment must send the raw-data, rather than the statements which cannot be applied directly to a target datawarehouse.

  You must configure the `my.cnf` file to enable ROW-based binary logging:

  ```
  binlog-format = ROW
  ```

  ROW-based binary logging can also be enabled without restarting the MySQL server:

  ```
  mysql> select @@global.binlog_format\G
  *************************** 1. row ***************************
  @@global.binlog_format: MIXED
  1 row in set (0.00 sec)

  mysql> SET GLOBAL binlog_format = 'ROW';
  Query OK, 0 rows affected (0.00 sec)

  mysql> select @@global.binlog_format\G
  *************************** 1. row ***************************
  @@global.binlog_format: ROW
  1 row in set (0.00 sec)
  ```

- Enable and Configure the Extractor Filters

  Heterogeneous mode should be enabled within the cluster.

  The extractor filters and two associated properties add the column names and primary key details to the THL. This is required so that the information can be replicated into the datawarehouse correctly.

  For example, on every cluster node the lines below would be added to the `/etc/tungsten/tungsten.ini` file, then tpm update would be executed:

  ```
  [alpha]
  ...
  repl-svc-extractor-filters=colnames,pkey
  property=replicator.filter.pkey.addColumnsToDeletes=true
  property=replicator.filter.pkey.addPkeyToInserts=true
  ```

  For staging deployments, prepend two hyphens to each line and include on the command line.

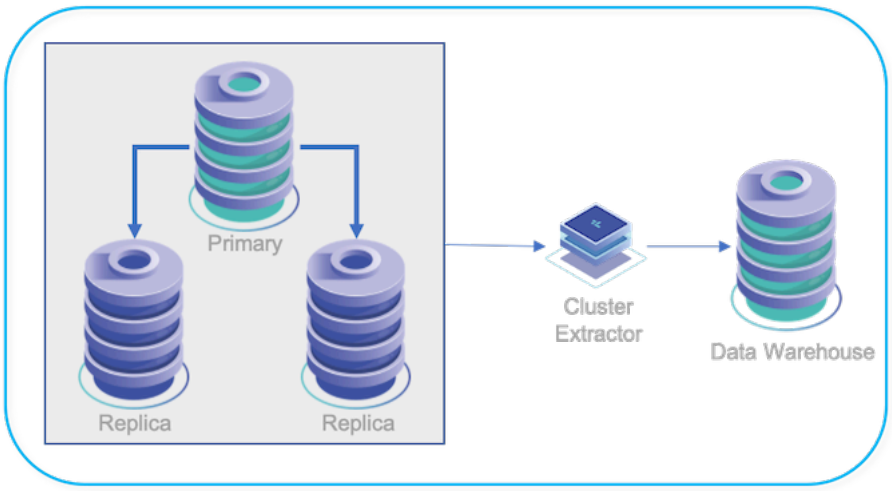
3.8.3. Replicating from a Cluster to a Datawarehouse - Configuring the Cluster-Extractor

Configure the replicator that will act as an Extractor, reading information from the cluster and then applying that data into the chosen datawarehouse. Multiple example targets are shown.

This node may be located either on a separate host (for example when replicating to Amazon Redshift), or on the same node as the target datawarehouse service (i.e. HP Vertica or Hadoop).

On the following pages are the steps to configure a Cluster-Extractor target replicator writing into a datawarehouse for both staging and INI methods of installation.

Figure 3.7. Topologies: Replication from a Cluster to an Offboard Datawarehouse



3.8.3.1. Replicating Data from a Cluster to a Datawarehouse (Staging Use Case)

The following Staging-method procedure will install the Tungsten Replicator software onto target node `host6`, extracting from a cluster consisting of three (3) nodes (`host1`, `host2` and `host3`) and applying into the target datawarehouse via `host6`.

Important

If you are replicating to a MySQL-specific target, please see Section 3.7, "Replicating Data Out of a Cluster" for more information.

1. On your staging server, go to the software directory.

```
shell> cd /opt/continuent/software
```

2. Download the latest Tungsten Replicator version.

3. Unpack the release package

```
shell> tar xvzf tungsten-replicator-5.4.1-41.tar.gz
```

4. Change to the unpackaged directory:

```
shell> cd tungsten-replicator-5.4.1-41.tar.gz
```

5. Execute the tpm command to configure defaults for the installation.

```
shell> ./tools/tpm configure defaults \
--install-directory=/opt/replicator \
'--profile-script=~/.bashrc' \
--replication-password=secret \
--replication-port=13306 \
--replication-user=tungsten \
--start-and-report=true \
--mysql-allow-intensive-checks=true \
--user=tungsten
```

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- tpm configure defaults

  This runs the tpm command. configure defaults indicates that we are setting options which will apply to all dataservices.

- `--install-directory=/opt/replicator` [450]

  The installation directory of the Tungsten service. This is where the service will be installed on each server in your dataservice.

- `--profile-script="~/.bashrc"` [461]

The profile script used when your shell starts. Using this line modifies your profile script to add a path to the Tungsten tools so that managing Tungsten Cluster™ are easier to use.

- `--user=tungsten` [471]

  The operating system user name that you have created for the Tungsten service, `tungsten`.

- `--replication-user=tungsten` [464]

  The user name that will be used to apply replication changes to the database on Replicas.

- `--replication-password=password` [463]

  The password that will be used to apply replication changes to the database on Replicas.

- `--replication-port=13306` [463]

  Set the port number to use when connecting to the MySQL server.

- `--start-and-report` [466]

  Tells tpm to startup the service, and report the current configuration and status.

6. Configure a cluster alias that points to the Primaries and Replicas within the current Tungsten Cluster service that you are replicating from:

```
shell> ./tools/tpm configure alpha \
    --master=host1 \
    --slaves=host2,host3 \
    --thl-port=2112 \
    --topology=cluster-alias
```

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- tpm configure alpha

  This runs the tpm command. configure indicates that we are creating a new dataservice, and `alpha` is the name of the dataservice being created.

  This definition is for a dataservice alias, not an actual dataservice because `--topology=cluster-alias` [470] has been specified. This alias is used in the cluster-slave section to define the source hosts for replication.

- `--master=host1` [454]

  Specifies the hostname of the default Primary in the cluster.

- `--slaves=host2,host3` [466]

  Specifies the name of any other servers in the cluster that may be replicated from.

- `--thl-port=2112` [470]

  The THL port for the cluster. The default value is 2112 but any other value must be specified.

- `--topology=cluster-alias` [470]

  Define this as a cluster dataservice alias so tpm does not try to install cluster software to the hosts.

  Important

  This dataservice `cluster-alias` name MUST be the same as the cluster dataservice name that you are replicating from.

7. On the Cluster-Extractor node, copy the `convertstringfrommysql.json` filter configuration sample file into the `/opt/replicator/share` directory then edit it to suit:

```
cp /opt/replicator/tungsten/tungsten-replicator/support/filters-config/convertstringfrommysql.json /opt/replicator/share/
vi /opt/replicator/share/convertstringfrommysql.json
```

Once the `convertstringfrommysql` JSON configuration file has been edited, update the `/etc/tungsten/tungsten.ini` file to add and configure any addition options needed for the specific datawarehouse you are using.

8. Create the configuration that will replicate from cluster dataservice `alpha` into the database on the host specified by `--relay=host6` [454]:

```
shell> ./tools/tpm configure omega \
--relay=host6 \
--relay-source=alpha \
--repl-svc-remote-filters=convertstringfrommysql \
--property=replicator.filter.convertstringfrommysql.definitionsFile=/opt/replicator/share/convertstringfrommysql.json \
--topology=cluster-slave
```

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- tpm configure omega

  This runs the tpm command. configure indicates that we are creating a new replication service, and `omega` is the unique service name for the replication stream from the cluster.

- `--relay=host6` [454]

  Specifies the hostname of the destination database into which data will be replicated.

- `--relay-source=alpha` [463]

  Specifies the name of the source cluster dataservice alias (defined above) that will be used to read events to be replicated.

- `--topology=cluster-slave` [470]

  Read source replication data from any host in the `alpha` dataservice.

9. Now finish configuring the `omega` dataservice with the options specific to the datawarehouse target in use.

- AWS RedShift Target

```
shell> ./tools/tpm configure omega \
--batch-enabled=true \
--batch-load-template=redshift \
--enable-heterogeneous-slave=true \
--datasource-type=redshift \
--replication-host=REDSHIFT_ENDPOINT_FQDN_HERE \
--replication-user=REDSHIFT_PASSWORD_HERE \
--replication-password=REDSHIFT_PASSWORD_HERE \
--redshift-dbname=REDSHIFT_DB_NAME_HERE \
--svc-applier-filters=dropstatementdata \
--svc-applier-block-commit-interval=10s \
--svc-applier-block-commit-size=5
```

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- tpm configure

  Configures default options that will be configured for all future services.

- `--topology=cluster-slave` [470]

  Configure the topology as a cluster-slave. This will configure the individual replicator as ac Extractor of all the nodes in the cluster, as defined in the previous configuration of the cluster topology.

- `--relay` [454]

  Configure the node as the relay for the cluster which will replicate data into the datawarehouse.

- `--enable-heterogeneous-slave` [448]

  Configures the Extractor to correctly process the incoming data so that it can be written to the datawarehouse. This includes correcting the processing of text data types and configuring the appropriate filters.

- `--replication-host` [463]

  The target host for writing data. In the case of Redshift, this is the fully qualified hostname of the Redshift host.

- `--replication-user` [464]

The user within the Redshift service that will be used to write data into the database.

- `--replication-password=password` [463]

  The password for the user within the Redshift service that will be used to write data into the database.

- `--datasource-type=redshift` [444]

  Set the datasource type to be used when storing information about the replication state.

- `--batch-enabled=true` [435]

  Enable the batch service, this configures the JavaScript batch engine and CSV writing semantics to generate the data to be applied into a datawarehouse.

- `--batch-load-template=redshift` [435]

  The batch load template to be used. Since we are replicating into Redshift, the `redshift` template is used.

- `--redshift-dbname=dev` [462]

  The name of the database within the Redshift service where the data will be written.

Please see Install Amazon Redshift Applier for more information.

- Vertica Target

```
shell> ./tools/tpm configure omega \
--batch-enabled=true  \
--batch-load-template=vertica6 \
--batch-load-language=js  \
--datasource-type=vertica  \
--disable-relay-logs=true \
--enable-heterogeneous-service=true \
--replication-user=dbadmin \
--replication-password=VERTICA_DB_PASSWORD_HERE \
--replication-host=VERTICA_HOST_NAME_HERE \
--replication-port=5433  \
--svc-applier-block-commit-interval=5s \
--svc-applier-block-commit-size=500  \
--vertica-dbname=VERTICA_DB_NAME_HERE
```

  Please see Install Vertica Applier for more information.

- For additional targets, please see the full list at Deploying Appliers, or click on some of the targets below:

10. Once the configuration has been completed, you can perform the installation to set up the Tungsten Replicator services using the tpm command run from the staging directory:

```
shell> ./tools/tpm install
```

If the installation process fails, check the output of the `/tmp/tungsten-configure.log` file for more information about the root cause.

The Cluster-Extractor replicator should now be installed and ready to use.

3.8.3.2. Replicating Data from a Cluster to a Datawarehouse (INI Use Case)

The following INI-based procedure will install the Tungsten Replicator software onto target node `host6`, extracting from a cluster consisting of three (3) nodes (`host1`, `host2` and `host3`) and applying into the target datawarehouse via `host6`.

> **Important**
>
> If you are replicating to a MySQL-specific target, please see Deploying the MySQL Applier for more information.

1. On the Cluster-Extractor node, copy the `convertstringfrommysql.json` filter configuration sample file into the `/opt/replicator/share` directory then edit it to suit:

```
cp /opt/replicator/tungsten/tungsten-replicator/support/filters-config/convertstringfrommysql.json /opt/replicator/share/
vi /opt/replicator/share/convertstringfrommysql.json
```

   Once the `convertstringfrommysql` JSON configuration file has been edited, update the `/etc/tungsten/tungsten.ini` file to add and configure any addition options needed for the specific datawarehouse you are using.

2. Create the configuration file `/etc/tungsten/tungsten.ini` on the destination DBMS host, i.e. `host6`:

```
[defaults]
user=tungsten
install-directory=/opt/replicator
replication-user=tungsten
replication-password=secret
replication-port=3306
profile-script=~/.bashrc
mysql-allow-intensive-checks=true
start-and-report=true

[alpha]
topology=cluster-alias
master=host1
members=host1,host2,host3
thl-port=2112

[omega]
topology=cluster-slave
relay=host6
relay-source=alpha
repl-svc-remote-filters=convertstringfrommysql
property=replicator.filter.convertstringfrommysql.definitionsFile=/opt/replicator/share/convertstringfrommysql.json
```

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- [defaults]

  `defaults` indicates that we are setting options which will apply to all cluster dataservices.

- `user=tungsten` [471]

  The operating system user name that you have created for the Tungsten service, `tungsten`.

- `install-directory=/opt/replicator` [450]

  The installation directory of the Tungsten Replicator service. This is where the replicator software will be installed on the destination DBMS server.

- `replication-user=tungsten` [464]

  The MySQL user name to use when connecting to the MySQL database.

- `replication-password=secret` [463]

  The MySQL password for the user that will connect to the MySQL database.

- `replication-port=3306` [463]

  The TCP/IP port on the destination DBMS server that is listening for connections.

- `start-and-report=true` [466]

  Tells tpm to startup the service, and report the current configuration and status.

- `profile-script=~/.bashrc` [461]

  Tells tpm to add PATH information to the specified script to initialize the Tungsten Replicator environment.

- [alpha]

  `alpha` is the name and identity of the source cluster alias being created.

  This definition is for a dataservice alias, not an actual dataservice because `topology=cluster-alias` [470] has been specified. This alias is used in the cluster-slave section to define the source hosts for replication.

- `topology=cluster-alias` [470]

  Define this as a cluster dataservice alias so tpm does not try to install cluster software to the hosts.

- `members=host1,host2,host3` [455]

  A comma separated list of all the hosts that are part of this cluster dataservice.

- `master=host1` [454]

  The hostname of the server that is the current cluster Primary MySQL server.

- `thl-port=2112` [470]

  The THL port for the cluster. The default value is 2112 but any other value must be specified.

- [omega]

  `omega` is is the unique service name for the replication stream from the cluster.

  This replication service will extract data from cluster dataservice `alpha` and apply into the database on the DBMS server specified by `relay=host6` [454].

- `topology=cluster-slave` [470]

  Tells tpm this is a Cluster-Extractor replication service which will have a list of all source cluster nodes available.

- `relay=host6` [454]

  The hostname of the destination DBMS server.

- `relay-source=alpha` [463]

  Specifies the name of the source cluster dataservice alias (defined above) that will be used to read events to be replicated.

  Important

  The `cluster-alias` name (i.e. `alpha`) MUST be the same as the cluster dataservice name that you are replicating from.

  Note

  Do not include `start-and-report=true` [466] if you are taking over for MySQL native replication. See Section 6.11.1, "Migrating from MySQL Native Replication 'In-Place'" for next steps after completing installation.

3. Now finish configuring the `omega` dataservice with the options specific to the datawarehouse target in use.

   Append the appropriate code snippet below to the bottom of the existing `[omega]` stanza:

   - AWS RedShift Target - Offboard Batch Applier

     ```
     batch-enabled=true
     batch-load-template=redshift
     datasource-type=redshift
     enable-heterogeneous-slave=true
     replication-host=REDSHIFT_ENDPOINT_FQDN_HERE
     replication-user=REDSHIFT_PASSWORD_HERE
     replication-password=REDSHIFT_PASSWORD_HERE
     redshift-dbname=REDSHIFT_DB_NAME_HERE
     svc-applier-filters=dropstatementdata
     svc-applier-block-commit-interval=1m
     svc-applier-block-commit-size=5000
     ```

     The description of each of the options is shown below; click the icon to hide this detail:

     Click the icon to show a detailed description of each argument.

     - `--topology=cluster-slave` [470]

       Configure the topology as a Cluster-Extractor. This will configure the individual replicator as an trext; of all the nodes in the cluster, as defined in the previous configuration of the cluster topology.

     - `--relay` [454]

       Configure the node as the relay for the cluster which will replicate data into the datawarehouse.

     - `--enable-heterogeneous-slave=true` [448]

       Configures the Extractor to correctly process the incoming data so that it can be written to the datawarehouse. This includes correcting the processing of text data types and configuring the appropriate filters.

- `--replication-host` [463]

  The target host for writing data. In the case of Redshift, this is the fully qualified hostname of the Redshift host.

- `--replication-user` [464]

  The user within the Redshift service that will be used to write data into the database.

- `--replication-password=password` [463]

  The password for the user within the Redshift service that will be used to write data into the database.

- `--datasource-type=redshift` [444]

  Set the datasource type to be used when storing information about the replication state.

- `--batch-enabled=true` [435]

  Enable the batch service, this configures the JavaScript batch engine and CSV writing semantics to generate the data to be applied into a datawarehouse.

- `--batch-load-template=redshift` [435]

  The batch load template to be used. Since we are replicating into Redshift, the `redshift` template is used.

- `--redshift-dbname=dev` [462]

  The name of the database within the Redshift service where the data will be written.

Please see Install Amazon Redshift Applier for more information.

- Vertica Target - Onboard/Offboard Batch Applier

```
batch-enabled=true
batch-load-template=vertica6
batch-load-language=js
datasource-type=vertica
disable-relay-logs=true
enable-heterogeneous-service=true
replication-user=dbadmin
replication-password=VERTICA_DB_PASSWORD_HERE
replication-host=VERTICA_HOST_NAME_HERE
replication-port=5433
svc-applier-block-commit-interval=5s
svc-applier-block-commit-size=500
vertica-dbname=VERTICA_DB_NAME_HERE
```

  Please see Install Vertica Applier for more information.

- For additional targets, please see the full list at Deploying Appliers, or click on some of the targets below:

4. Download and install the latest Tungsten Replicator package (`.rpm`), or download the compressed tarball and unpack it on `host6`:

```
shell> cd /opt/continuent/software
shell> tar xvzf tungsten-replicator-5.4.1-41.tar.gz
```

5. Change to the Tungsten Replicator staging directory:

```
shell> cd tungsten-replicator-5.4.1-41
```

6. Run tpm to install the Tungsten Replicator software with the INI-based configuration:

```
shell > ./tools/tpm install
```

   During the installation and startup, tpm will notify you of any problems that need to be fixed before the service can be correctly installed and started. If the service starts correctly, you should see the configuration and current status of the service.

If the installation process fails, check the output of the `/tmp/tungsten-configure.log` file for more information about the root cause.

The Cluster-Extractor replicator should now be installed and ready to use.

3.9. Migrating and Seeding Data

3.9.1. Migrating from MySQL Native Replication 'In-Place'

If you are migrating an existing MySQL native replication deployment to use Tungsten Cluster the configuration of the Tungsten Cluster replication must be updated to match the status of the Replica.

1. Deploy Tungsten Cluster using the model or system appropriate according to Chapter 2, *Deployment*. Ensure that the Tungsten Cluster is not started automatically by excluding the `--start` [466] or `--start-and-report` [466] options from the tpm commands.

2. On each Replica

   Confirm that native replication is working on all Replica nodes :

   ```
   shell> echo 'SHOW SLAVE STATUS\G' | tpm mysql | \
   egrep 'Master_Host| Last_Error| Slave_SQL_Running'
                   Master_Host: tr-ssl1
              Slave_SQL_Running: Yes
                     Last_Error:
   ```

3. On the Primary and each Replica

   Reset the Tungsten Replicator position on all servers :

   ```
   shell> replicator start offline
   shell> trepctl -service alpha reset -all -y
   ```

4. On the Primary

   Login and start Tungsten Cluster services and put the Tungsten Replicator online:

   ```
   shell> startall
   shell> trepctl online
   ```

5. On the Primary

   Put the cluster into maintenance mode using cctrl to prevent Tungsten Cluster automatically reconfiguring services:

   ```
   cctrl > set policy maintenance
   ```

6. On each Replica

   Record the current Replica log position (as reported by the `Relay_Master_Log_File` and `Exec_Master_Log_Pos` output from `SHOW SLAVE STATUS`. Ideally, each Replica should be stopped at the same position:

   ```
   shell> echo 'SHOW SLAVE STATUS\G' | tpm mysql | \
   egrep 'Master_Host| Last_Error| Relay_Master_Log_File| Exec_Master_Log_Pos'
                   Master_Host: tr-ssl1
          Relay_Master_Log_File: mysql-bin.000025
                     Last_Error: Error executing row event: 'Table 'tungsten_alpha.heartbeat' doesn't exist'
            Exec_Master_Log_Pos: 181268
   ```

   If you have multiple Replicas configured to read from this Primary, record the Replica position individually for each host. Once you have the information for all the hosts, determine the earliest log file and log position across all the Replicas, as this information will be needed when starting Tungsten Cluster replication. If one of the servers does not show an error, it may be replicating from an intermediate server. If so, you can proceed normally and assume this server stopped at the same position as the host is replicating from.

7. On the Primary

   Take the replicator offline and clear the THL:

   ```
   shell> trepctl offline
   shell> trepctl -service alpha reset -all -y
   ```

8. On the Primary

   Start replication, using the *lowest* binary log file and log position from the Replica information determined in step 6.

   ```
   shell> trepctl online -from-event 000025:181268
   ```

   Tungsten Replicator will start reading the MySQL binary log from this position, creating the corresponding THL event data.

9. On each Replica

a. Disable native replication to prevent native replication being accidentally started on the Replica.

On MySQL 5.0 or MySQL 5.1:

```
shell> echo "STOP SLAVE; CHANGE MASTER TO MASTER_HOST='';" | tpm mysql
```

On MySQL 5.5 or later:

```
shell> echo "STOP SLAVE; RESET SLAVE ALL;" | tpm mysql
```

b. If the final position of MySQL replication matches the lowest across all Replicas, start Tungsten Cluster services :

```
shell> trepctl online
shell> startall
```

The Replica will start reading from the binary log position configured on the Primary.

If the position on this Replica is different, use trepctl online -from-event to set the online position according to the recorded position when native MySQL was disabled. Then start all remaining services with startall.

```
shell> trepctl online -from-event 000025:188249
shell> startall
```

10. Use cctrl to confirm that replication is operating correctly across the dataservice on all hosts.

11. Put the cluster back into automatic mode:

```
cctrl> set policy automatic
```

12. Update your applications to use the installed connector services rather than a direct connection.

13. Remove the `master.info` file on each Replica to ensure that when a Replica restarts, it does not connect up to the Primary MySQL server again.

Once these steps have been completed, Tungsten Cluster should be operating as the replication service for your MySQL servers. Use the information in Chapter 6, *Operations Guide* to monitor and administer the service.

3.9.2. Migrating from MySQL Native Replication Using a New Service

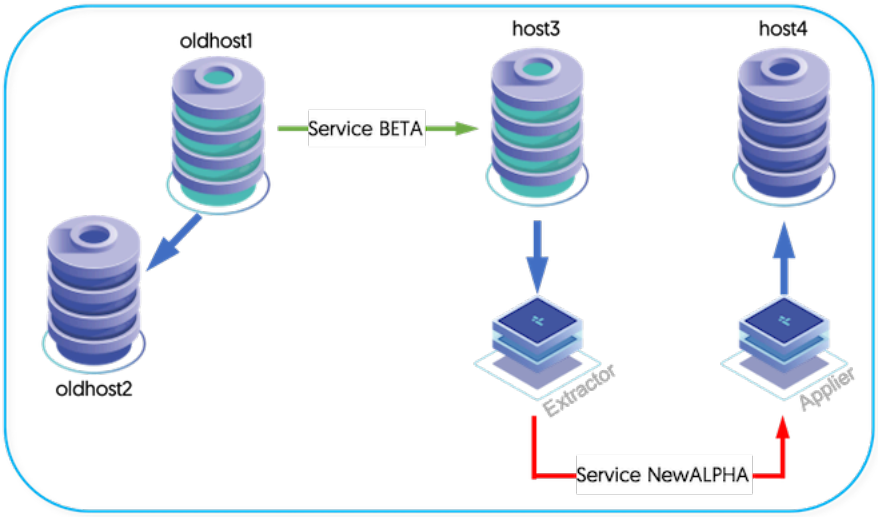
When running an existing MySQL native replication service that needs to be migrated to a Tungsten Cluster service, one solution is to create the new Tungsten Cluster service, synchronize the content, and then install a service that migrates data from the existing native service to the new service while applications are reconfigured to use the new service. The two can then be executed in parallel until applications have been migrated.

The basic structure is shown in Figure 3.8, “Migration: Migrating Native Replication using a New Service”. The migration consists of two steps:

- Initializing the new service with the current database state.
- Creating a Tungsten Replicator deployment that continues to replicate data from the native MySQL service to the new service.

Once the application has been switched and is executing against the new service, the secondary replication can be disabled by shutting down the Tungsten Replicator in `/opt/replicator`.

Figure 3.8. Migration: Migrating Native Replication using a New Service



To configure the service:

1. Stop replication on a Replica for the existing native replication installation :

```
mysql> STOP SLAVE;
```

   Obtain the current Replica position within the Primary binary log :

```
mysql> SHOW SLAVE STATUS\G
...
                Master_Host: host3
        Relay_Master_Log_File: mysql-bin.000002
          Exec_Master_Log_Pos: 559
...
```

2. Create a backup using any method that provides a consistent snapshot. The MySQL Primary may be used if you do not have a Replica to backup from. Be sure to get the binary log position as part of your back. This is included in the output to Xtrabackup or using the `--master-data=2` option with mysqldump.

3. Restart the Replica using native replication :

```
mysql> START SLAVE;
```

4. On the Primary and each Replica within the new service, restore the backup data and start the database service

5. Setup the new Tungsten Cluster deployment using the MySQL servers on which the data has been restored. For clarity, this will be called `newalpha`.

6. Configure a second replication service, `beta` to apply data using the existing MySQL native replication server as the Primary, and the Primary of `newalpha`. The information provided in Section 3.6, “Replicating Data Into an Existing Dataservice” will help. Do not start the new service.

7. Set the replication position for `beta` using tungsten_set_position to set the position to the point within the binary logs where the backup was taken:

```
shell> /opt/replicator/tungsten/tungsten-replicator/bin/tungsten_set_position \
    --seqno=0 --epoch=0 --service=beta \
    --source-id=host3 --event-id=mysql-bin.000002:559
```

8. Start replicator service `beta`:

```
shell> /opt/replicator/tungsten/tungsten-replicator/bin/replicator start
```

Once replication has been started, use trepctl to check the status and ensure that replication is operating correctly.

The original native MySQL replication Primary can continue to be used for reading and writing from within your application, and changes will be replicated into the new service on the new hardware. Once the applications have been updated to use the new service, the old servers can be decommissioned and replicator service `beta` stopped and removed.

3.9.3. Seeding Data through MySQL

Once the Tungsten Replicator is installed, it can be used to provision all Replicas with the Primary data. The Replicas will need enough information in order for the installation to succeed and for Tungsten Replicator to start. The provisioning process requires dumping all data on the Primary and reloading it back into the Primary server. This will create a full set of THL entries for the Replica replicators to apply. There may be no other applications accessing the Primary server while this process is running. Every table will be emptied out and repopulated so other applications would get an inconsistent view of the database. If the Primary is a MySQL Replica, then the Replica process may be stopped and started to prevent any changes without affecting other servers.

1. If you are using a MySQL Replica as the Primary, stop the replication thread :

```
mysql> STOP SLAVE;
```

2. Check Tungsten Replicator status on all servers to make sure it is `ONLINE` and that the *`appliedLastSeqno`* values are matching :

```
shell> trepctl status
```

   Starting the process before all servers are consistent could cause inconsistencies. If you are trying to completely reprovision the server then you may consider running trepctl reset before proceeding. That will reset the replication position and ignore any previous events on the Primary.

3. Use mysqldump to output all of the schemas that need to be provisioned :

```
shell> mysqldump --opt --skip-extended-insert -hhost3 -utungsten -P13306 -p \
    --databases db1,db2 > ~/dump.sql
```

   Optionally, you can just dump a set of tables to be provisioned :

```
shell> mysqldump --opt --skip-extended-insert -hhost3 -utungsten -P13306 -p \
    db1 table1 table2 > ~/dump.sql
```

4. If you are using heterogeneous replication all tables on the Replica must be empty before proceeding. The Tungsten Replicator does not replicate DDL statements such as `DROP TABLE` and `CREATE TABLE`. You may either truncate the tables on the Replica or use ddlscan to recreate them.

5. Load the dump file back into the Primary to recreate all data :

```
shell> cat ~/dump.sql | tpm mysql
```

   The Tungsten Replicator will read the binary log as the dump file is loaded into MySQL. The Replicas will automatically apply these statements through normal replication.

6. If you are using a MySQL Replica as the Primary, restart the replication thread after the dump file as completed loading :

```
mysql> START SLAVE;
```

7. Monitor replication status on the Primary and Replicas :

```
shell> trepctl status
```

Chapter 4. Deployment: Advanced

The following sections provide guidance and instructions for creating advanced deployments, including configuration automatic startup and shutdown during boot procedures, upgrades, downgrades, and removal of Tungsten Cluster.

4.1. Deploying Parallel Replication

Parallel apply is an important technique for achieving high speed replication and curing Replica lag. It works by spreading updates to Replicas over multiple threads that split transactions on each schema into separate processing streams. This in turn spreads I/O activity across many threads, which results in faster overall updates on the Replica. In ideal cases throughput on Replicas may improve by up to 5 times over single-threaded MySQL native replication.

> **Note**
>
> It is worth noting that the only thing Tungsten parallelizes is applying transactions to Replicas. All other operations in each replication service are single-threaded.

4.1.1. Application Prerequisites for Parallel Replication

Parallel replication works best on workloads that meet the following criteria:

- ROW based binary logging must be enabled in the MySQL database.
- Data are stored in independent schemas. If you have 100 customers per server with a separate schema for each customer, your application is a good candidate.
- Transactions do not span schemas. Tungsten serializes such transactions, which is to say it stops parallel apply and runs them by themselves. If more than 2-3% of transactions are serialized in this way, most of the benefits of parallelization are lost.
- Workload is well-balanced across schemas.
- The Replica host(s) are capable and have free memory in the OS page cache.
- The host on which the Replica runs has a sufficient number of cores to operate a large number of Java threads.
- Not all workloads meet these requirements. If your transactions are within a single schema only, you may need to consider different approaches, such as Replica prefetch. Contact Continuent for other suggestions.

Parallel replication does not work well on underpowered hosts, such as Amazon m1.small instances. In fact, any host that is already I/O bound under single-threaded replication will typical will not show much improvement with parallel apply.

> **Note**
>
> Currently, it is not recommended to use the SMARTSCALE connector configuration in conjunction with Parallel Apply. This is due to progress only being measured against the slowest channel.

4.1.2. Enabling Parallel Apply During Install

Parallel apply is enabled using the `svc-parallelization-type` [467] and `channels` [436] options of tpm. The parallelization type defaults to *`none`* which is to say that parallel apply is disabled. You should set it to *`disk`* [114]. The `channels` [436] option sets the the number of channels (i.e., threads) you propose to use for applying data. Here is a code example of a MySQL Applier installation with parallel apply enabled. The Replica will apply transactions using 30 channels.

Show Staging

Show INI

```
shell> ./tools/tpm configure defaults \
    --reset \
    --install-directory=/opt/continuent \
    --user=tungsten \
    --mysql-allow-intensive-checks=true \
    --profile-script=~/.bash_profile \
    --application-port=3306 \
    --application-user=app_user \
    --application-password=secret \
    --replication-port=13306 \
    --replication-user=tungsten \
    --replication-password=secret \
    --svc-parallelization-type=disk \
    --connector-smartscale=false # parallel apply and smartscale are not compatible \
```

```
    --channels=10 \
    --rest-api-admin-user=apiuser \
    --rest-api-admin-pass=secret

shell> ./tools/tpm configure alpha \
    --master=host1 \
    --members=host1,host2,host3 \
    --connectors=host1,host2,host3 \
    --topology=clustered
```

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[defaults]
install-directory=/opt/continuent
user=tungsten
mysql-allow-intensive-checks=true
profile-script=~/.bash_profile
application-port=3306
application-user=app_user
application-password=secret
replication-port=13306
replication-user=tungsten
replication-password=secret
svc-parallelization-type=disk
connector-smartscale=false # parallel apply and smartscale are not compatible
channels=10
rest-api-admin-user=apiuser
rest-api-admin-pass=secret

[alpha]
master=host1
members=host1,host2,host3
connectors=host1,host2,host3
topology=clustered
```

Configuration group **defaults**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--reset` [464]

  `reset` [464]

  For staging configurations, deletes all pre-existing configuration information between updating with the new configuration values.

- `--install-directory=/opt/continuent` [450]

  `install-directory=/opt/continuent` [450]

  Path to the directory where the active deployment will be installed. The configured directory will contain the software, THL and relay log information unless configured otherwise.

- `--user=tungsten` [471]

  `user=tungsten` [471]

  System User

- `--mysql-allow-intensive-checks=true` [457]

  `mysql-allow-intensive-checks=true` [457]

  For MySQL installation, enables detailed checks on the supported data types within the MySQL database to confirm compatibility. This includes checking each table definition individually for any unsupported data types.

- `--profile-script=~/.bash_profile` [461]

  `profile-script=~/.bash_profile` [461]

  Append commands to include env.sh in this profile script

- `--application-port=3306` [432]

  `application-port=3306` [432]

  Port for the connector to listen on

- `--application-user=app_user` [433]

  `application-user=app_user` [433]

  Database username for the connector

- `--application-password=secret` [432]

  `application-password=secret` [432]

  Database password for the connector

- `--replication-port=13306` [463]

  `replication-port=13306` [463]

  The network port used to connect to the database server. The default port used depends on the database being configured.

- `--replication-user=tungsten` [464]

  `replication-user=tungsten` [464]

  For databases that required authentication, the username to use when connecting to the database using the corresponding connection method (native, JDBC, etc.).

- `--replication-password=secret` [463]

  `replication-password=secret` [463]

  The password to be used when connecting to the database using the corresponding `--replication-user` [464].

- `--svc-parallelization-type=disk` [467]

  `svc-parallelization-type=disk` [467]

  Method for implementing parallel apply

- `--connector-smartscale=false # parallel apply and smartscale are not compatible` [440]

  `connector-smartscale=false # parallel apply and smartscale are not compatible` [440]

  Enable SmartScale R/W splitting in the connector

- `--channels=10` [436]

  `channels=10` [436]

  Number of replication channels to use for parallel apply.

- `--rest-api-admin-user=apiuser`

  `rest-api-admin-user=apiuser`
  Optional: Must be specified along with rest-api-admin-pass if you wish to access the full API features and use the Dashboard GUI for cluster installations.

- `--rest-api-admin-pass=secret`

  `rest-api-admin-pass=secret`
  Optional: Must be specified along with rest-api-admin-user if you wish to access the full API features.

Configuration group **`alpha`**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--master=host1` [454]

  `master=host1` [454]

  The hostname of the primary (extractor) within the current service.

- `--members=host1,host2,host3` [455]

`members=host1,host2,host3` [455]

Hostnames for the dataservice members

- `--connectors=host1,host2,host3` [440]

  `connectors=host1,host2,host3` [440]

  Hostnames for the dataservice connectors

- `--topology=clustered` [470]

  `topology=clustered` [470]

  Replication topology for the dataservice.

If the installation process fails, check the output of the `/tmp/tungsten-configure.log` file for more information about the root cause.

There are several additional options that default to reasonable values. You may wish to change them in special cases.

- `buffer-size` — Sets the replicator block commit size, which is the number of transactions to commit at once on Replicas. Values up to 100 are normally fine.
- `native-slave-takeover` [459] — Used to allow Tungsten to take over from native MySQL replication and parallelize it. See here for more.

You can check the number of active channels on a Replica by looking at the "channels" property once the replicator restarts.

```
Replica shell> trepctl -service alpha status| grep channels
channels               : 10
```

Important

The channel count for a Primary will ALWAYS be 1 because extraction is single-threaded:

```
Primary shell> trepctl -service alpha status| grep channels
channels               : 1
```

Warning

Enabling parallel apply will dramatically increase the number of connections to the database server.

Typically the calculation on a Replica would be: Connections = Channel_Count x Sevice_Count x 2, so for a 4-way Composite Composite Active/Active topology with 30 channels there would be 30 x 4 x 2 = 240 connections required for the replicator alone, not counting application traffic.

You may display the currently used number of connections in MySQL:

```
mysql> SHOW STATUS LIKE 'max_used_connections';
+----------------------+-------+
| Variable_name        | Value |
+----------------------+-------+
| Max_used_connections | 190   |
+----------------------+-------+
1 row in set (0.00 sec)
```

Below are suggestions for how to change the maximum connections setting in MySQL both for the running instance as well as at startup:

```
mysql> SET GLOBAL max_connections = 512;

mysql> SHOW VARIABLES LIKE 'max_connections';
+-----------------+-------+
| Variable_name   | Value |
+-----------------+-------+
| max_connections | 512   |
+-----------------+-------+
1 row in set (0.00 sec)

shell> vi /etc/my.cnf
#max_connections = 151
max_connections = 512
```

4.1.3. Channels

Channels and Parallel Apply

Parallel apply works by using multiple threads for the final stage of the replication pipeline. These threads are known as channels. Restart points for each channel are stored as individual rows in table `trep_commit_seqno` if you are applying to a relational DBMS server, including MySQL, Oracle, and data warehouse products like Vertica.

When you set the `channels` [436] argument, the tpm program configures the replication service to enable the requested number of channels. A value of 1 results in single-threaded operation.

Do not change the number of channels without setting the replicator offline cleanly. See the procedure later in this page for more information.

How Many Channels Are Enough?

Pick the smallest number of channels that loads the Replica fully. For evenly distributed workloads this means that you should increase channels so that more threads are simultaneously applying updates and soaking up I/O capacity. As long as each shard receives roughly the same number of updates, this is a good approach.

For unevenly distributed workloads, you may want to decrease channels to spread the workload more evenly across them. This ensures that each channel has productive work and minimizes the overhead of updating the channel position in the DBMS.

Once you have maximized I/O on the DBMS server leave the number of channels alone. Note that adding more channels than you have shards does not help performance as it will lead to idle channels that must update their positions in the DBMS even though they are not doing useful work. This actually slows down performance a little bit.

Effect of Channels on Backups

If you back up a Replica that operates with more than one channel, say 30, you can only restore that backup on another Replica that operates with the same number of channels. Otherwise, reloading the backup is the same as changing the number of channels without a clean offline.

When operating Tungsten Replicator in a Tungsten cluster, you should always set the number of channels to be the same for all replicators. Otherwise you may run into problems if you try to restore backups across MySQL instances that load with different locations.

If the replicator has only a single channel enabled, you can restore the backup anywhere. The same applies if you run the backup after the replicator has been taken offline cleanly.

4.1.4. Parallel Replication and Offline Operation

4.1.4.1. Clean Offline Operation

When you issue a trepctl offline command, Tungsten Replicator will bring all channels to the same point in the log and then go offline. This is known as going offline cleanly. When a Replica has been taken offline cleanly the following are true:

- The `trep_commit_seqno` table contains a single row
- The `trep_shard_channel` table is empty

When parallel replication is not enabled, you can take the replicator offline by stopping the replicator process. There is no need to issue a trepctl offline command first.

4.1.4.2. Tuning the Time to Go Offline Cleanly

Putting a replicator offline may take a while if the slowest and fastest channels are far apart, i.e., if one channel gets far ahead of another. The separation between channels is controlled by the *`maxOfflineInterval`* parameter, which defaults to 5 seconds. This sets the allowable distance between commit timestamps processed on different channels. You can adjust this value at installation or later. The following example shows how to change it after installation. This can be done at any time and does not require the replicator to go offline cleanly.

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41
```

```
shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --property=replicator.store.parallel-queue.maxOfflineInterval=30
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
property=replicator.store.parallel-queue.maxOfflineInterval=30
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

The offline interval is only the the approximate time that Tungsten Replicator will take to go offline. Up to a point, larger values (say 60 or 120 seconds) allow the replicator to parallelize in spite of a few operations that are relatively slow. However, the down side is that going offline cleanly can become quite slow.

4.1.4.3. Unclean Offline

If you need to take a replicator offline quickly, you can either stop the replicator process or issue the following command:

```
shell> trepctl offline -immediate
```

Both of these result in an unclean shutdown. However, parallel replication is completely crash-safe provided you use transactional table types like InnoDB, so you will be able to restart without causing Replica consistency problems.

> **Warning**
>
> You must take the replicator offline cleanly to change the number of channels or when reverting to MySQL native replication. Failing to do so can result in errors when you restart replication.

4.1.5. Adjusting Parallel Replication After Installation

4.1.5.1. How to Enable Parallel Apply After Installation

> **Warning**
>
> Be sure to place the cluster into MAINTENANCE mode first so the Manager does not attempt to automatically bring the replicator online.
>
> ```
> cctrl> set policy maintenance
> ```

To enable parallel replication after installation, take the replicator offline cleanly using the following command:

```
shell> trepctl offline
```

Modify the configuration to add two parameters:

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41
```

```
shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure defaults \
    --svc-parallelization-type=disk \
    --channels=10
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
[defaults]
...
svc-parallelization-type=disk
channels=10
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

Note

You make use an actual data service name in place of the keyword `defaults`.

Signal the changes by a complete restart of the Replicator process:

```
shell> replicator restart
```

Warning

Be sure to place the cluster into AUTOMATIC mode as soon as all replicators are updated and back online.

```
cctrl> set policy automatic
```

You can check the number of active channels on a Replica by looking at the "channels" property once the replicator restarts.

```
Replica shell> trepctl -service alpha status| grep channels
channels               : 10
```

Important

The channel count for a Primary will ALWAYS be 1 because extraction is single-threaded:

```
Primary shell> trepctl -service alpha status| grep channels
channels               : 1
```

Warning

Enabling parallel apply will dramatically increase the number of connections to the database server.

Typically the calculation on a Replica would be: Connections = Channel_Count x Sevice_Count x 2, so for a 4-way Composite Composite Active/Active topology with 30 channels there would be 30 x 4 x 2 = 240 connections required for the replicator alone, not counting application traffic.

You may display the currently used number of connections in MySQL:

```
mysql> SHOW STATUS LIKE 'max_used_connections';
+----------------------+-------+
| Variable_name        | Value |
+----------------------+-------+
| Max_used_connections | 190   |
+----------------------+-------+
1 row in set (0.00 sec)
```

Below are suggestions for how to change the maximum connections setting in MySQL both for the running instance as well as at startup:

```
mysql> SET GLOBAL max_connections = 512;

mysql> SHOW VARIABLES LIKE 'max_connections';
+-----------------+-------+
| Variable_name   | Value |
+-----------------+-------+
| max_connections | 512   |
+-----------------+-------+
1 row in set (0.00 sec)

shell> vi /etc/my.cnf
#max_connections = 151
max_connections = 512
```

4.1.5.2. How to Change Channels Safely

To change the number of channels you must take the replicator offline cleanly using the following command:

```
shell> trepctl offline
```

This command brings all channels up the same transaction in the log, then goes offline. If you look in the `trep_commit_seqno` table, you will notice only a single row, which shows that updates to the Replica have been completely serialized to a single point. At this point you may safely reconfigure the number of channels on the replicator, for example using the following command:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --channels=5
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
[alpha]
...
channels=5
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

You can check the number of active channels on a Replica by looking at the "channels" property once the replicator restarts.

If you attempt to reconfigure channels without going offline cleanly, Tungsten Replicator will signal an error when you attempt to go online with the new channel configuration. The cure is to revert to the previous number of channels, go online, and then go offline cleanly. Note that attempting to clean up the `trep_commit_seqno` and `trep_shard_channel` tables manually can result in your Replicas becoming inconsistent and requiring full resynchronization. You should only do such cleanup under direction from Continuent support.

Warning

Failing to follow the channel reconfiguration procedure carefully may result in your Replicas becoming inconsistent or failing. The cure is usually full resynchronization, so it is best to avoid this if possible.

4.1.5.3. How to Disable Parallel Replication Safely

The following steps describe how to gracefully disable parallel apply replication.

Replication Graceful Offline (critical first step)

To disable parallel apply, you must first take the replicator offline cleanly using the following command:

```
shell> trepctl offline
```

This command brings all channels up the same transaction in the log, then goes offline. If you look in the `trep_commit_seqno` table, you will notice only a single row, which shows that updates to the Replica have been completely serialized to a single point. At this point you may safely disable parallel apply on the replicator, for example using the following command:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --svc-parallelization-type=none \
    --channels=1
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
[alpha]
...
svc-parallelization-type=none
channels=1
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

Verification

You can check the number of active channels on a Replica by looking at the "channels" property once the replicator restarts.

```
shell> trepctl -service alpha status| grep channels
channels               : 1
```

Notes and Warnings

If you attempt to reconfigure channels without going offline cleanly, Tungsten Replicator will signal an error when you attempt to go online with the new channel configuration. The cure is to revert to the previous number of channels, go online, and then go offline cleanly. Note that attempting to clean up the `trep_commit_seqno` and `trep_shard_channel` tables manually can result in your Replicas becoming inconsistent and requiring full resynchronization. You should only do such cleanup under direction from Continuent support.

Warning

Failing to follow the channel reconfiguration procedure carefully may result in your Replicas becoming inconsistent or failing. The cure is usually full resynchronization, so it is best to avoid this if possible.

4.1.5.4. How to Switch Parallel Queue Types Safely

As with channels you should only change the parallel queue type after the replicator has gone offline cleanly. The following example shows how to update the parallel queue type after installation:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --svc-parallelization-type=disk \
    --channels=5
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
[alpha]
...
svc-parallelization-type=disk
channels=5
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

4.1.6. Monitoring Parallel Replication

Basic monitoring of a parallel deployment can be performed using the techniques in Chapter 6, *Operations Guide*. Specific operations for parallel replication are provided in the following sections.

4.1.6.1. Useful Commands for Parallel Monitoring Replication

The replicator has several helpful commands for tracking replication performance:

Command	Description
trepctl status	Shows basic variables including overall latency of Replica and number of apply channels
trepctl status -name shards	Shows the number of transactions for each shard
trepctl status -name stores	Shows the configuration and internal counters for stores between tasks
trepctl status -name tasks	Shows the number of transactions (events) and latency for each independent task in the replicator pipeline

4.1.6.2. Parallel Replication and Applied Latency On Replicas

The trepctl status appliedLastSeqno parameter shows the sequence number of the last transaction committed. Here is an example from a Replica with 5 channels enabled.

```
shell> trepctl status
Processing status command...
NAME                     VALUE
----                     -----
appliedLastEventId     : mysql-bin.000211:0000000020094456;0
appliedLastSeqno       : 78021
appliedLatency         : 0.216
channels               : 5
...
Finished status command...
```

When parallel apply is enabled, the meaning of *appliedLastSeqno* changes. It is the minimum recovery position across apply channels, which means it is the position where channels restart in the event of a failure. This number is quite conservative and may make replication appear to be further behind than it actually is.

- Busy channels mark their position in table trep_commit_seqno as they commit. These are up-to-date with the traffic on that channel, but channels have latency between those that have a lot of big transactions and those that are more lightly loaded.
- Inactive channels do not get any transactions, hence do not mark their position. Tungsten sends a control event across all channels so that they mark their commit position in trep_commit_channel. It is possible to see a delay of many seconds or even minutes in unloaded systems from the true state of the Replica because of idle channels not marking their position yet.

For systems with few transactions it is useful to lower the synchronization interval to a smaller number of transactions, for example 500. The following command shows how to adjust the synchronization interval after installation:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --property=replicator.store.parallel-queue.syncInterval=500
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
[alpha]
...
property=replicator.store.parallel-queue.syncInterval=500
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

Note that there is a trade-off between the synchronization interval value and writes on the DBMS server. With the foregoing setting, all channels will write to the `trep_commit_seqno` table every 500 transactions. If there were 50 channels configured, this could lead to an increase in writes of up to 10%—each channel could end up adding an extra write to mark its position every 10 transactions. In busy systems it is therefore better to use a higher synchronization interval for this reason.

You can check the current synchronization interval by running the trepctl status -name stores command, as shown in the following example:

```
shell> trepctl status -name stores
Processing status command (stores)...
...
NAME                      VALUE
----                      -----
...
name                    : parallel-queue
...
storeClass              : com.continuent.tungsten.replicator.thl.THLParallelQueue
syncInterval            : 10000
Finished status command (stores)...
```

You can also force all channels to mark their current position by sending a heartbeat through using the trepctl heartbeat command.

4.1.6.3. Relative Latency

Relative latency is a trepctl status parameter. It indicates the latency since the last time the appliedSeqno advanced; for example:

```
shell> trepctl status
Processing status command...
NAME                     VALUE
----                     -----
appliedLastEventId     : mysql-bin.000211:0000000020094766;0
appliedLastSeqno       : 78022
appliedLatency         : 0.571
...
relativeLatency        : 8.944
Finished status command...
```

In this example the last transaction had a latency of .571 seconds from the time it committed on the Primary and committed 8.944 seconds ago. If relative latency increases significantly in a busy system, it may be a sign that replication is stalled. This is a good parameter to check in monitoring scripts.

4.1.6.4. Serialization Count

Serialization count refers to the number of transactions that the replicator has handled that cannot be applied in parallel because they involve dependencies across shards. For example, a transaction that spans multiple shards must serialize because it might cause cause an out-of-order update with respect to transactions that update a single shard only.

You can detect the number of transactions that have been serialized by looking at the *`serializationCount`* parameter using the trepctl status -name stores command. The following example shows a replicator that has processed 1512 transactions with 26 serialized.

```
shell> trepctl status -name stores
Processing status command (stores)...
...
```

```
NAME                     VALUE
----                     -----
criticalPartition       : -1
discardCount            : 0
estimatedOfflineInterval: 0.0
eventCount              : 1512
headSeqno               : 78022
maxOfflineInterval      : 5
maxSize                 : 10
name                    : parallel-queue
queues                  : 5
serializationCount      : 26
serialized              : false
...
Finished status command (stores)...
```

In this case 1.7% of transactions are serialized. Generally speaking you will lose benefits of parallel apply if more than 1-2% of transactions are serialized.

4.1.6.5. Maximum Offline Interval

The maximum offline interval (*maxOfflineInterval*) parameter controls the "distance" between the fastest and slowest channels when parallel apply is enabled. The replicator measures distance using the seconds between commit times of the last transaction processed on each channel. This time is roughly equivalent to the amount of time a replicator will require to go offline cleanly.

You can change the *maxOfflineInterval* as shown in the following example, the value is defined in seconds.

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --property=replicator.store.parallel-queue.maxOfflineInterval=30
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
[alpha]
...
property=replicator.store.parallel-queue.maxOfflineInterval=30
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

You can view the configured value as well as the estimate current value using the trepctl status -name stores command, as shown in yet another example:

```
shell> trepctl status -name stores
Processing status command (stores)...
NAME                     VALUE
----                     -----
...
estimatedOfflineInterval: 1.3
...
maxOfflineInterval      : 30
...
Finished status command (stores)...
```

4.1.6.6. Workload Distribution

Parallel apply works best when transactions are distributed evenly across shards and those shards are distributed evenly across available channels. You can monitor the distribution of transactions over shards using the trepctl status -name shards command. This command lists transaction counts for all shards, as shown in the following example.

```
shell> trepctl status -name shards
Processing status command (shards)...
...
NAME                VALUE
----                -----
appliedLastEventId: mysql-bin.000211:0000000020095076;0
appliedLastSeqno  : 78023
appliedLatency    : 0.255
eventCount        : 3523
shardId           : cust1
stage             : q-to-dbms
...
Finished status command (shards)...
```

If one or more shards have a very large *eventCount* value compared to the others, this is a sign that your transaction workload is poorly distributed across shards.

The listing of shards also offers a useful trick for finding serialized transactions. Shards that Tungsten Replicator cannot safely parallelize are assigned the dummy shard ID #UNKNOWN. Look for this shard to find the count of serialized transactions. The *appliedLastSeqno* for this shard gives the sequence number of the most recent serialized transaction. As the following example shows, you can then list the contents of the transaction to see why it serialized. In this case, the transaction affected tables in different schemas.

```
shell> trepctl status -name shards
Processing status command (shards)...
NAME                VALUE
----                -----
appliedLastEventId: mysql-bin.000211:0000000020095529;0
appliedLastSeqno  : 78026
appliedLatency    : 0.558
eventCount        : 26
shardId           : #UNKNOWN
stage             : q-to-dbms
...
Finished status command (shards)...
shell> thl list -seqno 78026
SEQ# = 78026 / FRAG# = 0 (last frag)
- TIME = 2013-01-17 22:29:42.0
- EPOCH# = 1
- EVENTID = mysql-bin.000211:0000000020095529;0
- SOURCEID = logos1
- METADATA = [mysql_server_id=1;service=percona;shard=#UNKNOWN]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
- OPTIONS = [##charset = ISO8859_1, autocommit = 1, sql_auto_is_null = 0, »
    foreign_key_checks = 1, unique_checks = 1, sql_mode = '', character_set_client = 8, »
    collation_connection = 8, collation_server = 33]
- SCHEMA =
- SQL(0) = insert into mats_0.foo values(1) /* ___SERVICE___ = [percona] */
- OPTIONS = [##charset = ISO8859_1, autocommit = 1, sql_auto_is_null = 0, »
    foreign_key_checks = 1, unique_checks = 1, sql_mode = '', character_set_client = 8, »
    collation_connection = 8, collation_server = 33]
- SQL(1) = insert into mats_1.foo values(1)
```

The replicator normally distributes shards evenly across channels. As each new shard appears, it is assigned to the next channel number, which then rotates back to 0 once the maximum number has been assigned. If the shards have uneven transaction distributions, this may lead to an uneven number of transactions on the channels. To check, use the trepctl status -name tasks and look for tasks belonging to the q-to-dbms stage.

```
shell> trepctl status -name tasks
Processing status command (tasks)...
...
NAME                VALUE
----                -----
```

```
appliedLastEventId: mysql-bin.000211:0000000020095076;0
appliedLastSeqno  : 78023
appliedLatency    : 0.248
applyTime         : 0.003
averageBlockSize  : 2.520
cancelled         : false
currentLastEventId: mysql-bin.000211:0000000020095076;0
currentLastFragno : 0
currentLastSeqno  : 78023
eventCount        : 5302
extractTime       : 274.907
filterTime        : 0.0
otherTime         : 0.0
stage             : q-to-dbms
state             : extract
taskId            : 0
...
Finished status command (tasks)...
```

If you see one or more channels that have a very high *eventCount*, consider either assigning shards explicitly to channels or redistributing the workload in your application to get better performance.

4.1.7. Controlling Assignment of Shards to Channels

Tungsten Replicator by default assigns channels using a round robin algorithm that assigns each new shard to the next available channel. The current shard assignments are tracked in table `trep_shard_channel` in the Tungsten catalog schema for the replication service.

For example, if you have 2 channels enabled and Tungsten processes three different shards, you might end up with a shard assignment like the following:

```
foo => channel 0
bar => channel 1
foobar => channel 0
```

This algorithm generally gives the best results for most installations and is crash-safe, since the contents of the `trep_shard_channel` table persist if either the DBMS or the replicator fails.

It is possible to override the default assignment by updating the `shard.list` file found in the `tungsten-replicator/conf` directory. This file normally looks like the following:

```
# SHARD MAP FILE.
# This file contains shard handling rules used in the ShardListPartitioner
# class for parallel replication.  If unchanged shards will be hashed across
# available partitions.

# You can assign shards explicitly using a shard name match, where the form
# is <db>=<partition>.
#common1=0
#common2=0
#db1=1
#db2=2
#db3=3

# Default partition for shards that do not match explicit name.
# Permissible values are either a partition number or -1, in which
# case values are hashed across available partitions.  (-1 is the
# default.
#(*)=-1

# Comma-separated list of shards that require critical section to run.
# A "critical section" means that these events are single-threaded to
# ensure that all dependencies are met.
#(critical)=common1,common2

# Method for channel hash assignments.  Allowed values are round-robin and
# string-hash.
(hash-method)=round-robin
```

You can update the shard.list file to do three types of custom overrides.

1. Change the hashing method for channel assignments. Round-robin uses the `trep_shard_channel` table. The string-hash method just hashes the shard name.
2. Assign shards to explicit channels. Add lines of the form *shard=channel* to the file as shown by the commented-out entries.
3. Define critical shards. These are shards that must be processed in serial fashion. For example if you have a sharded application that has a single global shard with reference information, you can declare the global shard to be critical. This helps avoid applications seeing out of order information.

Changes to shard.list must be made with care. The same cautions apply here as for changing the number of channels or the parallelization type. For subscription customers we strongly recommend conferring with Continuent Support before making changes.

4.1.8. Disk vs. Memory Parallel Queues

Channels receive transactions through a special type of queue, known as a parallel queue. Tungsten offers two implementations of parallel queues, which vary in their performance as well as the requirements they may place on hosts that operate parallel apply. You choose the type of queue to enable using the `--svc-parallelization-type` [467] option.

> **Warning**
>
> Do not change the parallel queue type without setting the replicator offline cleanly. See the procedure later in this page for more information.

Disk Parallel Queue (*`disk`* option)

A disk parallel queue uses a set of independent threads to read from the Transaction History Log and feed short in-memory queues used by channels. Disk queues have the advantage that they minimize memory required by Java. They also allow channels to operate some distance apart, which improves throughput. For instance, one channel may apply a transaction that committed 2 minutes before the transaction another channel is applying. This separation keeps a single slow transaction from blocking all channels.

Disk queues minimize memory consumption of the Java VM but to function efficiently they do require pages from the Operating System page cache. This is because the channels each independently read from the Transaction History Log. As long as the channels are close together the storage pages tend to be present in the Operating System page cache for all threads but the first, resulting in very fast reads. If channels become widely separated, for example due to a high *`maxOfflineInterval`* value, or the host has insufficient free memory, disk queues may operate slowly or impact other processes that require memory.

Memory Parallel Queue (*`memory`* option)

A memory parallel queue uses a set of in-memory queues to hold transactions. One stage reads from the Transaction History Log and distributes transactions across the queues. The channels each read from one of the queues. In-memory queues have the advantage that they do not need extra threads to operate, hence reduce the amount of CPU processing required by the replicator.

When you use in-memory queues you must set the maxSize property on the queue to a relatively large value. This value sets the total number of transaction fragments that may be in the parallel queue at any given time. If the queue hits this value, it does not accept further transaction fragments until existing fragments are processed. For best performance it is often necessary to use a relatively large number, for example 10,000 or greater.

The following example shows how to set the maxSize property after installation. This value can be changed at any time and does not require the replicator to go offline cleanly:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --property=replicator.store.parallel-queue.maxSize=10000
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
[alpha]
...
```

```
property=replicator.store.parallel-queue.maxSize=10000
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

You may need to increase the Java VM heap size when you increase the parallel queue maximum size. Use the `--java-mem-size` [452] option on the tpm command for this purpose or edit the Replicator `wrapper.conf` file directly.

> **Warning**
>
> Memory queues are not recommended for production use at this time. Use disk queues.

4.2. Starting and Stopping Tungsten Cluster

To stop all of the services associated with a dataservice node, use the stopall script:

```
shell> stopall
Stopping Tungsten Connector...
Stopped Tungsten Connector.
Stopping Tungsten Replicator Service...
Stopped Tungsten Replicator Service.
Stopping Tungsten Manager Service...
Stopped Tungsten Manager Service.
```

To start all services, use the startall script:

```
shell> startall
Starting Tungsten Manager Service...

Starting Tungsten Replicator Service...

Starting Tungsten Connector...
```

4.2.1. Restarting the Replicator Service

> **Warning**
>
> Restarting a running replicator temporarily stops and restarts replication. Either set *MAINTENANCE* mode within cctrl (see Section 6.14, “Performing Database or OS Maintenance” or shun the datasource before restarting the replicator [Section 6.3.6.1, “Shunning a Datasource”.

To shutdown a running Tungsten Replicator you must switch off the replicator:

```
shell> replicator stop
Stopping Tungsten Replicator Service...
Stopped Tungsten Replicator Service.
```

To start the replicator service if it is not already running:

```
shell> replicator start
Starting Tungsten Replicator Service...
```

4.2.2. Restarting the Connector Service

> **Warning**
>
> Restarting the connector service will interrupt the communication of any running application or client connecting through the connector to MySQL.

To shutdown a running Tungsten Connector you must switch off the replicator:

```
shell> connector stop
Stopping Tungsten Connector Service...
```

```
Stopped Tungsten Connector Service.
```

To start the replicator service if it is not already running:

```
shell>  connector start
Starting Tungsten Connector Service...
Waiting for Tungsten Connector Service.....
running: PID:12338
```

If the cluster was configured with `auto-enable=false` [433] then you will need to put each node online individually.

4.2.3. Restarting the Manager Service

The manager service is designed to monitor the status and operation of the each of the datasources within the dataservice. In the event that the manager has become confused with the current configuration, for example due to a network or node failure, the managers can be restarted. This forces the managers to update their current status and topology information.

Before restarting managers, the dataservice should be placed in maintenance policy mode. In maintenance mode, the connectors will continue to service requests and the manager restart will not be treated as a failure.

To restart the managers across an entire dataservice, each manager will need to be restarted. The dataservice must be placed in maintenance policy mode first, then:

1. To set the maintenance policy mode:

   ```
   [LOGICAL:EXPERT] /dsone > set policy maintenance
   ```

2. On each datasource in the dataservice:

   a. Stop the service:

      ```
      shell> manager stop
      ```

   b. Then start the manager service:

      ```
      shell> manager start
      ```

3. Once all the managers have been restarted, set the policy mode back to the automatic:

   ```
   [LOGICAL:EXPORT] /alpha > set policy automatic
   policy mode is now AUTOMATIC
   ```

4.2.4. Restarting the Multi-Site/Active-Active Replicator Service

Warning

Restarting a running replicator temporarily stops and restarts replication. When using Multi-Site/Active-Active, restarting the additional replicator will stop replication between sites.

These instructions assume you have installed the additional replicator with the `--executable-prefix=mm` [449] option. If not, you should go to `/opt/replicator/tungsten/tungsten-replicator/bin` and run the replicator command directly.

To shutdown a running Tungsten Replicator you must switch off the replicator:

```
shell> mm_replicator stop
Stopping Tungsten Replicator Service...
Stopped Tungsten Replicator Service.
```

To start the replicator service if it is not already running:

```
shell> mm_replicator start
Starting Tungsten Replicator Service...
```

4.3. Configuring Startup on Boot

By default, Tungsten Cluster does not start automatically on boot. To enable Tungsten Cluster to start at boot time, use the deployall script provided in the installation directory to create the necessary boot scripts:

```
shell> sudo /opt/continuent/tungsten/cluster-home/bin/deployall
 Adding system startup for /etc/init.d/tmanager ...
   /etc/rc0.d/K80tmanager -> ../init.d/tmanager
   /etc/rc1.d/K80tmanager -> ../init.d/tmanager
   /etc/rc6.d/K80tmanager -> ../init.d/tmanager
```

```
  /etc/rc2.d/S80tmanager -> ../init.d/tmanager
  /etc/rc3.d/S80tmanager -> ../init.d/tmanager
  /etc/rc4.d/S80tmanager -> ../init.d/tmanager
  /etc/rc5.d/S80tmanager -> ../init.d/tmanager
Adding system startup for /etc/init.d/treplicator ...
  /etc/rc0.d/K81treplicator -> ../init.d/treplicator
  /etc/rc1.d/K81treplicator -> ../init.d/treplicator
  /etc/rc6.d/K81treplicator -> ../init.d/treplicator
  /etc/rc2.d/S81treplicator -> ../init.d/treplicator
  /etc/rc3.d/S81treplicator -> ../init.d/treplicator
  /etc/rc4.d/S81treplicator -> ../init.d/treplicator
  /etc/rc5.d/S81treplicator -> ../init.d/treplicator
Adding system startup for /etc/init.d/tconnector ...
  /etc/rc0.d/K82tconnector -> ../init.d/tconnector
  /etc/rc1.d/K82tconnector -> ../init.d/tconnector
  /etc/rc6.d/K82tconnector -> ../init.d/tconnector
  /etc/rc2.d/S82tconnector -> ../init.d/tconnector
  /etc/rc3.d/S82tconnector -> ../init.d/tconnector
  /etc/rc4.d/S82tconnector -> ../init.d/tconnector
  /etc/rc5.d/S82tconnector -> ../init.d/tconnector
```

To disable automatic startup at boot time, use the undeployall command:

```
shell> sudo /opt/continuent/tungsten/cluster-home/bin/undeployall
```

4.3.1. Configuring Multi-Site/Active-Active Replicator Startup on Boot

Because there is an additional Tungsten Replicator running, each must be individually configured to startup on boot:

- For the Tungsten Cluster service, use Section 4.3, “Configuring Startup on Boot”.
- For the Tungsten Replicator service, a custom startup script must be created, otherwise the replicator will be unable to start as it has been configured in a different directory.

1. Create a link from the Tungsten Replicator service startup script in the operating system startup directory (`/etc/init.d`):

   ```
   shell> sudo ln -s /opt/replicator/tungsten/tungsten-replicator/bin/replicator /etc/init.d/mmreplicator
   ```

2. Stop the Tungsten Replicator process. Failure to do this will cause issues because the service will no longer recognize the existing PID file and report it is not running.

   ```
   shell> /etc/init.d/mmreplicator stop
   ```

3. Modify the `APP_NAME` variable within the startup script (`/etc/init.d/mmreplicator`) to mmreplicator:

   ```
   APP_NAME="mmreplicator"
   ```

4. Start the Tungsten Replicator process.

   ```
   shell> /etc/init.d/mmreplicator start
   ```

5. Update the operating system startup configuration to use the updated script.

   On Debian/Ubuntu:

   ```
   shell> sudo update-rc.d mmreplicator defaults
   ```

   On RedHat/CentOS:

   ```
   shell> sudo chkconfig --add mmreplicator
   ```

4.4. Upgrading Tungsten Cluster

To upgrade an existing installation of Tungsten Cluster, the new distribution must be downloaded and unpacked, and the included tpm command used to update the installation. The upgrade process implies a small period of downtime for the cluster as the updated versions of the tools are restarted, However the process that takes place should not present as an outage to your applications providing steps when upgrading the connectors are followed carefully. Any downtime is deliberately kept to a minimum, and the cluster should be in the same operation state once the upgrade has finished as it was when the upgrade was started.

Warning

During the update process, the cluster will be in `MAINTENANCE` mode. This is intentional to prevent unwanted failovers during the process, however it is important to understand that should the primary faill for genuine reasons NOT associated with the upgrade, then failover will also not happen at that time.

It is important to ensure clusters are returned to the `AUTOMATIC` state as soon as all Maintenance operations are complete and the cluster is stable.

Note

It is NOT advised to perform rolling upgrades of the tungsten software to avoid miscommunication between components running older/newer versions of the software that may prevent switches/failovers from occuring, therefore it is recommended to upgrade all nodes in place. The process of the upgrade places the cluster into MAINTENANCE mode which in itself avoids outages whilst components are restarted, and allows for a successful upgrade.

4.4.1. Upgrading using the Staging Method (with ssh Access)

Note

For INI file upgrades, see Section 4.4.2, “Upgrading when using INI-based configuration, or without ssh Access”

Warning

Before performing and upgrade, please ensure that you have checked the Appendix B, *Prerequisites*, as software and system requirements may have changed between versions and releases.

To perform an upgrade of an entire cluster from a staging directory installation, where you have ssh access to the other hosts in the cluster:

1. On your staging server, download the release package.
2. Unpack the release package:

```
shell> tar zxf tungsten-clustering-5.4.1-41.tar.gz
```

3. Change to the extracted directory:

```
shell> cd tungsten-clustering5.4.1-41
```

4. The next step depends on your existing deployment:

   - If you are upgrading a Multi-Site/Active-Active deployment:

     If you installed the original service by making use of the `$CONTINUENT_PROFILES` and `$REPLICATOR_PROFILES` environment variables, no further action needs to be taken to update the configuration information. Confirm that these variables are set before performing the validation and update.

     If you did not use these environment variables when deploying the solution, you must load the existing configuration from the current hosts in the cluster before continuing by using tpm fetch:

```
shell> ./tools/tpm fetch --hosts=east1,east2,east3,west1,west2,west3 \
    --user=tungsten --directory=/opt/continuent
```

     #### Important

     You must specify ALL the hosts within both clusters within the current deployment when fetching the configuration; use of the `autodetect` keyword will not collect the correct information.

   - If you are upgrading any other deployment:

     If you are are using the `$CONTINUENT_PROFILES` variable to specify a location for your configuration, make sure that the variable has been set correctly.

     If you are not using `$CONTINUENT_PROFILES`, a copy of the existing configuration must be fetched from the installed Tungsten Cluster installation:

```
shell> ./tools/tpm fetch --hosts=host1,host2,host3,autodetect \
    --user=tungsten --directory=/opt/continuent
```

     #### Important

     You must use the version of tpm from within the staging directory (./tools/tpm) of the new release, not the tpm installed with the current release.

     The current configuration information will be retrieved to be used for the upgrade:

```
shell> ./tools/tpm fetch --hosts=host1,host2,host3 --user=tungsten --directory=/opt/continuent
```

```
.......
NOTE  >> Configuration loaded from host1,host2,host3
```

5. Check that the update configuration matches what you expect by using tpm reverse:

```
shell> ./tools/tpm reverse
# Options for the dsone data service
tools/tpm configure dsone \
--application-password=password \
--application-port=3306 \
--application-user=app_user \
--connectors=host1,host2,host3 \
--datasource-log-directory=/var/log/mysql \
--install-directory=/opt/continuent \
--master=host1 \
--members=host1,host2,host3 \
'--profile-script=~/.bashrc' \
--replication-password=password \
--replication-port=13306 \
--replication-user=tungsten \
--start-and-report=true \
--user=tungsten \
--witnesses=192.168.0.1
```

6. Run the upgrade process:

```
shell> ./tools/tpm update
```

> **Note**
>
> During the update process, tpm may report errors or warnings that were not previously reported as problems. This is due to new features or functionality in different MySQL releases and Tungsten Cluster updates. These issues should be addressed and the tpm update command re-executed.

The following additional options are available when updating:

- `--no-connectors` [459] (optional)

  By default, an update process will restart all services, including the connector. Adding this option prevents the connectors from being restarted. If this option is used, the connectors must be manually updated to the new version during a quieter period. This can be achieved by running on each host the command:

  ```
  shell> tpm promote-connector
  ```

  This will result in a short period of downtime (couple of seconds) only on the host concerned, while the other connectors in your configuration keep running. During the upgrade, the Connector is restarted using the updated software and/or configuration.

A successful update will report the cluster status as determined from each host in the cluster:

```
.....................................................................................................
Getting cluster status on host1
Tungsten Clustering (for MySQL) 5.4.1 build 41
connect to 'dsone@host1'
dsone: session established
[LOGICAL] /dsone > ls

COORDINATOR[host3:AUTOMATIC:ONLINE]

ROUTERS:
+---------------------------------------------------------------------------+
|connector@host1[31613](ONLINE, created=0, active=0)                        |
|connector@host2[27649](ONLINE, created=0, active=0)                        |
|connector@host3[21475](ONLINE, created=0, active=0)                        |
+---------------------------------------------------------------------------+

...

#####################################################################
# Next Steps
#####################################################################
We have added Tungsten environment variables to ~/.bashrc.
Run `source ~/.bashrc` to rebuild your environment.

Once your services start successfully you may begin to use the cluster.
To look at services and perform administration, run the following command
from any database server.

  $CONTINUENT_ROOT/tungsten/tungsten-manager/bin/cctrl

Configuration is now complete.  For further information, please consult
```

```
Tungsten documentation, which is available at docs.continuent.com.

NOTE  >> Command successfully completed
```

The update process should now be complete. The current version can be confirmed by starting cctrl.

4.4.2. Upgrading when using INI-based configuration, or without ssh Access

To perform an upgrade of an individual node, tpm can be used on the individual host. The same method can be used to upgrade an entire cluster without requiring tpm to have ssh access to the other hosts in the dataservice.

> **Warning**
>
> Before performing and upgrade, please ensure that you have checked the Appendix B, *Prerequisites*, as software and system requirements may have changed between versions and releases.

> **Important**
>
> Application traffic to the nodes will be disconnected when the connector restarts. Use the `--no-connectors` [459] tpm option when you upgrade to prevent the connectors from restarting until later when you want them to.

4.4.2.1. Upgrading

To upgrade:

1. Place the cluster into maintenance mode
2. Upgrade the Replicas in the dataservice. Be sure to shun and welcome each Replica.
3. Upgrade the Primary node

   > **Important**
   >
   > Replication traffic to the Replicas will be delayed while the replicator restarts. The delays will increase if there are a large number of stored events in the THL. Old THL may be removed to decrease the delay. Do NOT delete THL that has not been received on all Replica nodes or events will be lost.

4. Upgrade the connectors in the dataservice one-by-one

   > **Important**
   >
   > Application traffic to the nodes will be disconnected when the connector restarts.

5. Place the cluster into automatic mode

4.4.2.2. Upgrading a Single Host using `tpm`

> **Note**
>
> For more information on performing maintenance across a cluster, see Section 6.14.3, "Performing Maintenance on an Entire Dataservice".

To upgrade a single host using the tpm command:

1. Download the release package.
2. Unpack the release package:

   ```
   shell> tar zxf tungsten-clustering-5.4.1-41.tar.gz
   ```

3. Change to the extracted directory:

   ```
   shell> cd tungsten-clustering-5.4.1-41
   ```

4. Execute tpm update, specifying the installation directory. This will update only this host:

   ```
   shell> ./tools/tpm update --replace-release
   ```

To update all of the nodes within a cluster, the steps above will need to be performed individually on each host.

4.4.3. Upgrade/Convert: From Multi-Site/Active-Active (MSAA) to Composite Active/Passive (CAP)

These steps are designed to guide you in the safe conversion of an existing Multi-Site/Active-Active (MSAA) topology to a Composite Active/Passive (CAP) topology, based on an ini installation.

For details of the difference between these two topologies, please review the following pages:

- Section 3.3, "Deploying Multi-Site/Active-Active Clustering"
- Section 3.2, "Deploying Composite Active/Passive Clustering"

> **Warning**
>
> It is very important to follow all the below steps and ensure full backups are taken when instructed. These steps can be destructive and without proper care and attention, data loss, data corruption or a split-brain scenario can happen.

> **Warning**
>
> Parallel apply MUST be disabled before starting your upgrade. You may re-enable it once the upgrade has been fully completed. See Section 4.1.5.3, "How to Disable Parallel Replication Safely" and Section 4.1.2, "Enabling Parallel Apply During Install" for more information.

> **Note**
>
> The examples in this section are based on three clusters named 'nyc', 'london' and 'tokyo'
>
> Each cluster has two dedicated connectors on separate hosts.
>
> The converted cluster will consist of a Composite Service named 'global' and the 'nyc' cluster will be the Active cluster, with 'london' and 'tokyo' as Passive clusters.
>
> If you do not have exactly three clusters, please adjust this procedure to match your environment.
>
> Examples of before and after tungsten.ini files can be downloaded here:
>
> - Multi-Site/Active-Active Config (Before)
> - Composite Active/Passive Config (After)

If you are currently installed using a staging-based installation, you must convert to an INI based installed for this process to be completed with minimal risk and minimal interuption. For notes on how to perform the staging to INI file conversion using the `translatetoini.pl` script, please visit Section 10.4.6, "Using the `translatetoini.pl` Script".

4.4.3.1. Conversion Prerequisites

> **Warning**
>
> Parallel apply MUST be disabled before starting your upgrade. You may re-enable it once the upgrade has been fully completed. See Section 4.1.5.3, "How to Disable Parallel Replication Safely" and Section 4.1.2, "Enabling Parallel Apply During Install" for more information.

- Obtain the latest Tungsten Cluster software build and place it within `/opt/continuent/software`

  If you are not upgrading, just converting, then this step is not required since you will already have the extracted software bundle available.
- Extract the package
- The examples below refer to the `tungsten_prep_upgrade` script, this can be located in the extracted software package within the `tools` directory.

4.4.3.2. Step 1: Backups

Take a full and complete backup of one node - this can be a Replica, and preferably should be either performed by:

- Percona xtrabackup whilst database is open
- Manual backup of all datafiles after stopping the database instance

4.4.3.3. Step 2: Redirect Client Connections

A big difference between Multi-Site/Active-Active (MSAA) and Composite Active/Passive (CAP) is that with MSAA, clients can write into all custers. With CAP clients only write into a single cluster.

To be able to complete this conversion process with minimal interuption and risk, it is essential that clients are redirected and only able to write into a single cluster. This cluster will become the ACTIVE custer after the conversion. For the purpose of this procedure, we will use the 'nyc' cluster for this role.

After redirecting you client applications to connect through the connectors associated with the 'nyc' cluster, stop the connectors associated with the remaining clusters as an extra safeguard against writes happening

On every connector node associated with london and tokyo :

```
shell> connector stop
```

4.4.3.4. Step 3: Enter Maintenance Mode

Enable Maintenance mode on all clusters using the cctrl command:

```
shell> cctrl
cctrl> set policy maintenance
```

4.4.3.5. Step 4: Stop the Cross-site Replicators

Important

Typically the cross-site replicators will be installed within `/opt/replicator`, if you have installed this in a different location you will need to pass this to the script in the examples using the --path option

1. The following commands tell the replicators to go offline at a specific point, in this case when they receive an explicit heartbeat. This is to ensure that all the replicators stop at the same sequence number and binary log position. The replicators will NOT be offline until the explicit heartbeat has been issued a bit later in this step.

   - On every nyc node:

     ```
     shell> ./tungsten_prep_upgrade -o
     ~or~
     shell> ./tungsten_prep_upgrade --service london --offline
     shell> ./tungsten_prep_upgrade --service tokyo --offline
     ```

   - On every london node:

     ```
     shell> ./tungsten_prep_upgrade -o
     ~or~
     shell> ./tungsten_prep_upgrade --service nyc --offline
     shell> ./tungsten_prep_upgrade --service tokyo --offline
     ```

   - On every tokyo node:

     ```
     shell> ./tungsten_prep_upgrade -o
     ~or~
     shell> ./tungsten_prep_upgrade --service london --offline
     shell> ./tungsten_prep_upgrade --service tokyo --offline
     ```

2. Next, on the Primary hosts within each cluster we issue the heartbeat, execute the following using the cluster-specific trepctl, typically in `/opt/continuent`:

   ```
   shell> trepctl heartbeat -name offline_for_upg
   ```

   Ensure that every cross-site replicator on every node is now in the `OFFLINE:NORMAL` state:

   ```
   shell> mmtrepctl status
   ~or~
   shell> mmtrepctl --service {servicename} status
   ```

3. Capture the position of the cross-site replicators on all nodes in all clusters.

   The service name provided should be the name of the remote service(s) for this cluster, so for example in the london cluster you get the positions for nyc and tokyo, and in nyc you get the position for london and tokyo, etc.

   - On every london node:

     ```
     shell> ./tungsten_prep_upgrade -g
     ```

```
~or~
shell> ./tungsten_prep_upgrade --service nyc --get
(NOTE: saves to ~/position-nyc-YYYYMMDDHHMMSS.txt)
shell> ./tungsten_prep_upgrade --service tokyo --get
(NOTE: saves to ~/position-tokyo-YYYYMMDDHHMMSS.txt)
```

- On every nyc node:

```
shell> ./tungsten_prep_upgrade -g
~or~
shell> ./tungsten_prep_upgrade --service london --get
(NOTE: saves to ~/position-london-YYYYMMDDHHMMSS.txt)
shell> ./tungsten_prep_upgrade --service tokyo --get
(NOTE: saves to ~/position-tokyo-YYYYMMDDHHMMSS.txt)
```

- On every tokyo node:

```
shell> ./tungsten_prep_upgrade -g
~or~
shell> ./tungsten_prep_upgrade --service london --get
(NOTE: saves to ~/position-london-YYYYMMDDHHMMSS.txt)
shell> ./tungsten_prep_upgrade --service nyc --get
(NOTE: saves to ~/position-nyc-YYYYMMDDHHMMSS.txt)
```

4. Finally, to complete this step, stop the cross-site replicators on all nodes:

```
shell> ./tungsten_prep_upgrade --stop
```

4.4.3.6. Step 5: Export the tracking schema databases

On every node in each intended Passive cluster (london and tokyo), export the tracking schema associated the intended Active cluster (nyc)

Note the generated dump file is called `tungsten_global.dmp`. global refers to the name of the intended Composite Cluster service, if you choose a different service name, change this accordingly.

- On every london node:

```
shell> mysqldump --opt --single-transaction tungsten_nyc > ~/tungsten_global.dmp
```

- On every tokyo node:

```
shell> mysqldump --opt --single-transaction tungsten_nyc > ~/tungsten_global.dmp
```

4.4.3.7. Step 6: Uninstall the Cross-site Replicators

To uninstall the cross-site replicators, execute the following on every node:

```
shell> cd {replicator software path}
shell> tools/tpm uninstall --i-am-sure
```

4.4.3.8. Step 7: Create Composite Tracking Schema

In this step, we pre-create the database for the composite service tracking schema, we are using global as the service name in this example, if you choose a different Composite service name, adjust this accordingly

On every node in all clusters:

```
shell> mysql -e 'set session sql_log_bin=0; create database tungsten_global'
```

4.4.3.9. Step 8: Reload the tracking schema for Passive clusters

This step reloads the tracking schema associated with the intended Active cluster (nyc) into the tracking schema we created in the previous step. This should ONLY be carried out within the intended Passive clusters at this stage.

We DO NOT want the reloading of this schema to appear in the binary logs on the Primary, therefore the reload needs to be performed on each node individually:

- On every london node:

```
shell> mysql -e 'set session sql_log_bin=0; use tungsten_global; source ~/tungsten_global.dmp;'
```

- On every tokyo node:

```
shell> mysql -e 'set session sql_log_bin=0; use tungsten_global; source ~/tungsten_global.dmp;'
```

4.4.3.10. Step 9: Stop local cluster Replicators

On every node in every cluster:

```
shell> replicator stop
```

> **Warning**
>
> The effect of this step will now mean that only the Primary node in the Active cluster will be up to date with ongoing data changes. You must ensure that your applications handle this accordingly until the replicators are restarted at Step 14

4.4.3.11. Step 10: Remove THL

> **Warning**
>
> This step, if not followed correctly, could be destructive to the entire conversion. It is CRITICAL that this step is NOT performed on the intended Active cluster (nyc)

By default, THL files will be located within `/opt/continuent/thl`, if you have configured this in a different location you will need to adjust the path below accordingly

- On every london node:

```
shell> cd /opt/continuent/thl
shell> rm */thl*
```

- On every tokyo node:

```
shell> cd /opt/continuent/thl
shell> rm */thl*
```

4.4.3.12. Step 11: Export the tracking schema database on Active cluster

On every node within the intended Active cluster (nyc), export the tracking schema associated with the local service

Note the generated dump file is called `tungsten_global.dmp`. global refers to the name of the intended Composite Cluster service, if you choose a different service name, change this accordingly.

- On every nyc node:

```
shell> mysqldump --opt --single-transaction tungsten_nyc > ~/tungsten_global.dmp
```

4.4.3.13. Step 12: Reload the tracking schema for Active cluster

This step reloads the tracking schema associated with the intended Active cluster (nyc) into the tracking schema we created in the earlier step.

We DO NOT want the reloading of this schema to appear in the binary logs on the Primary, therefore the reload needs to be performed on each node individually:

- On every nyc node:

```
shell> mysql -e 'set session sql_log_bin=0; use tungsten_global; source ~/tungsten_global.dmp;'
```

4.4.3.14. Step 13: Update Configuration

Update `/etc/tungsten/tungsten.ini` to a valid Composite Active/Passive config. An example of a valid config is as follows, a sample can also be downloaded from Section 4.4.3.1, “Conversion Prerequisites” above:

> **Important**
>
> Within a Composite Active/Passive topology, the ini file must be identical on EVERY node, including Connector Nodes

```
[defaults]
user=tungsten
home-directory=/opt/continuent
application-user=app_user
application-password=secret
application-port=3306
```

```
profile-script=~/.bash_profile
replication-user=tungsten
replication-password=secret
mysql-allow-intensive-checks=true
skip-validation-check=THLSchemaChangeCheck

[nyc]
topology=clustered
master=db1
slaves=db2,db3
connectors=nyc-conn1,nyc-conn2

[london]
topology=clustered
master=db4
slaves=db5,db6
connectors=ldn-conn1,ldn-conn2b6
relay-source=nyc

[tokyo]
topology=clustered
master=db7
slaves=db8,db9
connectors=tky-conn1,tky-conn2
relay-source=nyc

[global]
composite-datasources=nyc,london,tokyo
```

4.4.3.15. Step 14: Install the Software on Active Cluster

Validate and install the new release on all nodes in the Active (nyc) cluster only:

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> tools/tpm validate-update
```

If validation shows no errors, run the install:

```
shell> tools/tpm update --replace-release
```

4.4.3.16. Step 15: Start Local Replicators on Active cluster

After the installation is complete on all nodes in the Active cluster, restart the replicator services:

```
shell> replicator start
```

After restarting, check the status of the replicator using the trepctl and check that all replicators are ONLINE:

```
shell> trepctl status
```

4.4.3.17. Step 16: Install the Software on remaining Clusters

Validate and install the new release on all nodes in the remaining Passive clusters (london and tokyo):

> **Important**
>
> The update should be performed on the Primary nodes within each cluster first, validation will report and error that the roles conflict (Primary vs Relay). This is expected and to override this warning the `-f` options should be used on the Primary nodes only

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> tools/tpm validate-update
```

If validation shows no errors, run the install:

```
On Primary Nodes:
shell> tools/tpm update --replace-release -f

On Replica Nodes:
shell> tools/tpm update --replace-release
```

4.4.3.18. Step 17: Start Local Replicators on remaining clusters

After the installation is complete on all nodes in the Active cluster, restart the replicator services:

```
shell> replicator start
```

After restarting, check the status of the replicator using the trepctl and check that all replicators are ONLINE:

```
shell> trepctl status
```

4.4.3.19. Step 18: Convert Datasource roles for Passive clusters

Following the upgrades, there are a number of "clean-up" steps that we need to perform within cctrl to ensure the datasource roles have been converted from the previous "master" roles to "relay" roles.

The following steps can be performed in a single cctrl session initiated from any node within any cluster

```
shell> cctrl

Connect to Active cluster
cctrl> use nyc

Check Status and verify all nodes online
cctrl> ls

Connect to COMPOSITE service
cctrl> use global

Place Active service online
cctrl> datasource nyc online

Connect to london Passive service
cctrl> use london

Convert old Primary to relay
cctrl> set force true
cctrl> datasource oldPrimaryhost offline
cctrl> datasource oldPrimaryhost relay

Repeat on tokyo Passive service
cctrl> use tokyo
cctrl> set force true
cctrl> datasource oldPrimaryhost offline
cctrl> datasource oldPrimaryhost relay

Connect to COMPOSITE service
cctrl> use global

Place Passive services online
cctrl> datasource london online
cctrl> datasource tokyo online

Place all clusters into AUTOMATIC
cctrl> set policy automatic
```

4.4.3.20. Step 19: Upgrade the Software on Connectors

Validate and install the new release on all connectors nodes:

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> tools/tpm validate-update
```

If validation shows no errors, run the install:

```
shell> tools/tpm update --replace-release
```

After upgrading previously stopped connectors, you will need to restart the process:

```
shell> connector restart
```

Warning

Upgrading a running connector will initiate a restart of the connector services, this will result in any active connections being terminated, therefore care should be taken with this process and client redirection should be handled accordingly prior to any connector upgrade/restart

4.4.4. Installing an Upgraded JAR Patch

Warning

The following instructions should only be used if Continuent Support have explicitly provided you with a customer JAR file designed to address a problem with your deployment.

If a custom JAR has been provided by Continuent Support, the following instructions can be used to install the JAR into your installation.

1. Determine your staging directory or untarred installation directory:

   ```
   shell> tpm query staging
   ```

   Go to the appropriate host (if necessary) and the staging directory.

   ```
   shell>  cd tungsten-clustering-5.4.1-41
   ```

2. Change to the correct directory. For example, to update Tungsten Replicator change to `tungsten-replicator/lib`; for Tungsten Manager use `tungsten-manager/lib`; for Tungsten Connector use `tungsten-connector/lib`:

   ```
   shell> cd tungsten-replicator/lib
   ```

3. Copy the existing JAR to a backup file:

   ```
   shell> cp tungsten-replicator.jar tungsten-replicator.jar.orig
   ```

4. Copy the replacement JAR into the directory:

   ```
   shell> cp /tmp/tungsten-replicator.jar .
   ```

5. Change back to the root directory of the staging directory:

   ```
   shell> cd ../..
   ```

6. Update the release:

   ```
   shell> ./tools/tpm update --replace-release
   ```

4.4.5. Installing Patches

Warning

This procedure should only be followed with the advice and guidance of a Continuent Support Engineer.

There are two ways we can patch the running environment, and the method chosen will depend on the severity of the patch and whether or not your use case would allow for a maintenance window

- Upgrade using a full software update following the standard upgrade procedures
- Use the patch command to patch just the files necessary

From time to time, Continuent may provide you with a patch to apply as a quicker way to fix small issues. Patched software will always be provided in a subsequent release so the manual patch method described here should only be used as a temporary measure to patch a live installation when a full software update may not immediately be possible

You will have been supplied with a file containing the patch, for the purpose of this example we will assume the file you have been given is called `undeployallnostop.patch`

1. Place cluster into `maintenance` mode
2. On each node of your installation:
   a. Copy the supplied patch file to the host
   b. From the installed directory (Typically this would be `/opt/continuent`) issue the following:

      ```
      shell> cd /opt/continuent/tungsten
      shell> patch -p1 -i undeployallnostop.patch
      ```

3. Return cluster to `automatic` mode

Warning

If a tpm update --replace-release is issued from the original software staging directory, the manual patch applied above will be over-written and removed.

The manual patch method is a temporary approach to patching a running environment, but is not a total replacement for a proper upgrade.

Following a manual patch, you MUST plan to upgrade the staged software to avoid reverting to an unpatched system.

If in doubt, always check with a Continuent Support Engineer.

4.4.6. Upgrading to v7.0.0+

Warning

v7 is a major release with many changes, specifically to security. At this time, upgrading directly to v7 is only supported from v5 onwards. If security is NOT enabled in your installation, then upgrading from an older release may work, however any issues encountered will not be addressed and upgrading to v6 first will be the advised route.

Warning

Whilst every care has been taken to ensure upgrades are as smooth and easy as possible, ALWAYS ensure full backups are taken before proceeding, and if possible, test the upgrade on a non-Production environment first.

4.4.6.1. Background

4.4.6.1.1. v6 (and earlier) behavior

Prior to v7, Tungsten came with security turned OFF through the tpm flag `disable-security-controls` [446] set to `true` by default. This flag, when set to `false` would translate to the following settings being applied:

```
file-protection-level=0027 [449]
rmi-ssl=true [448]
thl-ssl=true [449]
rmi-authentication=true [448]
jgroups-ssl=true [448]
```

This would enable SSL communication between Tungsten components. However, connection to the database remained unencrypted, which would translate to the following settings being applied:

```
datasource-enable-ssl=false [442]
connector-ssl=false [447]
```

Setting these to true is possible, however there are many more manual steps that would have been required.

4.4.6.1.2. New behavior in v7

v7 enables full security by default, so the `disable-security-controls` [446] flag will default to `false` when not specified.

In addition to the default value changing, `disable-security-controls` [446] now enables encrypted communication to the database. Setting this value to `false`, now translates to the following settings being applied:

```
file-protection-level=0027 [449]
rmi-ssl=true [448]
thl-ssl=true [449]
rmi-authentication=true [448]
jgroups-ssl=true [448]
datasource-enable-ssl=true [442]
connector-ssl=true [447]
```

4.4.6.1.3. Summary

In summary, this change in behavior means that upgrades need to be handled with care and appropriate decisions being made, both by the tpm process, and by the "human" to decide on what end result is desired. The various options and examples are outlined in the following sections of this document.

4.4.6.2. Upgrade Decisions

4.4.6.2.1. Keep existing level of security

This is the easiest and smoothest approach. tpm will process your configuration and do its best to maintain the same level of security. In order to achieve that, tpm will dynamically update your configuration (either the `tungsten.ini` file for INI installs, or the `deploy.cfg` for staging installs) with additional properties to adjust the level of security to match.

The properties that tpm will add to your configuration will be some or all of the following depending on the initial starting point of your configuration:

```
disable-security-controls [446]
connector-rest-api-ssl
```

```
manager-rest-api-ssl
replicator-rest-api-ssl
datasource-enable-ssl [442]
enable-connector-ssl [447]
```

You can now proceed with the upgrade, refer to Section 4.4.6.7, “Steps to upgrade using tpm” for the required steps

4.4.6.2.2. Apply new recommendations and setup security

The following security setting levels can be enabled, and will require user action prior to upgrading. These are:

1. Internal Encryption and Authentication
2. Tungsten to Database Encryption
3. Application (Connector) to Database Encryption
4. API SSL

Applying all of the above steps will bring full security, equivalent to the default v7 configuration.

The steps to enable will depend on what (if any) security is enabled in your existing installation. The following sections outline the steps required to be performed to enable security for each of the various layers. To understand whether you have configured any of the various layers of security, the following summary will help to understand your configuration:

No Security

If no security has been configured, the installation that you are starting from will have `disable-security-controls=true` [446] (or it will not supplied at all) and no additional securoty properties will be supplied.

Partial Security

The installation that you are starting from will have partial security in place. This could be a combination of any of the following:

- Internal encryption is configured (`disable-security-controls=false` [446]), and/or
- Connector encryption is enabled (`enable-connector-ssl=true` [447] and/or
- Cluster to the database encryption is enabled (`datasource-enable-ssl=true` [442] or `repl-datasource-enable-ssl=true` [442])

To upgrade and enable security, you should follow one or more of the following steps based on your requirements. At a minimum, the first step should always be included, the remaining steps are optional.

1. Section 4.4.6.3, “Setup internal encryption and authentication”
2. Section 4.4.6.4, “Enable Tungsten to Database Encryption” (if required)
3. Section 4.4.6.5, “Enable Connector to Database Encryption” (if required)

4.4.6.3. Setup internal encryption and authentication

Prior to running the upgrade, you need to manually create the keystore, to do this follow these steps on one host, and then copy the files to all other hosts in your topology:

```
db1> mkdir /etc/tungsten/secure
db1> keytool -genseckey -alias jgroups -validity 3650 -keyalg Blowfish -keysize 56 \
-keystore /etc/tungsten/secure/jgroups.jceks -storepass tungsten -keypass tungsten -storetype JCEKS
```

If you have an INI based install, and this is the only level of security you plan on configuring you should now copy these new keystores to all other hosts in your topology. If you plan to enable SSL at the other remaining layers, or you use a Staging based install, then skip this copy step.

```
db1> for host in db2 db3 db4 db5 db6; do
ssh ${host} mkdir /etc/tungsten/secure
scp /etc/tungsten/secure/*.jceks ${host}:/etc/tungsten/secure
done
```

Enabling internal encryption and authentication will also enable API SSL by default.

If you need to enable encryption to the underlying database, now proceed to the next step Section 4.4.6.4, “Enable Tungsten to Database Encryption” before running the upgrade, otherwise you can then start the upgrade by following the steps in Section 4.4.6.7, “Steps to upgrade using tpm”.

The following additional configuration properties will need adding to your existing configuration. The suggested process based on an INI or Staging based install are outlined in the final upgrade steps referenced above.

```
disable-security-controls=false [446]
connector-rest-api-ssl=true
manager-rest-api-ssl=true
replicator-rest-api-ssl=true
java-jgroups-keystore-path=/etc/tungsten/secure/jgroups.jceks [452]
```

4.4.6.4. Enable Tungsten to Database Encryption

The following prerequisite steps must be performed before continuing with this step

- Section 4.4.6.3, "Setup internal encryption and authentication"
- Section 4.4.6.6, "Enable MySQL SSL"

In this step, you pre-create the various keystores required and register the MySQL certificates for Tungsten. Execute all of the following steps on a single host, for example, db1. In the example below it is assumed that the mysql certificates reside in `/etc/mysql/certs`. If you use the example syntax below, you will also need to ensure the following directory exists: `/etc/tungsten/secure`

These commands will import the MySQL certificates into the required Tungsten truststores.

```
db1> keytool -importkeystore -srckeystore /etc/mysql/certs/client-cert.p12 -srcstoretype PKCS12 \
-destkeystore /etc/tungsten/secure/keystore.jks -deststorepass tungsten -srcstorepass tungsten

db1> keytool -import -alias mysql -file /etc/mysql/certs/ca.pem -keystore /etc/tungsten/secure/truststore.ts \
-storepass tungsten -noprompt
```

If you have an INI based install, and you do not intend to configure SSL for your applications (via Connectors), or if your connectors reside on remote, dedicated hosts, you should now copy all of the generated keystores and truststores to all of the other hosts. If you use a Staging based install, then skip this copy step.

```
db1> for host in db2 db3 db4 db5 db6; do
ssh ${host} mkdir /etc/tungsten/secure
scp /etc/tungsten/secure/*.jceks ${host}:/etc/tungsten/secure
scp /etc/tungsten/secure/*.jks ${host}:/etc/tungsten/secure
scp /etc/tungsten/secure/*.ts ${host}:/etc/tungsten/secure
done
```

If you need to enable encryption to the underlying database from the connectors, now proceed to Section 4.4.6.5, "Enable Connector to Database Encryption" before running the upgrade, alternatively you can now follow the steps outlined in Section 4.4.6.7, "Steps to upgrade using tpm"

The following additional configuration properties will need adding to your existing configuration. The suggested process based on an INI or Staging based install are outlined in the final upgrade steps referenced above.

```
datasource-enable-ssl=true [442]
java-truststore-path=/etc/tungsten/secure/truststore.ts [453]
java-truststore-password=tungsten [453]
java-keystore-path=/etc/tungsten/secure/keystore.jks [452]
java-keystore-password=tungsten [452]
datasource-mysql-ssl-cert=/etc/mysql/certs/client-cert.pem [443]
datasource-mysql-ssl-key=/etc/mysql/certs/client-key.pem [443]
datasource-mysql-ssl-ca=/etc/mysql/certs/ca.pem [443]
```

4.4.6.5. Enable Connector to Database Encryption

The steps outlined in this section will need to be performed on all nodes where the Connector has been installed

If you are also enabling Internal Encryption, you would have followed the steps in Section 4.4.6.3, "Setup internal encryption and authentication" and you would have a number of files already in /etc/tungsten/secure. This next step will pre-create the keystore and truststore, and register the MySQL certificates for the Connectors. Execute all of the following steps on a single host, in this example, db1. In the example below it is assumed the mysql certificates reside in `/etc/mysql/certs`. If you use the example syntax below, you will need to ensure the following directory also exists: `/etc/tungsten/secure`

```
db1> keytool -importkeystore -srckeystore /etc/mysql/certs/client-cert.p12 \
-srcstoretype PKCS12 -destkeystore /etc/tungsten/secure/tungsten_connector_keystore.jks \
-deststorepass tungsten -srcstorepass tungsten

db1> keytool -import -alias mysql -file /etc/mysql/certs/ca.pem \
-keystore /etc/tungsten/secure/tungsten_connector_truststore.ts -storepass tungsten -noprompt
```

Now that all of the necessary steps have been taken to create the various keystores, and if you use an INI based install, you now need to copy all of these files to all other hosts in your topology. If you are using a Staging based installation, then skip this copy step.

```
db1> for host in db2 db3 db4 db5 db6; do
ssh ${host} mkdir /etc/tungsten/secure
scp /etc/tungsten/secure/*.jceks ${host}:/etc/tungsten/secure
scp /etc/tungsten/secure/*.jks ${host}:/etc/tungsten/secure
scp /etc/tungsten/secure/*.ts ${host}:/etc/tungsten/secure
done
```

Once the steps above have been performed, you can then continue with the upgrade, following the steps outlined in Section 4.4.6.7, “Steps to upgrade using tpm”

The following additional configuration properties will need adding to your existing configuration. The suggested process based on an INI or Staging based install are outlined in the final upgrade steps referenced above.

```
enable-connector-ssl=true [447]
java-connector-keystore-path=/etc/tungsten/secure/tungsten_connector_keystore.jks [451]
java-connector-keystore-password=tungsten [451]
java-connector-truststore-path=/etc/tungsten/secure/tungsten_connector_truststore.ts [451]
java-connector-truststore-password=tungsten [451]
```

4.4.6.6. Enable MySQL SSL

A prerequisite to enabling full security, is to enable SSL within your database if this isn't already configured. To do this, we can use the mysql_ssl_rsa_setup tool supplied with most distributions of MySQL. If you do not have this tool, or require more detail, you can refer to Section 5.13.1, “Enabling Database SSL”. The steps below summarise the process using the mysql_ssl_rsa_setup

1. The first step is to setup the directories for the certs, perform this on ALL hosts in your topology:

   ```
   shell> sudo mkdir -p /etc/mysql/certs
   shell> sudo chown -R tungsten: /etc/mysql/certs/
   ```

   NB: The ownership is temporarily set to tungsten so that the subsequent scp will work between hosts.

2. This next step should be performed on just one single host, for the purpose of this example we will use db1 as the host:

   ```
   db1> mysql_ssl_rsa_setup -d /etc/mysql/certs/
   db1> openssl pkcs12 -export -inkey /etc/mysql/certs/client-key.pem \
   -name mysql -in /etc/mysql/certs/client-cert.pem -out /etc/mysql/certs/client-cert.p12 \
   -passout pass:tungsten
   ```

   > **Important**
   >
   > When using OpenSSL 3.0 with Java 1.8, you MUST add the `-legacy` option to the openssl command.

   ```
   db1> for host in db2 db3 db4 db5 db6; do
   scp /etc/mysql/certs/* ${host}:/etc/mysql/certs
   done
   ```

3. Next, on every host we need to reset the directory ownership

   ```
   shell> sudo chown -R mysql: /etc/mysql/certs/
   shell> sudo chmod g+r /etc/mysql/certs/client-*
   ```

4. Now on every host, we need to reconfigure MySQL. Add the following properties into your `my.cnf`

   ```
   [mysqld]
   ssl-ca=/etc/mysql/certs/ca.pem
   ssl-cert=/etc/mysql/certs/server-cert.pem
   ssl-key=/etc/mysql/certs/server-key.pem

   [client]
   ssl-cert=/etc/mysql/certs/client-cert.pem
   ssl-key=/etc/mysql/certs/client-key.pem
   ssl-ca=/etc/mysql/certs/ca.pem
   ```

5. Next, place your cluster(s) into `MAINTENANCE` mode

   ```
   shell> cctrl
   cctrl> set policy maintenance
   ```

6. Restart MySQL for the new settings to take effect

   ```
   shell> sudo service mysqld restart
   ```

7. Finally, return your cluster(s) into `AUTOMATIC` mode

   ```
   shell> cctrl
   cctrl> set policy automatic
   ```

4.4.6.7. Steps to upgrade using tpm

When you are ready to perform the upgrade, the following steps should be followed:

4.4.6.7.1. Steps for INI Based Installations

1. Ensure you place your cluster(s) into `MAINTENANCE` mode
2. If no additional steps taken, and you wish to maintain the same level of security, skip Step 3, and proceed directly to Step 4.
3. Update your `tungsten.ini` and include some, or all, of the options below depending on which steps you took earlier. All entries should be placed within the `[defaults]` stanza.

   ```
   disable-security-controls=false [446]
   connector-rest-api-ssl=true
   manager-rest-api-ssl=true
   replicator-rest-api-ssl=true
   java-jgroups-keystore-path=/etc/tungsten/secure/jgroups.jceks [452]
   ```

   If "Tungsten to Database Encryption" IS configured, also add:

   ```
   datasource-enable-ssl=true [442]
   java-truststore-path=/etc/tungsten/secure/truststore.ts [453]
   java-truststore-password=tungsten [453]
   java-keystore-path=/etc/tungsten/secure/keystore.jks [452]
   java-keystore-password=tungsten [452]
   datasource-mysql-ssl-cert=/etc/mysql/certs/client-cert.pem [443]
   datasource-mysql-ssl-key=/etc/mysql/certs/client-key.pem [443]
   datasource-mysql-ssl-ca=/etc/mysql/certs/ca.pem [443]
   ```

   If "Tungsten to Database Encryption" IS NOT configured, also add:

   ```
   datasource-enable-ssl=false [442]
   ```

   If "Application (Connector) to Database Encryption" IS configured, also add:

   ```
   enable-connector-ssl=true [447]
   java-connector-keystore-path=/etc/tungsten/secure/tungsten_connector_keystore.jks [451]
   java-connector-keystore-password=tungsten [451]
   java-connector-truststore-path=/etc/tungsten/secure/tungsten_connector_truststore.ts [451]
   java-connector-truststore-password=tungsten [451]
   ```

   If "Application (Connector) to Database Encryption" IS NOT configured, also add:

   ```
   enable-connector-ssl=false [447]
   ```

   > **Important**
   >
   > If `start-and-report=true` [466], remove this value or set to `false`

4. Obtain the TAR or RPM package for your installation. If using a TAR file unpack this into your software staging tree, typically `/opt/continuent/software`. If you use the INI install method, this needs to be performed on every host. For staging install, this applies to the staging host only.
5. Change into the directory for the software

   ```
   shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
   ```

6. Issue the following command on all hosts.

   ```
   shell> tools/tpm update --replace-release
   ```

   When upgrading the connectors, you could include the optional `--no-connectors` option if you wish to control the restart of the connectors manually
7. For Multi-Site/Active-Active topologies, you will also need to repeat the steps for the cross-site replicators
8. Finally, before returning the cluster(s) to `AUTOMATIC`, you will need to sync the new certificates, created by the upgrade, to all hosts. This step will be required even if you have disabled security as these files will be used by the API and also, if you choose to enable it, THL Encryption.

   From one host, copy the certificate and keystore files to ALL other hosts in your topology. The following scp command is an example assuming you are issuing from db1, and the install directory is /opt/continuent:

   ```
   db1> for host in db2 db3 db4 db5 db6; do
   ```

```
scp /opt/continuent/share/[jpt]* ${host}:/opt/continuent/share
scp /opt/continuent/share/.[jpt]* ${host}:/opt/continuent/share
done
```

> **Note**
>
> The examples assume you have the ability to scp between hosts as the tungsten OS user. If your security restrictions do not permit this, you will need to use alternative procedures appropriate to your environment to ensure these files are in sync across all hosts before continuing.
>
> If the files are not in sync between hosts, the software will fail to start!

9. You will also need to repeat this if you have a Multi-Site/Active-Active topology for the cross-site replicators:

```
db1> for host in db2 db3 db4 db5 db6; do
scp /opt/replicator/share[jpt]* ${host}:/opt/replicator/share
scp /opt/replicator/share.[jpt]* ${host}:/opt/replicator/share
done
```

10. Restart all tungsten components, one host at a time

```
shell> manager restart
shell> replicator restart
shell> connector restart
```

11. Return the cluster(s) to `AUTOMATIC` mode

4.4.6.7.2. Steps for Staging Based Installations

1. Ensure you place your cluster(s) into `MAINTENANCE` mode
2. Obtain the TAR or RPM package for your installation. If using a TAR file unpack this into your software staging tree, typically `/opt/continuent/software`. If you use the INI install method, this needs to be performed on every host. For staging install, this applies to the staging host only.
3. Change into the directory for the software and fetch the configuration, e.g

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> tpm reverse > deploy.sh
```

4. If no additional steps taken, and you wish to maintain the same level of security, skip Step 5, and proceed directly to Step 6.
5. Edit the deploy.sh file just created, and include some, or all, of the options below depending on which steps you took earlier (They should be placed within the `defaults`.

```
--disable-security-controls=false [446]
--connector-rest-api-ssl=true
--manager-rest-api-ssl=true
--replicator-rest-api-ssl=true
--java-jgroups-keystore-path=/etc/tungsten/secure/jgroups.jceks [452]
```

If "Tungsten to Database Encryption" IS configured, also add:

```
--datasource-enable-ssl=true [442]
--java-truststore-path=/etc/tungsten/secure/truststore.ts [453]
--java-truststore-password=tungsten [453]
--java-keystore-path=/etc/tungsten/secure/keystore.jks [452]
--java-keystore-password=tungsten [452]
--datasource-mysql-ssl-cert=/etc/mysql/certs/client-cert.pem [443]
--datasource-mysql-ssl-key=/etc/mysql/certs/client-key.pem [443]
--datasource-mysql-ssl-ca=/etc/mysql/certs/ca.pem [443]
```

If "Tungsten to Database Encryption" IS NOT configured, also add:

```
--datasource-enable-ssl=false [442]
```

If "Application (Connector) to Database Encryption" IS configured, also add:

```
--enable-connector-ssl=true [447]
--java-connector-keystore-path=/etc/tungsten/secure/tungsten_connector_keystore.jks [451]
--java-connector-keystore-password=tungsten [451]
--java-connector-truststore-path=/etc/tungsten/secure/tungsten_connector_truststore.ts [451]
--java-connector-truststore-password=tungsten [451]
```

If "Application (Connector) to Database Encryption" IS NOT configured, also add:

```
--enable-connector-ssl=false [447]
```

Important

If `start-and-report=true` [466], remove this value or set to `false`

An example of a BEFORE and AFTER edit including all options:

```
shell> cat deploy.sh
# BEFORE
tools/tpm configure defaults \
--reset \
--application-password=secret \
--application-port=3306 \
--application-user=app_user \
--disable-security-controls=true \
--install-directory=/opt/continuent \
--mysql-allow-intensive-checks=true \
--profile-script=/home/tungsten/.bash_profile \
--replication-password=secret \
--replication-user=tungsten \
--start-and-report=true \
--user=tungsten
# Options for the nyc data service
tools/tpm configure nyc \
--connectors=db1,db2,db3 \
--master=db1 \
--slaves=db2,db3 \
--topology=clustered
```

```
shell> cat deploy.sh
# AFTER
tools/tpm configure defaults \
--reset \
--application-password=secret \
--application-port=3306 \
--application-user=app_user \
--install-directory=/opt/continuent \
--mysql-allow-intensive-checks=true \
--profile-script=/home/tungsten/.bash_profile \
--replication-password=secret \
--replication-user=tungsten \
--user=tungsten \
--start-and-report=false \
--disable-security-controls=false \
--connector-rest-api-ssl=true \
--manager-rest-api-ssl=true \
--replicator-rest-api-ssl=true \
--datasource-enable-ssl=true \
--java-jgroups-keystore-path=/etc/tungsten/secure/jgroups.jceks \
--java-truststore-path=/etc/tungsten/secure/truststore.ts \
--java-truststore-password=tungsten \
--java-keystore-path=/etc/tungsten/secure/keystore.jks \
--java-keystore-password=tungsten \
--enable-connector-ssl=true \
--java-connector-keystore-path=/etc/tungsten/secure/tungsten_connector_keystore.jks \
--java-connector-keystore-password=tungsten \
--java-connector-truststore-path=/etc/tungsten/secure/tungsten_connector_truststore.ts \
--java-connector-truststore-password=tungsten \
--datasource-mysql-ssl-cert=/etc/mysql/certs/client-cert.pem \
--datasource-mysql-ssl-key=/etc/mysql/certs/client-key.pem \
--datasource-mysql-ssl-ca=/etc/mysql/certs/ca.pem

# Options for the nyc data service
tools/tpm configure nyc \
--connectors=db1,db2,db3 \
--master=db1 \
--slaves=db2,db3 \
--topology=clustered
```

6. Next, source the file to load the configuration and then execute the update:

```
shell> source deploy.sh
shell> tools/tpm update --replace-release
```

You may wish to include the optional `--no-connectors` option if you wish to control the restart of the connectors manually

7. For Multi-Site/Active-Active topologies, you will also need to repeat the steps for the cross-site replicators

8. Finally, before returning the cluster(s) to `AUTOMATIC`, you will need to sync the new certificates, created by the upgrade, to all hosts. This step will be required even if you have disabled security as these files will be used by the API and also, if you choose to enable it, THL Encryption.

From one host, copy the certificate and keystore files to ALL other hosts in your topology. The following scp command is an example assuming you are issuing from db1, and the install directory is /opt/continuent:

```
db1> for host in db2 db3 db4 db5 db6; do
scp /opt/continuent/share/[jpt]* ${host}:/opt/continuent/share
scp /opt/continuent/share/.[jpt]* ${host}:/opt/continuent/share
done
```

> **Note**
>
> The examples assume you have the ability to scp between hosts as the tungsten OS user. If your security restrictions do not permit this, you will need to use alternative procedures appropriate to your environment to ensure these files are in sync across all hosts before continuing.
>
> If the files are not in sync between hosts, the software will fail to start!

9. You will also need to repeat this if you have a Multi-Site/Active-Active topology for the cross-site replicators:

```
db1> for host in db2 db3 db4 db5 db6; do
scp /opt/replicator/share[jpt]* ${host}:/opt/replicator/share
scp /opt/replicator/share.[jpt]* ${host}:/opt/replicator/share
done
```

10. Restart all tungsten components, one host at a time

```
shell> manager restart
shell> replicator restart
shell> connector restart
```

11. Return the cluster(s) to `AUTOMATIC` mode

4.4.6.8. Optional Post-Upgrade steps to configure API

Once the upgrade has been completed, if you plan on using the API you will need to complete a few extra steps before you can use it. By default, after installation the API will only allow the ping method and the createAdminUser method.

To open up the API and access all of its features, you will need to configure the API User. To do this, execute the following on all hosts (Setting the value of pass to your preferred password):

```
shell> curl -k -H 'Content-type: application/json' --request POST 'https://127.0.0.1:8096/api/v2/createAdminUser?i-am-sure=true' \
> --data-raw '{
>   "payloadType": "credentials",
>   "user":"tungsten",
>   "pass":"security"
> }'
```

For more information on using the new API, please refer to ???

4.5. Removing Datasources, Managers or Connectors

Removing components from a dataservice is quite straightforward, usually involved both modifying the running service and changing the configuration. Changing the configuration is necessary to ensure that the host is not re-configured and installed when the installation is next updated.

In this section:

- Section 4.5.1, “Removing a Datasource from an Existing Deployment”
- Section 4.5.3, “Removing a Connector from an Existing Deployment”

4.5.1. Removing a Datasource from an Existing Deployment

To remove a datasource from an existing deployment there are two primary stages, removing it from the active service, and then removing it from the active configuration.

For example, to remove `host6` from a service:

1. Check the current service state:

```
[LOGICAL] /alpha > ls

COORDINATOR[host1:AUTOMATIC:ONLINE]
```

```
ROUTERS:
+----------------------------------------------------------------------------+
|connector@host1[11401](ONLINE, created=17, active=0)                        |
|connector@host2[7998](ONLINE, created=0, active=0)                          |
|connector@host3[31540](ONLINE, created=0, active=0)                         |
|connector@host4[26829](ONLINE, created=27, active=1)                        |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|host1(slave:ONLINE, progress=373, latency=0.000)                            |
|STATUS [OK] [2014/02/12 12:48:14 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=host6, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=30, active=0)                                         |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host2(slave:ONLINE, progress=373, latency=1.000)                            |
|STATUS [OK] [2014/01/24 05:02:34 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=host6, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host3(slave:ONLINE, progress=373, latency=1.000)                            |
|STATUS [OK] [2014/02/11 03:17:08 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=host6, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host6(master:ONLINE, progress=373, THL latency=0.936)                       |
|STATUS [OK] [2014/02/12 12:39:52 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=master, state=ONLINE)                                     |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=14, active=1)                                         |
+----------------------------------------------------------------------------+
```

2. Switch to *MAINTENANCE* policy mode:

```
[LOGICAL] /alpha > set policy maintenance
policy mode is now MAINTENANCE
```

3. Switch to administration mode:

```
[LOGICAL] /alpha > admin
```

4. Remove the node from the active service using the rm command. You will be warned that this is an expert command and to confirm the operation:

```
[ADMIN] /alpha > rm host6

WARNING: This is an expert-level command:
Incorrect use may cause data corruption
or make the cluster unavailable.

Do you want to continue? (y/n)> y
```

5. Switch back to logical mode:

```
[ADMIN] /alpha > logical
```

6. Switch to *AUTOMATIC* policy mode:

```
[LOGICAL] /alpha > set policy automatic
policy mode is now AUTOMATIC
```

Now the node has been removed from the active dataservice, the services must be stopped and then removed from the configuration.

1. Stop the running services:

```
shell> stopall
```

2. Now you must remove the node from the configuration, although the exact method depends on which installation method used with tpm:

   - If you are using staging directory method with tpm:

     ```
     shell> tpm query staging
     tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

     shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
     The staging USER is tungsten

     shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
     The staging HOST is db1

     shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
     The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

     shell> ssh {STAGING_USER}@{STAGING_HOST}
     shell> cd {STAGING_DIRECTORY}
     ```

     ```
     shell> ./tools/tpm configure alpha \
         --connectors=host1,host2,host3,host4 \
         --members=host1,host2,host3
     ```

     Run the tpm command to update the software with the Staging-based configuration:

     ```
     shell> ./tools/tpm update
     ```

     For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

   - If you are using the INI file method with tpm:

     - Remove the INI configuration file:

       ```
       shell> rm /etc/tungsten/tungsten.ini
       ```

3. Stop the replicator/manager from being started again.

   - If this all the services on the this node, replicator, manager and connector are being removed, remove the Tungsten Cluster installation entirely:

     - Remove the startup scripts from your server:

       ```
       shell> sudo /opt/continuent/tungsten/cluster-home/bin/undeployall
       ```

     - Remove the installation directory:

       ```
       shell> rm -rf /opt/continuent
       ```

   - If the replicator/manager has been installed on a host but the connector is not being removed, remove the start scripts to prevent the services from being automatically started:

     ```
     shell> rm /etc/init.d/tmanager
     shell> rm /etc/init.d/treplicator
     ```

4.5.2. Removing a Composite Datasource/Cluster from an Existing Deployment

To remove an entire composite datasource (cluster) from an existing deployment there are two primary stages, removing it from the active service, and then removing it from the active configuration.

For example, to remove cluster `west` from a composite dataservice:

1. Check the current service state:

   ```
   shell> cctrl -multi
   [LOGICAL] / > ls

   +----------------------------------------------------------------------------+
   |DATA SERVICES:                                                              |
   +----------------------------------------------------------------------------+
   east
   global
   west
   ```

```
[LOGICAL] / > use global
[LOGICAL] /global > ls

COORDINATOR[db1:AUTOMATIC:ONLINE]

DATASOURCES:
+------------------------------------------------------------------------------+
|east(composite master:ONLINE)                                                 |
|STATUS [OK] [2017/05/16 01:25:31 PM UTC]                                      |
+------------------------------------------------------------------------------+

+------------------------------------------------------------------------------+
|west(composite slave:ONLINE)                                                  |
|STATUS [OK] [2017/05/16 01:25:30 PM UTC]                                      |
+------------------------------------------------------------------------------+
```

2. Switch to *MAINTENANCE* policy mode:

```
[LOGICAL] /global > set policy maintenance
policy mode is now MAINTENANCE
```

3. Remove the composite member cluster from the composite service using the drop command.

```
[LOGICAL] /global > drop composite datasource west
COMPOSITE DATA SOURCE 'west@global' WAS DROPPED

[LOGICAL] /global > ls

COORDINATOR[db1:AUTOMATIC:ONLINE]

DATASOURCES:
+------------------------------------------------------------------------------+
|east(composite master:ONLINE)                                                 |
|STATUS [OK] [2017/05/16 01:25:31 PM UTC]                                      |
+------------------------------------------------------------------------------+

[LOGICAL] /global > cd /
[LOGICAL] / > ls

+------------------------------------------------------------------------------+
|DATA SERVICES:                                                                |
+------------------------------------------------------------------------------+
east
global
```

4. If the removed composite datasource still appears in the top-level listing, then you will need to clean up by hand. For example:

```
[LOGICAL] /global > cd /
[LOGICAL] / > ls

+------------------------------------------------------------------------------+
|DATA SERVICES:                                                                |
+------------------------------------------------------------------------------+
east
global
west
```

Stop all managers on all nodes at the same time

```
[LOGICAL] /global > use west
[LOGICAL] /west > manager * stop
```

```
shell > vim $CONTINUENT_HOME/cluster-home/conf/dataservices.properties

Before:
east=db1,db2,db3
west=db4,db5,db6

After:
east=db1,db2,db3
```

Start all managers one-by-one, starting with the current Primary

```
shell > manager start
```

Once all managers are running, check the list again:

```
shell> cctrl -multi
[LOGICAL] / > ls

+------------------------------------------------------------------------------+
```

```
|DATA SERVICES:                                                                |
+------------------------------------------------------------------------------+
east
global
```

5. Switch to *AUTOMATIC* policy mode:

```
[LOGICAL] / > set policy automatic
policy mode is now AUTOMATIC
```

Now the cluster has been removed from the composite dataservice, the services on the old nodes must be stopped and then removed from the configuration.

1. Stop the running services on all nodes in the removed cluster:

```
shell> stopall
```

2. Now you must remove the node from the configuration, although the exact method depends on which installation method used with tpm:

   - If you are using staging directory method with tpm:

     a. Change to the staging directory. The current staging directory can be located using tpm query staging:

     ```
     shell> tpm query staging
     tungsten@host1:/home/tungsten/tungsten-clustering-5.4.1-41
     shell> cd /home/tungsten/tungsten-clustering-5.4.1-41
     ```

     b. Update the configuration, omitting the cluster datasource name from the list of members of the dataservice:

     ```
     shell> tpm update global --composite-datasources=east
     ```

   - If you are using the INI file method with tpm:

     - Remove the INI configuration file:

     ```
     shell> rm /etc/tungsten/tungsten.ini
     ```

3. Stop the replicator/manager from being started again.

   - If this all the services on the this node, replicator, manager and connector are being removed, remove the Tungsten Cluster installation entirely:

     - Remove the startup scripts from your server:

     ```
     shell> sudo /opt/continuent/tungsten/cluster-home/bin/undeployall
     ```

     - Remove the installation directory:

     ```
     shell> rm -rf /opt/continuent
     ```

   - If the replicator/manager has been installed on a host but the connector is not being removed, remove the start scripts to prevent the services from being automatically started:

   ```
   shell> rm /etc/init.d/tmanager
   shell> rm /etc/init.d/treplicator
   ```

4.5.3. Removing a Connector from an Existing Deployment

Removing a connector involves only stopping the connector and removing the configuration. When the connector is stopped, the manager will automatically remove it from the dataservice. Note that applications that have been configured to talk to the connector must be updated to point to another connector.

For example, to remove host4 from the current dataservice:

1. Login to the host running the connector.

2. Stop the connector service:

```
shell> connector stop
```

3. Remove the connector from the configuration, the exact method depends on which installation method used with tpm:

   - If you are using staging directory method with tpm:

a. Change to the staging directory. The current staging directory can be located using tpm query staging:

```
shell> tpm query staging
tungsten@host1:/home/tungsten/tungsten-clustering-5.4.1-41
shell> cd /home/tungsten/tungsten-clustering-5.4.1-41
```

b. Update the configuration, omitting the host from the list of members of the dataservice:

```
shell> tpm update alpha \
    --connectors=host1,host2,host3 \
    --members=host1,host2,host3
```

- If you are using the INI file method with tpm:
  - Remove the INI configuration file:

```
shell> rm /etc/tungsten/tungsten.ini
```

4. Stop the connector from being started again. If the connector is restarted, it will connect to the previously configured Primary and begin operating again.

- If this is a standalone Connector installation, remove the Tungsten Cluster installation entirely:
  - Remove the startup scripts from your server:

```
shell> sudo /opt/continuent/tungsten/cluster-home/bin/undeployall
```

  - Remove the installation directory:

```
shell> rm -rf /opt/continuent
```

- If the connector has been installed on a host with replicator and/or managers, remove the start script to prevent the connector from being automatically started:

```
shell> rm /etc/init.d/tconnector
```

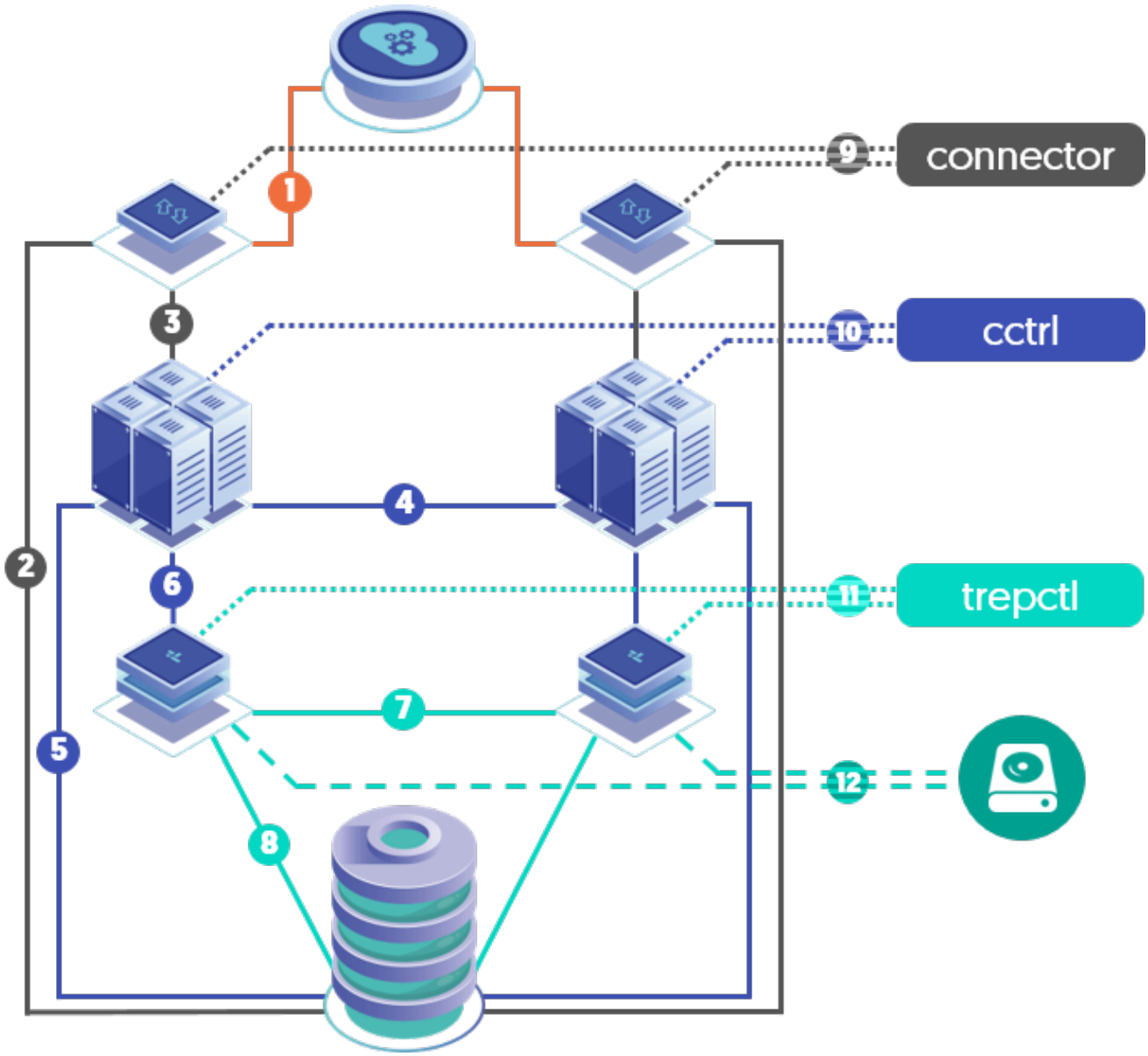
Chapter 5. Deployment: Security

Tungsten Cluster supports SSL, TLS and certificates for both communication and authentication for all components within the system. This security is disabled by default and includes:

- Authentication between command-line tools [cctrl], and between background services.
- SSL/TLS between command-line tools and background services.
- SSL/TLS between Tungsten Replicator and datasources.
- SSL/TLS between Tungsten Connector and datasources.
- File permissions and access by all components.

The following graphic provides a visual representation of the various communication channels which may be encrypted.

Figure 5.1. Security Internals: Cluster Communication Channels



For the key to the above diagram, please see ???.

If you are using a single staging directory to handle your complete installation, tpm will automatically create the necessary certificates for you. If you are using an INI based installation, then the installation process will create the certificates for you, however you will need to manually sync them between hosts prior to starting the various components.

> **Important**
>
> Due to a known issue in earlier Java revisions that may cause performance degradation with client connections, it is strongly advised that you ensure your Java version is one of the following MINIMUM releases before enabling SSL:
>
> - Oracle JRE 8 Build 261
> - OpenJDK 8 Build 222

5.1. Enabling Security

By default, security is disabled for the entire installation.

Security can be enabled/disabled by adding the `disable-security-controls` [446] option to the configuration.

If this property is not supplied, or set to true, then security will be disabled. If set to false, then security will be enabled.

Enabling security through this single option, has the same effect as adding:

- `--file-protection-level=0027` [449]
- `--rmi-ssl=true` [448]
- `--thl-ssl=true` [449]
- `--rmi-authentication=true` [448]
- `--jgroups-ssl=true` [448]

> **Important**
>
> **Important**
>
> Installing from a staging host will automatically generate certificates and configuration for a secured installation. No further changes or actions are required.
>
> For INI-based installations, there are additional steps required to copy the needed certificate files to all of the nodes. Please see Section 5.1.2, “Enabling Security using the INI Method” for details.

5.1.1. Enabling Security using the Staging Method

Security can be enabled either during initial installation or via an update.

For many reasons, it is much easier to enable SSL at install time. Both procedures follow below.

Enabling During Install

Security can be enabled at install time by using the `--disable-security-controls=false` [446] option to the tpm configure command.

```
shell> tools/tpm configure defaults --disable-security-controls=false \
[...the rest of the configuration options...]
shell> tools/tpm install
```

> **Important**
>
> Installing from a staging host will automatically generate certificates and configuration for a secured installation. No further changes or actions are required.

Enabling Post-Installation

Security can be enabled after install time by using the `--disable-security-controls=false` [446] option to the tpm configure command followed by a special invocation of the tpm update command..

```
shell> tools/tpm configure defaults --disable-security-controls=false
shell> tools/tpm update --replace-jgroups-certificate --replace-tls-certificate --replace-release
```

> **Warning**
>
> This update will force all running processes to be restarted. Connectors MUST be done at the same time or they will no longer be able to communicate with the managers.

5.1.2. Enabling Security using the INI Method

Security can be enabled either during initial installation or via an update.

For many reasons, it is much easier to enable SSL at install time. Both procedures follow below.

Enabling During Install

- First, configure the `tungsten.ini` file as follows:

```
disable-security-controls=false [446]
start-and-report=false [466]
```

- Next, do the fresh install on each node, which will generate new, different certificates on every node.

```
shell> tools/tpm install
```

- You must then select one of the nodes and copy that node's certificate files to all other nodes.

  For example, to seed a 6-node composite cluster, login to db1 and copy both the main and backup files to the other five nodes:

```
shell> for i in `seq 2 6`; do scp /opt/continuent/share/[jpt]* db$i:/opt/continuent/share/; done
shell> for i in `seq 2 6`; do scp /opt/continuent/share/.[jpt]* db$i:/opt/continuent/share/; done
```

- On all nodes:

```
shell> startall
```

Enabling Post-Installation

Security can be enabled after install time by updating the `tungsten.ini` file, followed by a special invocation of the tpm update command on all nodes.

- First, configure the `tungsten.ini` file as follows:

```
disable-security-controls=false [446]
start-and-report=false [466]
```

- Enable Maintenance mode on the cluster

```
shell> cctrl -multi
cctrl> use world
cctrl> set policy maintenance
```

- Do the update on each node, which will generate new, different certificates on every node.

  > **Warning**
  >
  > This update procedure will force all running Tungsten processes to be stopped. Connectors MUST be done at the same time or they will no longer be able to communicate with the Managers.

```
shell> stopall
shell> tpm query staging
shell> cd {staging_directory}
shell> tools/tpm update --replace-jgroups-certificate --replace-tls-certificate --replace-release
```

- As with a fresh install, you must then select one of the nodes and copy that node's certificate files to all other nodes:

  For example, to seed a 6-node composite cluster, login to db1 and copy both the main and backup files to the other five nodes:

```
shell> for i in `seq 2 6`; do scp /opt/continuent/share/[jpt]* db$i:/opt/continuent/share/; done
shell> for i in `seq 2 6`; do scp /opt/continuent/share/.[jpt]* db$i:/opt/continuent/share/; done
```

- On all nodes:

```
shell> startall
```

5.2. Disabling Security

There may be situations where you wish to disable securityfor the entire installation.

Security can be disabled in the following ways during configuration with tpm:

```
--disable-security-controls=true [446]
```

Disabling security through this single option, has the same effect as adding:

- `--file-protection-level=none` [449]

  Disables file level protection, including ownership and file mode settings.

- `--rmi-ssl=false` [448]

  Disables the use of SSL/TLS for communicating with services, this includes starting, stopping, or controlling individual services and operations, such as putting Tungsten Replicator online or offline.

- `--thl-ssl=false` [449]

  Disables the use of SSL/TLS for THL transmission between replicators.

- `--rmi-authentication=false` [448]

  Disables the use of authentication when accessing and controlling services.

- `--jgroups-ssl=false` [448]

  Disables SSL/TLS for group communication within the cluster.

5.3. Creating Suitable Certificates

By default, tpm can automatically create suitable certificates and configuration for use in your deployment. To create the required certificates by hand, use one of the following procedures.

5.3.1. Creating Tungsten Internal Certificates Manually

To manually generate the security files, use the steps below:

- Generating a JGroups Certificate

  Run this command to create the keystore in `/etc/tungsten/secure`. You may use your own location, but the values for `-storepass` and `-keypass` must be identical.

  ```
  shell> keytool -genseckey -alias jgroups \
  -validity 3650 \
  -keyalg Blowfish -keysize 56 -keystore /etc/tungsten/secure/tungsten_jgroups_keystore.jceks \
  -storepass mykeystorepass -keypass mykeystorepass \
  -storetype JCEKS
  ```

- Generating a TLS Certificate

  Run this command to create the keystore in `/etc/tungsten/secure`. You may use your own location, but the values for `-storepass` and `-keypass` must match.

  ```
  shell> keytool -genkey -alias tls \
  -validity 3650 \
  -keyalg RSA -keystore /etc/tungsten/secure/tungsten_tls_keystore.jks \
  -dname "cn=Continuent, ou=IT, o=Continuent, c=US" \
  -storepass mykeystorepass -keypass mykeystorepass
  ```

5.4. Installing from a Staging Host with Custom Certificates

Follow the steps in Section 5.3, “Creating Suitable Certificates” to create JGroups and TLS certificates.

Update your configuration to specify these certificates and the keystore password:

5.4.1. Installing from a Staging Host with Manually-Generated Certificates

```
shell> tools/tpm configure SERVICE \
    --java-tls-keystore-path=/etc/tungsten/secure/tungsten_tls_keystore.jks \
    --java-jgroups-keystore-path=/etc/tungsten/secure/tungsten_jgroups_keystore.jceks \
    --java-keystore-password=mykeystorepass
```

5.5. Installing via INI File with Custom Certificates

Follow the steps in Section 5.3, "Creating Suitable Certificates" to create JGroups and TLS certificates.

5.5.1. Installing via INI File with Manually-Generated Certificates

1. Transfer the generated certificates to the same path on all hosts.
2. Update your configuration to specify these certificates and the keystore password:

```
java-tls-keystore-path=/etc/tungsten/secure/tungsten_tls_keystore.jks
java-jgroups-keystore-path=/etc/tungsten/secure/tungsten_jgroups_keystore.jceks
java-keystore-password=mykeystorepass
```

5.6. Installing via INI File with CA-Signed Certificates

- This procedure will take a signed certificate from a known Certificate Authority and use it as the basis for all SSL operations within the cluster, not including Connector client-server SSL, which is configured separately. Please visit Section 5.13.3, "Configuring Connector SSL" for more information about configuring Connector SSL.
- The below example procedure assumes that you have an existing, installed and running cluster with security enabled by setting `disable-security-controls=false` [446]

  Assume a 3-node cluster called `alpha` with member hosts `db1`, `db2` and `db3`.

  > **Warning**
  >
  > In all examples below, because you are updating an existing secure installation, the password `tungsten` is required, do not change it.

- Select one node to create the proper set of certs, i.e. `db1`:

```
shell> su - tungsten
shell> mkdir /etc/tungsten/secure
shell> mkdir ~/certs
shell> cd ~/certs
```

- Copy the available files (CA cert, Intermediate cert (if needed), signed cert and signing key) into ~/certs/, i.e.:

```
ca.crt.pem
int.crt.pem
signed.crt.pem
signing.key.pem
```

- Create a pkcs12 (.p12) version of the signed certificate:

```
shell> openssl pkcs12 -export -in ~/certs/signed.crt.pem -inkey ~/certs/signing.key.pem \
  -out ~/certs/tungsten_sec.crt.p12 -name replserver
Enter Export Password: tungsten
Verifying - Enter Export Password: tungsten
```

  > **Important**
  >
  > When using OpenSSL 3.0 with Java 1.8, you MUST add the `-legacy` option to the openssl command.

- Create a pkcs12-based keystore (.jks) version of the signed certificate:

```
shell> keytool -importkeystore -deststorepass tungsten -destkeystore /etc/tungsten/secure/tungsten_keystore.jks \
  -srckeystore ~/certs/tungsten_sec.crt.p12 -srcstoretype pkcs12 -deststoretype pkcs12
Importing keystore /home/tungsten/certs/tungsten_sec.crt.p12 to /etc/tungsten/secure/tungsten_keystore.jks...
Enter source keystore password:  tungsten
Entry for alias replserver successfully imported.
Import command completed:  1 entries successfully imported, 0 entries failed or cancelled
```

- Import the Certificate Authority's certificate into the keystore:

```
shell> keytool -import -alias careplserver -file ~/certs/ca.crt.pem -keypass tungsten \
  -keystore /etc/tungsten/secure/tungsten_keystore.jks -storepass tungsten
...
Trust this certificate? [no]:  yes
Certificate was added to keystore
```

- Import the Certificate Authority's intermediate certificate (if supplied) into the keystore:

```
shell> keytool -import -alias interreplserver -file ~/certs/int.crt.pem -keypass tungsten \
```

```
  -keystore /etc/tungsten/secure/tungsten_keystore.jks -storepass tungsten
Certificate was added to keystore
```

- Export the cert from the keystore into file `client.cer` for use in the next step to create the truststore:

```
shell> keytool -export -alias replserver -file ~/certs/client.cer \
  -keystore /etc/tungsten/secure/tungsten_keystore.jks
Enter keystore password:  tungsten
Certificate stored in file </home/tungsten/certs/client.cer>
```

- Create the truststore:

```
shell> keytool -import -trustcacerts -alias replserver -file ~/certs/client.cer \
  -keystore /etc/tungsten/secure/tungsten_truststore.ts -storepass tungsten -noprompt
Certificate was added to keystore
```

- Create the rmi_jmx password store entry:

```
shell> tpasswd -c tungsten tungsten -t rmi_jmx -p /etc/tungsten/secure/passwords.store -e \
  -ts /etc/tungsten/secure/tungsten_truststore.ts -tsp tungsten
Using parameters:
-----------------
security.properties    = /opt/continuent/tungsten/cluster-home/../cluster-home/conf/security.properties
password.file.location    = /etc/tungsten/secure/passwords.store
encrypted.password    = true
truststore.location    = /etc/tungsten/secure/tungsten_truststore.ts
truststore.password    = *********
-----------------
Creating non existing file: /etc/tungsten/secure/passwords.store
User created successfuly: tungsten
```

- Create the tls password store entry:

```
shell> tpasswd -c tungsten tungsten -t unknown -p /etc/tungsten/secure/passwords.store -e \
  -ts /etc/tungsten/secure/tungsten_truststore.ts -tsp tungsten
Using parameters:
-----------------
security.properties    = /opt/continuent/tungsten/cluster-home/../cluster-home/conf/security.properties
password.file.location    = /etc/tungsten/secure/passwords.store
encrypted.password    = true
truststore.location    = /etc/tungsten/secure/tungsten_truststore.ts
truststore.password    = ********
-----------------
User created successfuly: tungsten
```

- List and verify the user for each security service password store entry, rmi_jmx and tls (which has a display tag of `unknown`):

```
shell> tpasswd -l -p /etc/tungsten/secure/passwords.store -ts /etc/tungsten/secure/tungsten_truststore.ts
Using parameters:
-----------------
security.properties    = /opt/continuent/tungsten/cluster-home/../cluster-home/conf/security.properties
password.file.location    = ./passwords.store
encrypted.password    = true
truststore.location    = ./tungsten_truststore.ts
truststore.password    = ********
-----------------
Listing users by application type:

[unknown]
-----------
tungsten

[rmi_jmx]
-----------
tungsten
```

- On host db1, transfer the generated certificates to the same path on all remaining hosts:

```
shell> for host in `seq 2 3`; do rsync -av /etc/tungsten/secure/ db$host:/etc/tungsten/secure/; done
```

- Edit the `/etc/tungsten/tungsten.ini` configuration file on all nodes and add:

```
[defaults]
...
disable-security-controls=false
java-keystore-path=/etc/tungsten/secure/tungsten_keystore.jks
java-keystore-password=tungsten
java-truststore-path=/etc/tungsten/secure/tungsten_truststore.ts
java-truststore-password=tungsten
rmi-ssl=true
rmi-authentication=true
rmi-user=tungsten
```

```
java-passwordstore-path=/etc/tungsten/secure/passwords.store
```

> **Important**
>
> When `java-keystore-path` [452] is passed to tpm, the keystore must contain both tls and mysql certs when appropriate. tpm will NOT add mysql cert nor generate tls cert when this flag is found, so both certs must be manually imported already.

- On one node only, enable maintenance mode:

```
cctrl> set policy maintenance
```

- On ALL nodes, stop the cluster software, execute the update, then start the cluster:

> **Warning**
>
> This procedure requires the complete restart of all layers of the Cluster, and will cause a brief downtime.

```
shell> tpm query staging
shell> cd {staging_dir}
shell> stopall
shell> tools/tpm update --replace-release
shell> startall
```

- On one node only, enable automatic mode and check cluster status:

```
shell> cctrl
Tungsten Clustering 6.0.5 build 40
alpha: session established, encryption=true, authentication=true
cctrl> set policy automatic
cctrl> ls
COORDINATOR[db1:AUTOMATIC:ONLINE]

ROUTERS:
+---------------------------------------------------------------------------+
|connector@db1[9871](ONLINE, created=0, active=0)                           |
|connector@db2[27930](ONLINE, created=0, active=0)                          |
|connector@db3[23727](ONLINE, created=0, active=0)                          |
+---------------------------------------------------------------------------+

DATASOURCES:
+---------------------------------------------------------------------------+
|db1(master:ONLINE, progress=1, THL latency=0.656)                          |
|STATUS [OK] [2019/06/06 12:48:11 PM UTC]                                   |
+---------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
|  REPLICATOR(role=master, state=ONLINE)                                    |
|  DATASERVER(state=ONLINE)                                                 |
|  CONNECTIONS(created=0, active=0)                                         |
+---------------------------------------------------------------------------+
+---------------------------------------------------------------------------+
|db2(slave:ONLINE, progress=1, latency=9.858)                               |
|STATUS [OK] [2019/06/06 12:48:11 PM UTC]                                   |
+---------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                         |
|  DATASERVER(state=ONLINE)                                                 |
|  CONNECTIONS(created=0, active=0)                                         |
+---------------------------------------------------------------------------+
+---------------------------------------------------------------------------+
|db3(slave:ONLINE, progress=1, latency=19.235)                              |
|STATUS [OK] [2019/06/06 12:48:10 PM UTC]                                   |
+---------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                         |
|  DATASERVER(state=ONLINE)                                                 |
|  CONNECTIONS(created=0, active=0)                                         |
+---------------------------------------------------------------------------+
```

5.7. Replacing the JGroups Certificate from a Staging Directory

If you meet the requirements to use an automatically generated certificate from the staging directory, the tpm update command can handle the certificate replacement. Simply add the `--replace-jgroups-certificate` option to your command. This will create errors if your staging configuration does not reflect the full list of hosts or if you limit the command to a specific host.

```
shell> tools/tpm update --replace-jgroups-certificate --replace-release
```

If you do not meet these requirements, generate a new certificate and update it through the tpm command.

```
shell> tools/tpm configure SERVICE \
     --java-jgroups-keystore-path=/etc/tungsten/jgroups.jceks \
     --java-keystore-password=mykeystorepass
```

Then perform an update and replace the entire release directory:

```
shell> tools/tpm update --replace-release
```

5.8. Replacing the TLS Certificate from a Staging Directory

If you meet the requirements to use an automatically generated certificate from the staging directory, the tpm update command can handle the certificate replacement. Simply add the `--replace-tls-certificate` [463] option to your command. This will create errors if your staging configuration does not reflect the full list of hosts or if you limit the command to a specific host.

```
shell> tools/tpm update --replace-tls-certificate --replace-release
```

If you do not meet these requirements, generate a new certificate and update it through the tpm command.

```
shell> tools/tpm configure SERVICE \
       --java-tls-keystore-path=/etc/tungsten/tls.jks \
       --java-keystore-password=mykeystorepass
```

Then perform an update and replace the entire release directory:

```
shell> tools/tpm update --replace-release
```

5.9. Removing JGroups Encryption from a Staging Directory

Using the tpm update command, the jgroups encryption can be easily removed.

```
shell> tpm configure SERVICE \
         --jgroups-ssl=false
```

Then perform an update and replace the entire release directory:

```
shell> tpm update --replace-release
```

5.10. Removing JGroups Encryption via INI File

To remove the JGroups encryption from a running cluster:

1. Put the cluster into *MAINTENANCE* mode
2. Update the INI file

   ```
   jgroups-ssl=false
   ```

3. Run tpm update and restart the manager

   ```
   shell> tpm update
   shell> manager restart
   ```

4. Check the cluster through cctrl
5. Put the cluster back into *AUTOMATIC* mode

5.11. Removing TLS Encryption from a Staging Directory

Using the tpm update command, the general Continuent service encryption can be easily removed.

```
shell> tpm configure SERVICE \
   --thl-ssl=false \
   --rmi-ssl=false \
   --rmi-authentication=false
```

Then perform an update and replace the entire release directory:

```
shell> tpm update --replace-release
```

5.12. Removing TLS Encryption via INI File

To remove the TLS encryption from a running cluster:

1. Put the cluster into *MAINTENANCE* mode

2. Update the INI file

```
thl-ssl=false
rmi-ssl=false
rmi-authentication=false
```

3. Run tpm update and restart the manager

```
shell> tpm update
shell> manager restart
shell> replicator restart
```

4. Check the cluster through cctrl

5. Cycle through the connectors and restart them

```
shell> connector restart
```

6. Put the cluster back into *AUTOMATIC* mode

5.13. Enabling Tungsten<>Database Security

This section explains how to enable security between the database and various other parts of the topology, including:

- Database server SSL

  This is the first step, and the prerequiste for all the remaining steps. You must have the database server properly configured to support SSL before any of the other procedures will work.

  See Section 5.13.1, "Enabling Database SSL"

- Tungsten Replicator to the database server

  This usually happens during the second step, and what allows Tungsten Replicator to communicate securely with the database server.

  See Section 5.13.2, "Configure Tungsten<>Database Secure Communication"

- Tungsten Manager to the database server

  This usually happens during the second step, and what allows Tungsten Manager to communicate securely with the database server.

  See Section 5.13.2, "Configure Tungsten<>Database Secure Communication"

- Connector to the database server

  This is usually the third step, and what allows the Tungsten Connector to communicate securely with the database server.

  See Section 5.13.3.1, "Enable and Test SSL encryption from the Connector to the Database"

- Application to the Database through the Connector

  This is usually the last step, and what allows the Application to communicate securely with the database server through the Tungsten Connector.

  See Section 5.13.3.2, "Test SSL encryption from the Application to the Database"

5.13.1. Enabling Database SSL

The steps outlined below explain how to enable security within MySQL (If it is not already enabled by default in the release your are using). There are different approaches depending on the version/distribution of MySQL you are using. If in any doubt, you should consult the appropriate documentation pages for the MySQL release you are using.

5.13.1.1. Using mysql_ssl_rsa_setup utility

This tool is shipped with MySQL 5.7 onwards and makes the creation of all of the certificates much easier. If you have this tool available, then you can follow the steps below:

- Invoke mysql_ssl_rsa_setup on one of the hosts. This will generate the SSL certificates and RSA keys by default in `/var/lib/mysql`. These files should be copied to the other hosts.

  The mysql_ssl_rsa_setup supports the `--datadir=/my/custom/path/` option if the you want to use a different location. Continuent recommends using `/etc/mysql/certs` as the location.

> **Note**
>
> The generated pem files should be readable by the `tungsten` and `mysql` OS users.

- Add the following to the `[mysqld]` stanza in your `my.cnf`

```
[mysqld]
ssl_ca=/etc/mysql/certs/ca.pem
ssl_cert=/etc/mysql/certs/server-cert.pem
ssl_key=/etc/mysql/certs/server-key.pem
require_secure_transport=ON
```

- Add the following to the `>[client]` stanz in your `my.cnf`

```
[client]
ssl_ca=/etc/mysql/certs/ca.pem
ssl_cert=/etc/mysql/certs/client-cert.pem
ssl_key=/etc/mysql/certs/client-key.pem
ssl_mode=REQUIRED
```

  This will allow the mysql client will connect through SSL to the server.

- tpm will parse the `my.cnf` file and retrieve the certificates paths. It is still possible to specify different paths via the following `tungsten.ini` settings:

```
repl-datasource-mysql-ssl-ca=/etc/mysql/certs/ca.pem
repl-datasource-mysql-ssl-cert=/etc/mysql/certs/client-cert.pem
repl-datasource-mysql-ssl-key=/etc/mysql/certs/client-key.pem
```

  tpm install will add these client certificates to the tungsten truststore, keystore, connector truststore and keystore.

5.13.1.2. Manually Creating Certificates

> **Important**
>
> The "Common Name" field for the Server and Client certificates MUST be different than the "Common Name" specified for the CA Cert.

1. Generate CA Cert

```
shell> openssl genrsa 2048 > $MYSQL_CERTS_PATH/ca-key.pem

shell> openssl req -sha256 -new -x509 -nodes -days 3650 \
-key $MYSQL_CERTS_PATH/ca-key.pem \
-out $MYSQL_CERTS_PATH/ca.pem
```

2. Generate Server Cert

```
shell> openssl req -sha256 -newkey rsa:2048 -nodes -days 3650 \
-keyout $MYSQL_CERTS_PATH/server-key.pem \
-out $MYSQL_CERTS_PATH/server-req.pem

shell> openssl rsa -in $MYSQL_CERTS_PATH/server-key.pem -out $MYSQL_CERTS_PATH/server-key.pem

shell> openssl x509 -sha256 -req -in $MYSQL_CERTS_PATH/server-req.pem -days 3650 \
-CA $MYSQL_CERTS_PATH/ca.pem \
-CAkey $MYSQL_CERTS_PATH/ca-key.pem \
-set_serial 01 \
-out $MYSQL_CERTS_PATH/server-cert.pem
```

3. Generate Client Cert

```
shell> openssl req -sha256 -newkey rsa:2048 -days 3600 -nodes \
-keyout $MYSQL_CERTS_PATH/client-key.pem \
-out $MYSQL_CERTS_PATH/client-req.pem

shell> openssl rsa -in $MYSQL_CERTS_PATH/client-key.pem -out $MYSQL_CERTS_PATH/client-key.pem

shell> openssl x509 -sha256 -req -in $MYSQL_CERTS_PATH/client-req.pem -days 3650 \
-CA $MYSQL_CERTS_PATH/ca.pem \
-CAkey $MYSQL_CERTS_PATH/ca-key.pem \
-set_serial 01 \
-out $MYSQL_CERTS_PATH/client-cert.pem
```

4. Verify All Certificates

```
shell> openssl verify -CAfile $MYSQL_CERTS_PATH/ca.pem \
```

```
$MYSQL_CERTS_PATH/server-cert.pem $MYSQL_CERTS_PATH/client-cert.pem
```

5. Copy certs to all Database nodes (repeat as needed so that every Database node has the same certificates)

```
shell> rsync -av $MYSQL_CERTS_PATH/ yourDBhost:$MYSQL_CERTS_PATH/
```

6. Set proper ownership and permissions on ALL DB nodes

```
shell> sudo chown -R mysql: $MYSQL_CERTS_PATH/
shell> sudo chmod -R g+w $MYSQL_CERTS_PATH/
```

7. Update the `my.cnf` file to include the SSL certificates you just created (add three lines to the `[mysqld]` stanza)

```
shell> vi /etc/my.cnf
[mysqld]
...
port=13306
# add three lines for SSL support
ssl-ca=/etc/mysql/certs/ca.pem
ssl-cert=/etc/mysql/certs/server-cert.pem
ssl-key=/etc/mysql/certs/server-key.pem
...
```

8. Restart MySQL on all nodes using the standard rolling maintenance procedure - see Section 6.14.3, “Performing Maintenance on an Entire Dataservice” for more information.

```
cctrl> ls
cctrl> datasource db3 shun
db3# service mysql restart
cctrl> recover

cctrl> datasource db2 shun
db2# service mysql restart
cctrl> recover

cctrl> switch to db2

cctrl> datasource db1 shun
db1# service mysql restart
cctrl> recover

cctrl> switch to db1
cctrl> ls
```

9. Add a new user to MySQL that requires SSL to connect. Do this just once on the current Primary and let it propagate to the Replicas.

```
shell> tpm mysql
mysql> DROP USER ssl_user;
mysql> CREATE USER ssl_user@'%' IDENTIFIED BY 'secret';
mysql> GRANT ALL ON *.* TO ssl_user@'%' REQUIRE SSL WITH GRANT OPTION;
mysql> flush privileges;
```

10. Verify that MySQL is working with SSL

    a. Expect this to fail, because the ssl_user is only allowed to connect to the database using SSL:

    ```
    shell> mysql -u ssl_user -psecret -h 127.0.0.1 -P 13306
    ```

    b. Expect this to pass, because we have supplied the proper SSL credentials:

    ```
    shell> mysql -u ssl_user -psecret -h 127.0.0.1 -P 13306 --ssl-ca=/etc/mysql/certs/ca.pem
    ```

    c. Verify SSL:

    ```
    mysql> status
    ...
    SSL:  Cipher in use is DHE-RSA-AES256-SHA
    ...
    ```

    Important

    If you are able to login to MySQL and see that the status is SSL: Cipher in use, then you have successfully configured MySQL to use SSL.

5.13.2. Configure Tungsten<>Database Secure Communication

If you choose to enable database level SSL within your MySQL installation, there are a number of additional steps required to allow the Replicators and Connectors to be able to communicate to the database layer.

The steps below make the following assumptions:

- You have enabled SSL using the correct procedures for your distribution of MySQL. If not, refer to Section 5.13.1, “Enabling Database SSL”.
- You have generated, and have access to, the client level certificates and keys

1. If SSL has been enabled within the Tungsten installation, then you should have the following parameter enabled within your configuration:

   ```
   disable-security-controls=false
   ```

   As a result, you should have a number of files within `/opt/continuent/share`

   ```
   shell> ls -l
   total 20
   -rw-rw-r-- 1 tungsten tungsten  104 Jul 18 10:15 jmxremote.access
   -rw-rw-r-- 1 tungsten tungsten  729 Jul 18 10:15 passwords.store
   -rw-rw-r-- 1 tungsten tungsten 2268 Jul 18 10:15 tungsten_keystore.jks
   -rw-rw-r-- 1 tungsten tungsten 1079 Jul 18 10:15 tungsten_truststore.ts
   ```

   > **Note**
   >
   > It's important to understand that the paramater above ONLY enables SSL between the various Tungsten components.

   If this is the case, skip the next step and move onto step 3

2. If you do not have SSL enabled within the installation and you require this, then follow the steps in Section 5.1, “Enabling Security” first

3. Next, add the following parameters to your installation, but do not run tpm update yet:

   ```
   datasource-enable-ssl=true
   ```

4. You now need to convert the mysql client key to PKCS12 format. Adjust the path and filename in the example to suit your environment

   ```
   shell> openssl pkcs12 -export -in /home/tungsten/client-cert.pem \
   -inkey /home/tungsten/client-key.pem \
   -name mysql -out /home/tungsten/client-key.p12
   ```

   > **Important**
   >
   > When prompted for a password, you MUST enter tungsten

   > **Important**
   >
   > When using OpenSSL 3.0 with Java 1.8, you MUST add the `-legacy` option to the openssl command.

5. You now need to import the key, either into the existing keystore if it exists, or into a new one if SSL is not being enabled at the replicator level

   If Tungsten level SSL has been enabled

   ```
   shell> keytool -importkeystore -deststorepass tungsten \
   -destkeystore /opt/continuent/share/tungsten_keystore.jks \
   -srckeystore /home/tungsten/client-key.p12 -srcstoretype PKCS12
   ```

   If ONLY Database SSL is required

   ```
   shell> keytool -importkeystore -deststorepass tungsten \
   -destkeystore /home/tungsten/tungsten_keystore.jks \
   -srckeystore /home/tungsten/client-key.p12 -srcstoretype PKCS12
   ```

   When prompted for a password, enter tungsten

6. Next, import the client certificate into the truststore

   If Tungsten level SSL has been enabled

   ```
   shell> keytool -import -alias mysql -trustcacerts -file /home/tungsten/ca.pem \
   -keystore /opt/continuent/share/tungsten_truststore.ts
   ```

   If ONLY Database SSL is required

   ```
   shell> keytool -import -alias mysql -trustcacerts -file /home/tungsten/ca.pem \
   -keystore /home/tungsten/tungsten_truststore.ts
   ```

When prompted for a password, enter tungsten

7. Finally, and only if Tungsten level SSL has been enabled, we need to create backups copies of the keystore and truststore as follows:

```
shell> cp /opt/continuent/share/tungsten_truststore.ts /opt/continuent/share/.tungsten_truststore.ts.orig
shell> cp /opt/continuent/share/tungsten_keystore.jks /opt/continuent/share/.tungsten_keystore.jks.orig
```

8. Issue tpm update to apply the configuration

The replicators will be restarted as part of the update process, and should now be using SSL to connect successfully to MySQL

5.13.3. Configuring Connector SSL

SSL communication is supported for Tungsten Connector in three different possible combinations:

- SSL from the application to Tungsten Connector; Non-SSL connections from Tungsten Connector to MySQL
- Non-SSL from the application to Tungsten Connector; SSL connections from Tungsten Connector to MySQL
- SSL from the application to Tungsten Connector; SSL connections from Tungsten Connector to MySQL

There are three different tpm properties that control SSL for the connectors when using Proxy mode, these are:

- `connector-client-ssl` [447] : This controls SSL between your applications and the connectors.
- `connector-server-ssl` [447] : This controls SSL between the connectors and MySQL.
- `connector-ssl` [447] : This is an alias that will control both of the above properties.

Additionally, `connector-ssl-capable` [440] can be used to control whether the connector advertises that it is SSL capable to clients. When SSL is enabled, this property is also enabled. With some clients, this triggers them to use SSL even if SSL has not been configured. This causes the connections to fail and not operate correctly. In those situations, setting this value to `false` would be appropriate

The connector also supports application connections using either SSL or Non-SSL communication on the same TCP/IP port. This allows you to choose SSL communication without changing your application ports.

To enable SSL communication with Tungsten Connector you must create suitable certificates keys and keystores, as described in Chapter 5, *Deployment: Security*. The keystores used for Tungsten Connector can be the same, or different, to the keystores used for securing the manager and replication communication.

> **Note**
>
> Please note that when operating in Bridge mode, the Connector is only involved in picking the correct server. In this situation the SSL configuration will be identical to the regular MySQL SSL setup, as explained in the MySQL documentation located here: https://dev.mysql.com/doc/refman/8.0/en/using-encrypted-connections.html

To enable connector SSL during installation or update, the `--connector-ssl=true` [447] option must be set to true

Before changing the property and enabling Connector SSL, a number of other steps first need to be accomplished.

- Create, activate and test SSL keys for the MySQL server. Refer to Section 5.13.1, “Enabling Database SSL” for steps on accomplishing this,
- Enable and test SSL encrypted traffic between the MySQL server and the Connector. See Section 5.13.3.1, “Enable and Test SSL encryption from the Connector to the Database”
- Enable and test SSL encrypted traffic between the Application/Client and the Connector. See Section 5.13.3.2, “Test SSL encryption from the Application to the Database”

5.13.3.1. Enable and Test SSL encryption from the Connector to the Database

1. Convert MySQL Client Cert to pkcs12 format

```
shell> openssl pkcs12 -export \
-inkey $MYSQL_CERTS_PATH/client-key.pem \
-in $MYSQL_CERTS_PATH/client-cert.pem \
-out $MYSQL_CERTS_PATH/client-cert.p12 \
-passout pass:secret
```

2. Create `tungsten_connector_keystore.jks`

```
shell> keytool -importkeystore \
-srckeystore $MYSQL_CERTS_PATH/client-cert.p12 \
```

```
-srcstoretype PKCS12 \
-destkeystore $CONN_CERTS_PATH/tungsten_connector_keystore.jks \
-deststorepass secret \
-srcstorepass secret
```

3. Import the CA Cert into the KeyStore

```
shell> keytool -import -alias mysqlServerCACert -file $MYSQL_CERTS_PATH/ca-cert.pem \
-keystore $CONN_CERTS_PATH/tungsten_connector_keystore.jks \
-storepass secret -noprompt
```

4. Import the CA Cert into the TrustStore

```
shell> keytool -import -alias mysqlServerCACert -file $MYSQL_CERTS_PATH/ca-cert.pem \
-keystore $CONN_CERTS_PATH/tungsten_connector_truststore.ts \
-storepass secret -noprompt
```

5. For INI-based deployments only, copy the certs to all Connector nodes (repeat as needed so that every Connector node has the same certificates)

```
shell> rsync -av $CONN_CERTS_PATH/ connectorHost:$CONN_CERTS_PATH/
```

6. Set proper ownership and permissions on ALL Connector nodes

```
shell> sudo chown tungsten: $CONN_CERTS_PATH/tungsten_connector_*
```

7. Add the new MySQL user to the Connector's `user.map` config file.

   See Section 7.6.1, "`user.map` File Format" for more information.

```
shell> vi /opt/continuent/tungsten/tungsten-connector/conf/user.map
ssl_user secret theSvcName
```

8. Update the Connector configuration to enable SSL

   - Staging Method

     Update all nodes (DB & Connector) in the cluster

```
shell> tpm query staging
shell> cd {STAGING_DIR}
shell> tools/tpm configure {yourServiceName} \
--connector-ssl=true \
--java-connector-keystore-password=secret \
--java-connector-truststore-password=secret \
--java-connector-truststore-path=$CONN_CERTS_PATH/tungsten_connector_truststore.ts \
--java-connector-keystore-path=$CONN_CERTS_PATH/tungsten_connector_keystore.jks

shell> tools/tpm update
```

   - INI Method

     Repeat these two steps on each node (DB & Connector)

```
shell> vi /etc/tungsten/tungsten.ini
[defaults]
...
# enable SSL from the connector to the DB
connector-ssl=true
java-connector-keystore-password=secret
java-connector-truststore-password=secret
java-connector-truststore-path=$CONN_CERTS_PATH/tungsten_connector_truststore.ts
java-connector-keystore-path=$CONN_CERTS_PATH/tungsten_connector_keystore.jks
...

shell> tpm update
```

9. Test SSL connectivity through the connector

   a. Connect as the default application user

```
shell> tpm connector
```

   b. Check the connection status

> **Note**
>
> Expecting "SSL.IN=false SSL.OUT=true"

SSL.IN is false because the the tpm connector command calls the mysql client in non-SSL mode.

SSL.OUT is true because the connection to the database is encrypted, even if the connection from the mysql client is not.

This can be verified with the "sudo tcpdump -X port 13306" command. Without the encryption, queries and responses are sent in plaintext and are visible in the output of tcpdump. When encryption is enabled, the queries and results are no longer visible.

```
mysql> tungsten connection status;
+-------------------------------------------------------------------------------+
| Message                                                                       |
+-------------------------------------------------------------------------------+
| db1@east(master:ONLINE) STATUS(OK), QOS=RW_STRICT SSL.IN=false SSL.OUT=true |
+-------------------------------------------------------------------------------+
1 row in set (0.00 sec)
```

c. Check the SSL status

Note

Expecting "SSL: Not in use"

SSL is not in use because the the tpm connector command calls the mysql client in non-SSL mode.

The connection to the database is encrypted, even if the connection from the mysql client is not.

This can be verified with the "sudo tcpdump -X port 13306" command. Without the encryption, queries and responses are sent in plaintext and are visible in the output of tcpdump. When encryption is enabled, the queries and results are no longer visible.

```
mysql> status
--------------
mysql  Ver 14.14 Distrib 5.5.42-37.1, for Linux (x86_64) using readline 5.1

Connection id:      70
Current database:
Current user:       app_user@app1
SSL:            Not in use
Current pager:      stdout
Using outfile:      ''
Using delimiter:    ;
Server version:      5.5.42-37.1-log-tungsten Percona Server (GPL), Release 37.1, Revision 39acee0
Protocol version:   10
Connection:      app1 via TCP/IP
Server characterset:    latin1
Db     characterset:    latin1
Client characterset:    latin1
Conn.  characterset:    latin1
TCP port:       3306
Uptime:         2 hours 27 min 53 sec

Threads: 4  Questions: 41474  Slow queries: 0  Opens: 47
Flush tables: 2  Open tables: 10  Queries per second avg: 4.674
--------------
```

Important

If you are able to login to MySQL and see that the "tungsten connection status;" is SSL.OUT=true, then you have successfully configured the communication between the Connector and MySQL to use SSL.

5.13.3.2. Test SSL encryption from the Application to the Database

1. Connect as the SSL-enabled application user through the Connector host

```
shell> mysql -u ssl_user -psecret -h 127.0.0.1 -P 3306 --ssl-ca=/etc/mysql/certs/ca-cert.pem
```

2. Check the connection status

Note

Expecting "SSL.IN=true SSL.OUT=true"

SSL.IN is true because the mysql client was invoked in SSL mode. Communications from the mysql client to the connector are encrypted.

- SSL.out is true because the connection to the Database from the Connector is encrypted.

```
mysql> tungsten connection status;
+-------------------------------------------------------------------------------+
| Message                                                                       |
+-------------------------------------------------------------------------------+
| db1@east(master:ONLINE) STATUS(OK), QOS=RW_STRICT SSL.IN=true SSL.OUT=true |
+-------------------------------------------------------------------------------+
1 row in set (0.00 sec)
```

3. Check the SSL status

Note

Expecting "Cipher in use is *xxx-xxx-xxxxxx-xxx*"

SSL is in use because the mysql client was invoked in SSL mode.

The connection from the mysql client to the database is encrypted.

```
mysql> status
--------------
mysql  Ver 14.14 Distrib 5.5.42-37.1, for Linux (x86_64) using readline 5.1

Connection id:      68
Current database:
Current user:       ssl_user@app1
SSL:            Cipher in use is DHE-RSA-AES256-SHA
Current pager:      stdout
Using outfile:      ''
Using delimiter:    ;
Server version:      5.5.42-37.1-log-tungsten Percona Server (GPL), Release 37.1, Revision 39acee0
Protocol version:   10
Connection:       app1 via TCP/IP
Server characterset:    latin1
Db     characterset:    latin1
Client characterset:    latin1
Conn.  characterset:    latin1
TCP port:       3306
Uptime:          2 hours 33 min 32 sec

Threads: 4  Questions: 43065  Slow queries: 0  Opens: 47
Flush tables: 2  Open tables: 10  Queries per second avg: 4.674
--------------
```

Important

If you are able to login to MySQL and see that the "tungsten connection status;" is "SSL.IN=true SSL.OUT=true", and the "status;" contains "Cipher in use is *xxx-xxx-xxxxxx-xxx*", then you have successfully configured SSL-encrypted communication between the Application/Client and MySQL through the Connector.

Chapter 6. Operations Guide

Tungsten Cluster™ has a wide range of tools and functionality available for checking and managing the status of a dataservice. The majority of the management and information structure is based around a small number of command-line utilities that provide a complete range of tools and information, either through a direct command-line, or secondary shell like interface.

When installing the dataservice using tpm , if requested, the login script for the staging user (for example `.bashrc`) will have been updated to execute a script within the installation directory called `env.sh` . This configures the location of the installation, configuration, and adds the script and binary directories to the `PATH` so that the commands can be executed without having to use the full path to the tools.

If the script was not added to the login script automatically, or needs to be added to the current session, the script is located within the `share` directory of the installation directory. For example, `/opt/continuent/share/env.sh`. To load into the current session use source. See Section 6.2, "Establishing the Shell Environment" for more information.

```
shell> source /opt/continuent/share/env.sh
```

The main tool for controlling dataservices is cctrl. This provides a shell like interface for querying and managing the dataservice and includes shell-like features such as command history and editing. Commands can be executed using cctrl either interactively:

```
shell> cctrl
connect to 'alpha@host1'
alpha: session established
[LOGICAL:EXPERT] /alpha > ls
```

Or by supplying a command and piping that as input to the cctrl shell:

```
shell> echo 'ls' | cctrl
```

6.1. The Home Directory

After installing Tungsten Cluster the home directory will be filled with a set of new directories. The home directory is specified by `--home-directory` [450] or `--install-directory` [450]. If you have multiple installations on a single server; each directory will include the same entries.

- tungsten - A symlink to the most recent version of the software. The symlink points into the `releases` directory. You should always use the symlink to ensure the most recent configuration and software is used.
- releases - Storage for the current and previous versions of the software. During an upgrade the new software will be copied into this directory and the `tungsten` symlink will be updated. See Section D.1.2, "The `releases` Directory" for more information.
- service_logs - Includes symlinks to the primary log for the replicator, manager and connector. This directory also includes logs for other tools distributed for Tungsten Cluster.
- backups - Storage for backup files created through trepctl or cctrl. See Section D.1.1, "The `backups` Directory" for more information.
- thl - Storage for THL files created by the replicator. Each replication service gets a dedicated sub-directory for storing THL files. See Section D.1.5, "The `thl` Directory" for more information.
- relay - Temporary storage for downloaded MySQL binary logs before they are converted into THL files.
- share - Storage for files that must persist between different software versions. The `env.sh` script will setup your shell environment to allow easy access to Tungsten Cluster tools.

6.2. Establishing the Shell Environment

The tools required to operate Tungsten Cluster are located in many directories around the home directory. The best way to access them is by setting up your shell environment.

The `env.sh` file will automatically be included if you specify the `--profile-script` [461] during installation. This option may be included during a configuration change with tpm update.

If the `env.sh` file hasn't been included you may do so by hand with source.

```
shell> source /opt/continuent/share/env.sh
```

Important

Special consideration must be taken if you have multiple installations on a single server. That applies for clustering and replication or multiple replicators.

Include the `--executable-prefix` [449] and `--profile-script` [461] options in your configuration. Instead of extending the `$PATH` variable; the `env.sh` script will define aliases for each command. If you specified `--executable-prefix=mm` [449] the trepctl command would be accessed as mm_trepctl.

6.3. Checking Dataservice Status

The cctrl command provides the main interface to the dataservice information and control. The current status and configuration of the dataservice can be determined by using the ls command within the cctrl shell:

```
shell> cctrl
Tungsten Clustering (for MySQL) 5.4.1 build 41
connect to 'alpha@host1'
alpha: session established
[LOGICAL:EXPERT] /alpha > ls

COORDINATOR[host1:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@host1[8805](ONLINE, created=0, active=0)                          |
|connector@host2[12039](ONLINE, created=0, active=0)                         |
|connector@host3[12712](ONLINE, created=0, active=0)                         |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|host1(master:ONLINE, progress=3, THL latency=0.561)                         |
|STATUS [OK] [2013/05/03 09:11:10 PM BST]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=master, state=ONLINE)                                     |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host2(slave:ONLINE, progress=3, latency=1.243)                              |
|STATUS [OK] [2013/05/04 05:40:43 AM BST]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=host1, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host3(slave:ONLINE, progress=3, latency=0.000)                              |
|STATUS [OK] [2013/05/04 07:40:12 AM BST]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=host1, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+
```

The output consists of the following major sections:

- COORDINATOR

  The coordinator is the node in the dataservice that is acting as the manager for the dataservice. The coordinator is decided upon within the dataservice by a consensus agreement, and the coordinator can change in the event of a failure of the existing coordinator. The coordinator is always the oldest datasource within the group that manages the dataservice, and does not need to be the same host as the Primary.

  The information about the coordinator is described in the following square brackets as `HOSTNAME:POLICY:STATUS` , where:

  - `HOSTNAME`

    The hostname of the current coordinator.

  - `POLICY`

    The current policy manager mode, which describes how the manager will respond to certain events. For example, in *`AUTOMATIC`* mode the manager will respond to issues and problems automatically, for example by performing an automatic Primary switch during a failover event.

    For more information on policy modes, see Section 6.4, “Policy Modes” .

  - `STATUS`

    The current status of the coordinator host.

- **ROUTERS**

  A list of the currently configured SQL routers (using Tungsten Connector™)that are directing queries to the datasources. In the example, the dataservice consists of three routers, each connected to all of the configured data sources. The information output includes a summary of the number of connections made through the router, and the number of active connections to each router.

- **DATASOURCES**

  The DATASOURCES section lists detailed information providing one block for each configured datasource. The header block of the datasource output describes the overall status of the datasource:

  ```
  +----------------------------------------------------------------------------+
  |host1(master:ONLINE, progress=3, THL latency=0.561)                         |
  |STATUS [OK] [2013/05/03 09:11:10 PM BST]                                    |
  +----------------------------------------------------------------------------+
  ```

  The first line describes the host and status information:

  - Hostname of the datasource (host1)]
  - Current role within the dataservice and status of the datasource. For more information on roles, see Understanding Datasource Roles. For information on datasource states, see Section 6.3.4, “Understanding Datasource States” .
  - The progress indicates the current sequence number from the THL for the datasource.
  - The THL latency shows the current latency of the datasource. For a Primary datasource using MySQL, this is the latency between the data being written to the MySQL binary log and being processed in the THL. For a Replica, it shows the latency between the original commit (from the Primary) and the application on the Replica.

  The second line provides a more detailed current status, and the time since the status was last changed. In the event of a change of status, for example to the SHUNNED or OFFLINE state, the time will indicate how long the node has been in that status.

- The remaining lines of the datasource description provide detailed information about each of the remaining services on the datasource and their status. The list will depend on the assigned roles and parameters for each datasource. It is important to note that each service has a status that is independent of the overall datasource status.

  - `|  MANAGER(state=ONLINE)                                                  |`

    The Manager service, and the current status of the manager. If a configured datasource is down, has recently been restarted, or the manager has been stopped, the status may be offline.

  - `|  REPLICATOR(role=slave, master=host1, state=ONLINE)                     |`

    The Tungsten Replicator service, which replicates data between hosts. The status shows the current role (Replica), the Primary host, and the current status of the replicator.

  - `|  DATASERVER(state=ONLINE)                                               |`

    The status of the dataserver service, which indicates the status of the underlying database service.

  - `|  CONNECTIONS(created=0, active=0)                                       |`

    The Tungsten Connector service, showing the number of connections have been created on this service, and the number that are currently active.

The main service status output, as provided by ls at the top level, provides a quick overview of the overall status of the dataservice. More detailed information on each service, and the current status of the individual services can be monitored and managed through cctrl .

6.3.1. Latency or Relative Latency Display

Tungsten Cluster can operate using either absolute or relative latency. The two are distinguished according to how the difference between transaction commit times are handled:

- Absolute latency — (default) is the difference between when a transaction was applied to a Replica and when the transaction was originally applied to the Primary.
- Relative latency — is the difference between now and when the last transaction was written to the Replica.

Absolute latency indicates the difference between transaction times, but, may also provide a misleading impression of the cluster state if there are large transactions being applied, or if the Replica has stopped or become 'stuck' due to a transient failure. This is because absolute latency shows the time difference between transactions. If a transaction takes 5 or 10 seconds to apply, the absolute latency will only display

the difference between when the transaction was written, and only after this has occurred on both the Primary and the Replica. The actual time difference between these may be less than a second, even though the transaction took 10 seconds to succeed.

Relative latency shows the time difference between the last transaction committed and the current time, hence if the transaction takes a considerable time to be applied, the relative latency will increase up until the transaction has finally been committed. If the relative latency increases and continues to increase, it may indicate a lagging or even failed Replica.

To enable relative latency, the cluster must have been deployed, or updated, using the `--use-relative-latency=true` [441] option to tpm. Once enabled, the following operational activities change:

- The output of show slave status when connected to MySQL through a connector will be updated so that the `Seconds_Behind_Master` field shows the relative, rather than absolute, latency. For example, in a cluster where relative latency is enabled, but no transactions are occurring, the output will show an increasing value:

```
mysql> show slave status\G
*************************** 1. row ***************************
...
Seconds_Behind_Master: 0
...
1 row in set (0.01 sec)
mysql> show slave status\G
*************************** 1. row ***************************
...
Seconds_Behind_Master: 7
...
1 row in set (0.01 sec)
mysql> show slave status\G
*************************** 1. row ***************************
...
Seconds_Behind_Master: 38
...
1 row in set (0.01 sec)
```

- cctrl will output an additional field, `relative`, showing the relative latency value against the standard latency value. This can be seen in the example below:

```
[LOGICAL] /alpha > ls

COORDINATOR[host1:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@host1[6189](ONLINE, created=1, active=0)                          |
|connector@host2[14253](ONLINE, created=3, active=2)                         |
|connector@host3[2419](ONLINE, created=1, active=0)                          |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|host1(master:ONLINE, progress=5, THL latency=1.008, relative=144.636)       |
|STATUS [OK] [2014/09/07 02:28:44 PM BST]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=master, state=ONLINE)                                     |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=4, active=1)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host2(slave:ONLINE, progress=5, latency=0.000, relative=144.638)            |
|STATUS [OK] [2014/09/07 02:28:58 PM BST]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=host1, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=1, active=1)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host3(slave:ONLINE, progress=5, latency=5.938, relative=144.620)            |
|STATUS [OK] [2014/09/07 02:29:13 PM BST]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=host1, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+
```

- The Tungsten Connector will use the value when the *`maxAppliedLatency`* option is used in the connection string to determine whether to route a connection to a Primary or a Replica.

For example, when running a scrip that sends a heartbeat, and then connects through a connector, the connection will be routed first to the Replica, and then to the Primary:

```
echo "cluster heartbeat" | cctrl
sleep 1
mysql -utungsten_testing -pprivate --port=9999 --host=`hostname` \
mysql@maxAppliedLatency=20?qos=RO_RELAXED -e"select 1;tungsten connection status;"

sleep 21

mysql -utungsten_testing -pprivate --port=9999 --host=`hostname` \
mysql@maxAppliedLatency=20?qos=RO_RELAXED -e"select 1;tungsten connection status;"
```

The output of the execution of the script shows the Replica and then Primary connections:

```
[LOGICAL] /alpha > cluster heartbeat
HEARTBEAT 'DEFAULT' INSERTED
[LOGICAL] /alpha >
Exiting...
+---+
| 1 |
+---+
| 1 |
+---+
+-------------------------------------------------------------------------------+
| Message                                                                       |
+-------------------------------------------------------------------------------+
| host1@alpha(slave:ONLINE) STATUS(OK), QOS=RO_RELAXED SSL.IN=false SSL.OUT=false |
+-------------------------------------------------------------------------------+
+---+
| 1 |
+---+
| 1 |
+---+
+-------------------------------------------------------------------------------+
| Message                                                                       |
+-------------------------------------------------------------------------------+
| host1@alpha(master:ONLINE) STATUS(OK), QOS=RO_RELAXED SSL.IN=false SSL.OUT=false |
+-------------------------------------------------------------------------------+
```

6.3.2. Getting Detailed Information

Detailed information about the individual nodes, datasources and services within the dataservice can be obtained by using the hierarchical structure of the dataservice as presented through cctrl . By using the -l command-line option detailed information can be obtained about any object. For example, getting the detailed listing of a specific host produces the following:

```
[LOGICAL:EXPERT] /alpha > ls -l host1

COORDINATOR[host1:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@host1[18348](ONLINE, created=403, active=0)                       |
|  host1(&mas_lc;:ONLINE, created=195, active=0)                               |
|  host2(&slv_lc;:ONLINE, created=0, active=0, latency=146.000)                |
|  host3(&slv_lc;:ONLINE, created=208, active=0, latency=31.000)               |
|  gateway:host2                                                             |
|connector@host2[26627](ONLINE, created=0, active=0)                         |
|  host1(&mas_lc;:ONLINE, created=0, active=0)                                 |
|  host2(&slv_lc;:ONLINE, created=0, active=0, latency=146.000)                |
|  host3(&slv_lc;:ONLINE, created=0, active=0, latency=31.000)                 |
|  gateway:host2                                                             |
|connector@host3[16117](ONLINE, created=0, active=0)                         |
|  host1(&mas_lc;:ONLINE, created=0, active=0)                                 |
|  host2(&slv_lc;:ONLINE, created=0, active=0, latency=146.000)                |
|  host3(&slv_lc;:ONLINE, created=0, active=0, latency=31.000)                 |
|  gateway:host1                                                             |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|host1(&mas_lc;:ONLINE, progress=154146, THL latency=0.390)                    |
+----------------------------------------------------------------------------+
|        activeConnectionsCount:    0                                        |
|                  alertMessage:                                             |
|                   alertStatus:    OK                                       |
|                     alertTime:    1368209428766                            |
|                appliedLatency:    0.0                                      |
|callableStatementsCreatedCount:    0                                        |
|       connectionsCreatedCount:    195                                      |
```

```
|              dataServiceName:    alpha                                    |
|                      driver:    com.mysql.jdbc.Driver                    |
|highWater:    0(mysql-bin.000006:0000000039179423;0)                       |
|                        host:    host1                                    |
|                 isAvailable:    true                                     |
|                 isComposite:    false                                    |
|                   lastError:                                             |
|               lastShunReason:                                            |
|                        name:    host1                                    |
|                  precedence:    99                                       |
|preparedStatementsCreatedCount:    0                                      |
|                        role:    &mas_lc;                                  |
|                    sequence:    Sequence(0:0)                            |
|                       state:    ONLINE                                   |
|       statementsCreatedCount:    0                                        |
|url:                                                                      |
|jdbc:mysql:thin://host1:13306/${DBNAME}?jdbcCompliantTruncation=false&zero  |
|DateTimeBehavior=convertToNull&tinyInt1isBit=false&allowMultiQueries=tru    |
|e&yearIsDateType=false                                                    |
|                     vendor:    mysql                                    |
|                  vipAddress:                                             |
|                vipInterface:                                             |
|                  vipIsBound:    false                                    |
+--------------------------------------------------------------------------+
+--------------------------------------------------------------------------+
|null:REPLICATOR(role=&mas_lc;, state=ONLINE)                               |
+--------------------------------------------------------------------------+
|           appliedLastEventId:    mysql-bin.000006:0000000039179423;0      |
|             appliedLastSeqno:    154146                                   |
|               appliedLatency:    0.39                                     |
|                     channels:    1                                        |
|                dataserviceName:    alpha                                 |
|               currentEventId:    mysql-bin.000006:0000000039179423        |
|            currentTimeMillis:    1368211431237                            |
|               dataServerHost:    host1                                    |
|                   extensions:                                            |
|            latestEpochNumber:    0                                        |
|             &mas_lc;ConnectUri:    thl://localhost:/                      |
|              &mas_lc;ListenUri:    thl://host1:2112/                      |
|           maximumStoredSeqNo:    154146                                   |
|           minimumStoredSeqNo:    0                                        |
|              offlineRequests:    NONE                                     |
|                 pendingError:    NONE                                     |
|             pendingErrorCode:    NONE                                     |
|          pendingErrorEventId:    NONE                                     |
|            pendingErrorSeqno:    -1                                       |
|      pendingExceptionMessage:    NONE                                     |
|               pipelineSource:    /var/log/mysql                           |
|             relativeLatency:    683.237                                  |
|          resourcePrecedence:    99                                       |
|                     rmiPort:    10000                                    |
|                        role:    &mas_lc;                                  |
|                   seqnoType:    java.lang.Long                           |
|                 serviceName:    alpha                                    |
|                 serviceType:    local                                    |
|            simpleServiceName:    alpha                                    |
|                    siteName:    default                                  |
|                    sourceId:    host1                                    |
|                       state:    ONLINE                                   |
|           timeInStateSeconds:    2014.526                                 |
|                uptimeSeconds:    2015.83                                  |
|                     version:    tungsten-clustering-5.4.1-41             |
+--------------------------------------------------------------------------+
+--------------------------------------------------------------------------+
|host1:DATASERVER(state=ONLINE)                                             |
+--------------------------------------------------------------------------+
|                       state:    ONLINE                                   |
+--------------------------------------------------------------------------+
```

The information output is very detailed and provides a summary of all the configuration and status information for the given host. The connector information shows connectors made to each configured dataserver by each connector service. The datasource section shows detailed information on the dataserver and replicator services. The output from the replicator service is equivalent to that output by trepctl .

6.3.3. Understanding Datasource Roles

All datasources within a dataservice have a specific role within he dataservice. The *Primary* role is one that provides a source of replication information, and a Replica one that receives that information.

Role	Supplies Replication Data	Receives Replication Data	Load Balancing	Failover
Master	Yes	No	Yes	Yes

Role	Supplies Replication Data	Receives Replication Data	Load Balancing	Failover
Slave	No	Yes	Yes	Yes
Standby	No	Yes	No	Yes
Archive	No	Yes	Yes	No

More detailed information for each role:

- *master*

  A datasource in a *Primary* role is providing a source for replication information to other datasources in the dataservice and is able to provide both read and write connections for applications.

- *slave*

  A *Replica* datasource is receiving data from a *Primary* and having that replicated data applied by Tungsten Cluster. Replicas are used for read-only operations by applications.

- *standby*

  A *standby* datasource receives replication data, but is never chosen by the connector to act as a read source by application clients. Standby datasources are therefore kept up to date with replication, but not used for load balancing.

  When a failover occurs, a *standby* datasource can be enabled as a standard *Replica* and included in load-balanced operations.

- *archive*

  An *archive* datasource can be used to provide an active (up to date) copy of the data, without the datasource being used in the event of a failover. This can be useful for providing backup support, offline querying outside of the normal dataservice operations, or auditing purposes.

6.3.4. Understanding Datasource States

All datasources will be in one of a number of states that indicate their current operational status.

6.3.4.1. ONLINE State

A datasource in the ONLINE state is considered to be operating normally, with replication, connector and other traffic being handled as normal.

6.3.4.2. OFFLINE State

A datasource in the OFFLINE does not accept connections through the connector for either reads or writes.

When the dataservice is in the *AUTOMATIC* policy mode, a datasource in the OFFLINE state is automatically recovered and placed into the ONLINE state. If this operation fails, the datasource remains in the OFFLINE state.

When the dataservice is in *MAINTENANCE* or *MANUAL* policy mode, the datasource will remain in the OFFLINE state until the datasource is explicitly switched to the ONLINE state.

6.3.4.3. FAILED State

When a datasource fails, for example when a failure in one of the services for the datasource stops responding or fails, the datasource will be placed into the FAILED state. In the example below, the underlying dataserver has failed:

```
+----------------------------------------------------------------------+
|host3(slave:FAILED(DATASERVER 'host3@alpha' STOPPED),                 |
|progress=154146, latency=31.419)                                      |
|STATUS [CRITICAL] [2013/05/10 11:51:42 PM BST]                        |
|REASON[DATASERVER 'host3@alpha' STOPPED]                              |
+----------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                               |
|  REPLICATOR(role=slave, master=host1, state=ONLINE)                  |
|  DATASERVER(state=STOPPED)                                           |
|  CONNECTIONS(created=208, active=0)                                  |
+----------------------------------------------------------------------+
```

For a FAILED datasource, the recover command within cctrl can be used to attempt to recover the datasource to the operational state. If this fails, the underlying fault must be identified and addressed before the datasource is recovered.

6.3.4.4. SHUNNED State

A SHUNNED datasource implies that the datasource is OFFLINE. Unlike the OFFLINE state, a SHUNNED datasource is not automatically recovered.

A datasource in a SHUNNED state is not connected or actively part of the dataservice. Individual services can be reconfigured and restarted. The operating system and any other maintenance to be performed can be carried out while a host is in the SHUNNED state without affecting the other members of the dataservice.

Datasources can be manually or automatically shunned. The current reason for the SHUNNED state is indicated in the status output. For example, in the sample below, the node host3 was manually shunned for maintenance reasons:

```
...
+----------------------------------------------------------------------------+
|host3(slave:SHUNNED(MANUALLY-SHUNNED), progress=157454, latency=1.000)   |
|STATUS [SHUNNED] [2013/05/14 05:12:52 PM BST]                              |
...
```

6.3.4.4.1. Various SHUNNED States

A SHUNNED node can have a number of different sub-states depending on certain actions or events that have happened within the cluster. These are as folllows:

- SHUNNED(DRAIN-CONNECTIONS)
- SHUNNED(FAILSAFE_SHUN)
- SHUNNED(MANUALLY-SHUNNED)
- SHUNNED(CONFLICTS-WITH-COMPOSITE-MASTER)
- SHUNNED(FAILSAFE AFTER Shunned by fail-safe procedure)
- SHUNNED(SUBSERVICE-SWITCH-FAILED)
- SHUNNED(FAILED-OVER-TO-db2)
- SHUNNED(SET-RELAY)
- SHUNNED(FAILOVER-ABORTED AFTER UNABLE TO COMPLETE FAILOVER…)
- SHUNNED(CANNOT-SYNC-WITH-HOME-SITE)

Below are various examples and possible troubleshooting steps and soultions, where applicable.

> **Warning**
>
> Please THINK before you issue ANY commands. These are examples ONLY, and are not to be followed blindly because every situation is different

6.3.4.4.1.1. SHUNNED(DRAIN-CONNECTIONS)

The DRAIN-CONNECTIONS state means that the datasource [NODE|CLUSTER] drain [timeout] command has been successfully completed and the node or cluster is now SHUNNED as requested.

The datasource drain command will prevent new connections to the specified data source, while ongoing connections remain untouched. If a timeout (in seconds) is given, ongoing connections will be severed after the timeout expires. This command returns immediately, no matter whether a timeout is given or not. Under the hood, this command will put the data source into SHUNNED state, with lastShunReason set to DRAIN-CONNECTIONS. This feature is available as of version 7.0.2

```
cctrl> use world
cctrl> ls
+----------------------------------------------------------------------------+
|emea(composite master:ONLINE, global progress=21269, max latency=8.997)    |
|STATUS [OK] [2023/01/17 09:11:36 PM UTC]                                    |
+----------------------------------------------------------------------------+
|  emea(master:ONLINE, progress=21, max latency=8.997)                       |
|  emea_from_usa(relay:ONLINE, progress=21248, max latency=3.000)            |
+----------------------------------------------------------------------------+
+----------------------------------------------------------------------------+
|usa(composite master:SHUNNED(DRAIN-CONNECTIONS), global progress=21, max    |
|latency=2.217)                                                              |
|STATUS [SHUNNED] [2023/01/19 08:05:02 PM UTC]                               |
+----------------------------------------------------------------------------+
|  usa(master:SHUNNED, progress=-1, max latency=-1.000)                      |
|  usa_from_emea(relay:ONLINE, progress=21, max latency=2.217)               |
+----------------------------------------------------------------------------+

cctrl> use usa
cctrl> ls
+----------------------------------------------------------------------------+
|db16-demo.continuent.com(master:SHUNNED(DRAIN-CONNECTIONS), progress=-1, THL|
|latency=-1.000)                                                             |
```

```
|STATUS [SHUNNED] [2023/01/19 08:05:02 PM UTC][SSL]                           |
+-----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                      |
|  REPLICATOR(role=master, state=OFFLINE)                                     |
|  DATASERVER(state=ONLINE)                                                   |
|  CONNECTIONS(created=0, active=0)                                           |
+-----------------------------------------------------------------------------+
+-----------------------------------------------------------------------------+
|db17-demo.continuent.com(slave:SHUNNED(DRAIN-CONNECTIONS), progress=-1,      |
|latency=-1.000)                                                              |
|STATUS [SHUNNED] [2023/01/19 08:05:03 PM UTC][SSL]                           |
+-----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                      |
|  REPLICATOR(role=slave, master=db16-demo.continuent.com, state=OFFLINE)     |
|  DATASERVER(state=ONLINE)                                                   |
|  CONNECTIONS(created=0, active=0)                                           |
+-----------------------------------------------------------------------------+
+-----------------------------------------------------------------------------+
|db18-demo.continuent.com(slave:SHUNNED(DRAIN-CONNECTIONS), progress=-1,      |
|latency=-1.000)                                                              |
|STATUS [SHUNNED] [2023/01/19 08:05:02 PM UTC][SSL]                           |
+-----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                      |
|  REPLICATOR(role=slave, master=db16-demo.continuent.com, state=OFFLINE)     |
|  DATASERVER(state=ONLINE)                                                   |
|  CONNECTIONS(created=0, active=0)                                           |
+-----------------------------------------------------------------------------+

cctrl> use world
cctrl> datasource usa welcome
```

6.3.4.4.1.2. SHUNNED(FAILSAFE_SHUN)

The `FAILSAFE_SHUN` state means that there was a complete network partition so that none of the nodes were able to communicate with each other. The database writes are blocked to prevent a split-brain from happening.

```
+-----------------------------------------------------------------------------+
|db1(master:SHUNNED(FAILSAFE_SHUN), progress=56747909871, THL                 |
|latency=12.157)                                                              |
|STATUS [OK] [2021/09/25 01:09:04 PM CDT]                                     |
+-----------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                       |
| REPLICATOR(role=master, state=ONLINE)                                       |
| DATASERVER(state=ONLINE)                                                    |
| CONNECTIONS(created=374639937, active=0)                                    |
+-----------------------------------------------------------------------------+
+-----------------------------------------------------------------------------+
|db2(slave:SHUNNED(FAILSAFE_SHUN), progress=-1, latency=-1.000)               |
|STATUS [OK] [2021/09/15 11:58:05 PM CDT]                                     |
+-----------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                       |
| REPLICATOR(role=slave, master=db1, state=OFFLINE)                           |
| DATASERVER(state=STOPPED)                                                   |
| CONNECTIONS(created=70697946, active=0)                                     |
+-----------------------------------------------------------------------------+
+-----------------------------------------------------------------------------+
|db3(slave:SHUNNED(FAILSAFE_SHUN), progress=56747909871, latency=12.267)      |
|STATUS [OK] [2021/09/25 01:09:21 PM CDT]                                     |
+-----------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                       |
| REPLICATOR(role=slave, master=db1, state=ONLINE)                            |
| DATASERVER(state=ONLINE)                                                    |
| CONNECTIONS(created=168416988, active=0)                                    |
+-----------------------------------------------------------------------------+


cctrl> set force true
cctrl> datasource db1 welcome
cctrl> datasource db1 online (if needed)
cctrl> recover
```

6.3.4.4.1.3. SHUNNED(MANUALLY-SHUNNED)

The `MANUALLY-SHUNNED` state means that an administrator has issued the datasource {NODE|CLUSTER} shun command using cctrl or the REST API, resulting in the specified node or cluster being SHUNNED.

```
+-----------------------------------------------------------------------------+
|db1(master:SHUNNED(MANUALLY-SHUNNED), progress=15969982, THL                 |
|latency=0.531)                                                               |
|STATUS [SHUNNED] [2014/01/17 02:57:19 PM MST]                                |
+-----------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                       |
```

```
| REPLICATOR(role=master, state=ONLINE)                                  |
| DATASERVER(state=ONLINE)                                               |
| CONNECTIONS(created=4204, active=23)                                   |
+------------------------------------------------------------------------+

cctrl> set force true
cctrl> datasource db1 welcome
cctrl> datasource db1 online (if needed)
cctrl> recover
```

6.3.4.4.1.4. SHUNNED(CONFLICTS-WITH-COMPOSITE-MASTER)

The `CONFLICTS-WITH-COMPOSITE-MASTER` state means that we already have an active primary in the cluster and we can't bring this primary online because of this.

```
+------------------------------------------------------------------------+
|db1(master:SHUNNED(CONFLICTS-WITH-COMPOSITE-MASTER),                    |
|progress=25475128064, THL latency=0.010)                                |
|STATUS [SHUNNED] [2015/04/11 02:35:24 PM PDT]                           |
+------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                  |
| REPLICATOR(role=master, state=ONLINE)                                  |
| DATASERVER(state=ONLINE)                                               |
| CONNECTIONS(created=2568, active=0)                                    |
+------------------------------------------------------------------------+
```

6.3.4.4.1.5. SHUNNED(FAILSAFE AFTER Shunned by fail-safe procedure)

The `FAILSAFE AFTER Shunned by fail-safe procedure` state means that the Manager voting Quorum encountered an unrecoverable problem and shut down database writes to prevent a Split-brain situation.

```
+------------------------------------------------------------------------+
|db1(master:SHUNNED(FAILSAFE AFTER Shunned by fail-safe                  |
|procedure), progress=96723577, THL latency=0.779)                       |
|STATUS [OK] [2014/03/22 01:12:35 AM EDT]                                |
+------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                  |
| REPLICATOR(role=master, state=ONLINE)                                  |
| DATASERVER(state=ONLINE)                                               |
| CONNECTIONS(created=135, active=0)                                     |
+------------------------------------------------------------------------+
+------------------------------------------------------------------------+
|db2(slave:SHUNNED(FAILSAFE AFTER Shunned by fail-safe                   |
|procedure), progress=96723575, latency=0.788)                           |
|STATUS [OK] [2014/03/31 04:52:39 PM EDT]                                |
+------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                  |
| REPLICATOR(role=slave, master=db1, state=ONLINE)                       |
| DATASERVER(state=ONLINE)                                               |
| CONNECTIONS(created=28, active=0)                                      |
+------------------------------------------------------------------------+
+------------------------------------------------------------------------+
|db5(slave:SHUNNED:ARCHIVE (FAILSAFE AFTER Shunned by                    |
|fail-safe procedure), progress=96723581, latency=0.905)                 |
|STATUS [OK] [2014/03/22 01:13:58 AM EDT]                                |
+------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                  |
| REPLICATOR(role=slave, master=db1, state=ONLINE)                       |
| DATASERVER(state=ONLINE)                                               |
| CONNECTIONS(created=23, active=0)                                      |
+------------------------------------------------------------------------+

cctrl> set force true
cctrl> datasource db1 welcome
cctrl> datasource db1 online (if needed)
cctrl> recover
```

6.3.4.4.1.6. SHUNNED(SUBSERVICE-SWITCH-FAILED)

The `SUBSERVICE-SWITCH-FAILED` state means that the cluster tried to switch the Primary role to another node in response to an admin request, but was unable to do so due to a failure at the sub-service level in a Composite Active-Active (CAA) cluster.

```
+------------------------------------------------------------------------+
|db1(relay:SHUNNED(SUBSERVICE-SWITCH-FAILED), progress=6668586,          |
|latency=1.197)                                                          |
|STATUS [SHUNNED] [2021/01/14 10:20:33 AM UTC][SSL]                      |
+------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                  |
| REPLICATOR(role=relay, master=db4, state=ONLINE)                       |
| DATASERVER(state=ONLINE)                                               |
+------------------------------------------------------------------------+
```

```
+----------------------------------------------------------------------------+
|db2(slave:SHUNNED(SUBSERVICE-SWITCH-FAILED), progress=6668586,              |
|latency=1.239)                                                              |
|STATUS [SHUNNED] [2021/01/14 10:20:39 AM UTC][SSL]                          |
+----------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                      |
| REPLICATOR(role=slave, master=db1, state=ONLINE)                           |
| DATASERVER(state=ONLINE)                                                   |
+----------------------------------------------------------------------------+
+----------------------------------------------------------------------------+
|db3(slave:SHUNNED(SUBSERVICE-SWITCH-FAILED), progress=6668591,              |
|latency=0.501)                                                              |
|STATUS [SHUNNED] [2021/01/14 10:20:36 AM UTC][SSL]                          |
+----------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                      |
| REPLICATOR(role=slave, master=pip-db1, state=ONLINE)                       |
| DATASERVER(state=ONLINE)                                                   |
+----------------------------------------------------------------------------+

cctrl> use {SUBSERVICE-NAME-HERE}
cctrl> set force true
cctrl> datasource db1 welcome
cctrl> datasource db1 online (if needed)
cctrl> recover
```

6.3.4.4.1.7. SHUNNED(FAILED-OVER-TO-node)

The `FAILED-OVER-TO-{nodename}` state means that the cluster automatically and successfully invoked a failover from one node to another. The fact that there appear to be two masters is completely normal after a failover, and indicates the cluster should be manually recovered once the node which failed is fixed.

```
+----------------------------------------------------------------------------+
|db1(master:SHUNNED(FAILED-OVER-TO-db2), progress=248579111,                 |
|THL latency=0.296)                                                          |
|STATUS [SHUNNED] [2016/01/23 02:15:16 AM CST]                               |
+----------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                      |
| REPLICATOR(role=master, state=ONLINE)                                      |
| DATASERVER(state=ONLINE)                                                   |
| CONNECTIONS(created=108494736, active=0)                                   |
+----------------------------------------------------------------------------+
+----------------------------------------------------------------------------+
|db2(master:ONLINE, progress=248777065, THL latency=0.650)                   |
|STATUS [OK] [2016/01/23 02:15:24 AM CST]                                    |
+----------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                      |
| REPLICATOR(role=master, state=ONLINE)                                      |
| DATASERVER(state=ONLINE)                                                   |
| CONNECTIONS(created=3859635, active=591)                                   |
+----------------------------------------------------------------------------+

cctrl> recover
```

6.3.4.4.1.8. SHUNNED(SET-RELAY)

The `SET-RELAY` state means that the cluster was in the middle of a switch which failed to complete for either a Composite (CAP) Passive cluster or in a Composite (CAA) sub-service.

```
+----------------------------------------------------------------------------+
|db1(relay:SHUNNED(SET-RELAY), progress=-1, latency=-1.000)                  |
|STATUS [SHUNNED] [2022/08/05 08:13:03 AM PDT]                               |
+----------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                      |
| REPLICATOR(role=relay, master=db4, state=SUSPECT)                          |
| DATASERVER(state=ONLINE)                                                   |
+----------------------------------------------------------------------------+
+----------------------------------------------------------------------------+
|db2(slave:SHUNNED(SUBSERVICE-SWITCH-FAILED), progress=14932,                |
|latency=0.000)                                                              |
|STATUS [SHUNNED] [2022/08/05 06:13:36 AM PDT]                               |
+----------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                      |
| REPLICATOR(role=slave, master=db1, state=ONLINE)                           |
| DATASERVER(state=ONLINE)                                                   |
+----------------------------------------------------------------------------+
+----------------------------------------------------------------------------+
|db3(slave:SHUNNED(SUBSERVICE-SWITCH-FAILED), progress=14932,                |
|latency=0.000)                                                              |
|STATUS [SHUNNED] [2022/08/05 06:13:38 AM PDT]                               |
+----------------------------------------------------------------------------+
| MANAGER(state=ONLINE) |
| REPLICATOR(role=slave, master=db1, state=ONLINE) |
```

```
| DATASERVER(state=ONLINE) |
+--------------------------------------------------------------------------------+

cctrl> use {PASSIVE-SERVICE-NAME-HERE}
cctrl> set force true
cctrl> datasource db1 welcome
cctrl> datasource db1 online (if needed)
cctrl> recover
```

6.3.4.4.1.9. SHUNNED(FAILOVER-ABORTED AFTER UNABLE TO COMPLETE FAILOVER...)

The `FAILOVER-ABORTED AFTER UNABLE TO COMPLETE FAILOVER` state means that the cluster tried to automatically fail over the Primary role to another node but was unable to do so.

```
+--------------------------------------------------------------------------------+
|db1(master:SHUNNED(FAILOVER-ABORTED AFTER UNABLE TO COMPLETE FAILOVER       |
|       FOR DATASOURCE 'db1'. CHECK COORDINATOR MANAGER LOG),                 |
|       progress=21179013, THL latency=4.580)                                |
|STATUS [SHUNNED] [2020/04/10 01:40:17 PM CDT]                               |
+--------------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=master, state=ONLINE)                                     |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=294474815, active=0)                                  |
+--------------------------------------------------------------------------------+
+--------------------------------------------------------------------------------+
|db2(slave:ONLINE, progress=21179013, latency=67.535)                        |
|STATUS [OK] [2020/04/02 09:42:42 AM CDT]                                    |
+--------------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=22139851, active=1)                                   |
+--------------------------------------------------------------------------------+
+--------------------------------------------------------------------------------+
|db3(slave:ONLINE, progress=21179013, latency=69.099)                        |
|STATUS [OK] [2020/04/07 10:20:20 AM CDT]                                    |
+--------------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=66651718, active=7)                                   |
+--------------------------------------------------------------------------------+
```

6.3.4.4.1.10. SHUNNED(CANNOT-SYNC-WITH-HOME-SITE)

The `CANNOT-SYNC-WITH-HOME-SITE` state is a composite-level state which means that the sites were unable to see each other at some point in time. This scenario may need a manual recovery at the composite level for the cluster to heal.

```
From usa side:
emea(composite master:SHUNNED(CANNOT-SYNC-WITH-HOME-SITE)

From emea side:
usa(composite master:SHUNNED(CANNOT-SYNC-WITH-HOME-SITE)

cctrl compositeSvc> recover
```

6.3.5. Understanding Replicator Roles

Replicators can have one of two main roles, Extractor[master] or Applier[slave]

- *master*

  A replicator in a *master* role extracts data from a source database (for example, by reading the binary log from a MySQL server), and generates THL. As a *master* the replicator also provides the THL to other replicators over the network connection.

- *slave*

  A *slave* replicator pulls THL data from a *master* and then applies that data to a target database.

6.3.6. Changing Datasource States

Changing the status of a service is required either when the dataservice needs to be reconfigured, the topology altered, or when performing system maintenance.

The datasource status can be changed by using the datasource command, which accepts the datasource name and a sub-command:

```
datasource DATASOURCENAME SUBCOMMAND
```

For example, to shun the node host1 :

```
[LOGICAL:EXPERT] /alpha > datasource host1 shun
```

For detailed operations for different subcommands, see the following sections.

6.3.6.1. Shunning a Datasource

Shunning a datasource identifies the source as unavailable; a shunned Replica will not be used during a failover or switch operation.

Datasources can be automatically or manually shunned:

- *Automatic* shunning occurs when the dataservice is in AUTOMATIC policy mode, and the datasource has become unresponsive or fails. For example, when a Primary fails, an automatic switch to a new Primary is performed, and the old Primary is shunned.
- *Manual* shunning occurs when the shun command is given to a datasource. Manual shunning can be used to set a datasource into a state that allows for maintenance and management operations to be performed on the datasource.

To manually shun the datasource:

```
[LOGICAL:EXPERT] /alpha > datasource host3 shun
DataSource 'host3' set to SHUNNED
```

Once shunned, the connector will stop using the datasource. The status can be checked using ls :

```
+----------------------------------------------------------------------------+
|host3(slave:SHUNNED(MANUALLY-SHUNNED), progress=157454, latency=1.000)   |
|STATUS [SHUNNED] [2013/05/14 05:24:41 PM BST]                              |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
|  REPLICATOR(role=slave, master=host2, state=ONLINE)                 |
|  DATASERVER(state=ONLINE)                                                 |
|  CONNECTIONS(created=0, active=0)                                         |
+----------------------------------------------------------------------------+
```

> **Important**
>
> Shunning a datasource does not stop the replicator; replication will continue on a shunned datasource until the replication service is explicitly placed into the offline state.

The level of the shunning is reported in the status as a manual operation. A manually shunned datasource can be enabled using the datasource recover command, see Section 6.3.6.2, “Recover a Datasource” .

6.3.6.2. Recover a Datasource

The datasource recover command is a deeper operation that performs a number of operations to get the datasource back into the operational state. When used, the datasource recover command performs the following operations:

- Restarts failed or stopped services
- Changes the datasource configuration so that it is configured as a Primary or Replica. For example, an automatically failed Primary will be reconfigured to operate as a Replica to the current Primary.
- Restarts the replicator service in the Replica or Primary role as appropriate

In all cases, the datasource recover command should be used if a datasource is offline or shunned, and it can be used at all times to get a datasource back in to operational state within the cluster. In essence, recover performs the same operations automatically as would be performed manually to get the node into the right state.

```
[LOGICAL:EXPERT] /alpha > datasource host3 recover
VERIFYING THAT WE CAN CONNECT TO DATA SERVER 'host3'
DATA SERVER 'host3' IS NOW AVAILABLE FOR CONNECTIONS
RECOVERING 'host3@alpha' TO A SLAVE USING 'host1@alpha' AS THE MASTER
DataSource 'host3' is now OFFLINE
RECOVERY OF 'host3@alpha' WAS SUCCESSFUL
```

During the recovery process, the node will be checked, replication reconfigured, and the node brought back in to active service. If this process fails because the databases and replication states are out of sync and cannot be recovered, Tungsten Cluster may advise that a backup of another datasource and recovery to this datasource is performed. For more information on restoring from backups, see Section 6.10, “Restoring a Backup” .

6.3.6.3. Offline a Datasource

A datasource can be explicitly placed into offline mode. In offline mode, client applications connections to datasources are paused. When switching to OFFLINE mode existing connections are given a five-second grace period to complete their operations before being forced to disconnect. Replicator operation is not affected.

To set a datasource offline:

```
[LOGICAL:EXPERT] /alpha > datasource host3 offline
DataSource 'host3@alpha' is now OFFLINE
```

If the dataservice is in *AUTOMATIC* policy mode, and there are no other faults in the datasource, it will automatically be placed into ONLINE mode. To set a datasource offline the dataservice must be in *MAINTENANCE* or *MANUAL* policy modes.

6.3.6.4. Mark a Datasource as Standby

standby datasources receive replication data, but are not part of the load-balancing provided by Tungsten Connector. In the event of a failover situation, a *standby* datasource will be enabled within the cluster as a Replica. Because the *standby* datasource is up to date with respect to the replication of data, this process is instantaneous. The connector will be updated, and the new Replica will operate as a read-only datasource.

To configure a datasource as a *standby*:

```
[LOGICAL:EXPERT] /alpha > datasource host3 standby
Datasource 'host3' now has role 'standby'
```

To clear the *standby* state:

```
[LOGICAL:EXPERT] /alpha > datasource host3 clear standby
Datasource 'host3' now has role 'slave'
```

Note

When a Replica goes into standby mode, it will finish running any SQL queries that were started before it went into standby mode. New queries, even on the same connection, will not be directed to a Replica that has just gone into standby

6.3.6.5. Mark a Datasource as Archive

An *archive* datasource receives replication data and is included as part of the load-balancing provided by Tungsten Connector. It is excluded from failover switches and will not be used as a Primary in the event of a failure. To mark a datasource as an archive datasource:

```
[LOGICAL:EXPERT] /alpha > datasource host3 set archive
```

To remove the archive role:

```
[LOGICAL:EXPERT] /alpha > datasource host3 clear archive
```

The archive role is a temporary requirement, and will not survive a re-install or upgrade.

6.3.7. Datasource Statuses

In addition to the overall state, all datasources have a specific status that indicates the current health and operation, rather than the configured state for that datasource. For example, a datasource can be in the online state, but have a DIMINISHED [171] status if there is a recoverable problem with one of the datasource components.

The purpose of the Alert STATUS field is to provide standard, datasource-state-specific values for ease of parsing and backwards-compatibility with older versions of the cctrl command.

The STATUS field is effectively the same information as the DataSource State that appears on the first line after the colon (:), just presented slightly differently.

Here are the possible values for STATUS, showing the DataSource State first, and the matching Alert STATUS second:

Datasource State	Alert STATUS
ONLINE	OK
OFFLINE	WARN (for non-composite datasources)
OFFLINE	DIMINISHED (for composite passive replica)
OFFLINE	CRITICAL (for composite active primary)
FAILED	CRITICAL
SHUNNED	SHUNNED

Any other DataSource State sets the STATUS to UNKNOWN.

- **OK** [171]

  The OK [171] status indicates that the datasource is currently operating correctly.

- **DIMINISHED** [171]

  A DIMINISHED [171] status indicates that there is a problem with one of the dataservice services which is causing a reduced level of expected service. For example, in the sample output below, the reason is indicated as a stopped replicator service.

```
+---------------------------------------------------------------------------+
|host1(master:ONLINE)                                                       |
|STATUS [DIMINISHED] [2013/05/11 12:38:33 AM BST]                           |
|REASON[REPLICATOR STOPPED]                                                 |
+---------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
|  REPLICATOR(state=STOPPED)                                                |
|  DATASERVER(state=ONLINE)                                                 |
|  CONNECTIONS(created=195, active=0)                                       |
+---------------------------------------------------------------------------+
```

  The underlying service fault should be fixed and the status rechecked.

If all the services are ONLINE, but one node is in the DIMINISHED [171] state, you should let the auto-recovery process complete. To do this:

1. Place the cluster into automatic mode:

```
[LOGICAL] /alpha > set policy automatic
```

2. Set the status of the node in the DIMINISHED [171] state to OFFLINE:

```
[LOGICAL:EXPERT] /alpha > datasource host1 offline
```

Automatic recovery will then recover the node for you.

6.3.8. Datasource States and Policy Mode Interactions

States can be explicit set through cctrl command, however, depending on the current policy mode, the actual status set may be different from that initially set. For example, when shunning a datasource, the datasource will immediately go into SHUNNED state.

```
[LOGICAL:EXPERT] /alpha > datasource host3 shun
DataSource 'host3' set to SHUNNED
```

To bring the datasource back into operation, it must be brought back using the recover command:

```
[LOGICAL:EXPERT] /alpha > datasource host3 recover
DataSource 'host3' is now OFFLINE
```

The datasource recover command performs whatever steps are necessary to bring the datasource back into operation within the dataservice. Even for manually shunned datasources, there may be additional configuration or recovery steps required.

If the dataservice policy mode is *MANUAL* or *MAINTENANCE* modes, the datasource remains in the OFFLINE state until manually put ONLINE .

6.4. Policy Modes

The dataservice operates using a policy mode, which configures how the dataservice management system responds to different events and operations within the dataservice. The policy mode can be set at will and enables maintenance and administration to be carried out without triggering the automatic failure and recovery procedures for operations that would otherwise trigger an automated response.

The procedure for how these operations are carried out are defined through a series of rules, with different policies applying different sets of the individual rules. The setting of the policy mode is dataservice-wide and instantaneous.

	Policy Mode		
Ruleset	Automatic	Manual	Maintenance
Monitoring	Yes	Yes	Yes
Fault Detection	Yes	Yes	No
Failure Fencing	Yes	Yes	No
Failure Recovery	Yes	No	No

The individual policy modes are described below:

- *AUTOMATIC* Policy Mode

In automatic mode, the following operations and status changes happen automatically, managed by the coordinator:

- Failed Replica datasources are automatically marked as failed, temporarily removed from the dataservice, with application connections redirect to the other nodes in the dataservice. When the datasource becomes available, the node is automatically recovered to the dataservice.
- Failed Primary datasources are automatically shunned and switched to the most up to date Replica within the dataservice, which becomes the Primary and remaining Replicas point to the newly promoted Primary.

> **Note**
>
> Automatic policy mode operates within a single dataservice only. Within a composite dataservice there is no automatic failover.

- *MANUAL* Policy Mode

  In the *MANUAL* policy mode, the dataservice identifies and isolates datasources when they fail, but automatic failover (for Primary datasources) and recovery is disabled.

- *MAINTENANCE* Policy Mode

  In *MAINTENANCE* policy mode all rules are disabled. Maintenance mode should be used when performing datasource or host maintenance that would otherwise trigger an automated fencing or recovery process.

  Maintenance mode should be used when administration or maintenance is required on the datasource, software, or operating system.

6.4.1. Setting Policy Modes

To set the policy, use the set command with the policy option. For example, to switch the current dataservice policy mode to manual:

```
[LOGICAL:EXPERT] /alpha > set policy manual
policy mode is now MANUAL
```

Policy mode changes are global, affecting the operation of all the members of the dataservice.

The current policy mode is shown when running ls within cctrl , see Section 6.3, “Checking Dataservice Status” .

6.5. Switching Primary Hosts

The Primary host within a dataservice can be switched, either automatically, or manually. Automatic switching occurs when the dataservice is in the *AUTOMATIC* policy mode, and a failure in the underlying datasource has been identified. The automatic process is designed to keep the dataservice running without requiring manual intervention.

Manual switching of the Primary can be performed during maintenance operations, for example during an upgrade or dataserver modification. In this situation, the Primary must be manually taken out of service, but without affecting the rest of the dataservice. By switching the Primary to another datasource in the dataservice, the original Primary can be put offline, or shunned, while maintenance occurs. Once the maintenance has been completed, the datasource can be re-enabled, and either remain as the a Replica, or switched back as the Primary datasource.

Switching a datasource, whether automatically or manually, occurs while the dataservice is running, and without affecting the operation of the dataservice as a whole. Client application connections through Tungsten Connector are automatically reassigned to the datasources in the dataservice, and application operation will be unaffected by the change. Switching the datasource manually requires a single command that performs all of the required steps, monitoring and managing the switch process.

Switching the Primary, manually or automatically, performs the following steps within the dataservice:

1. Set the Primary node to offline state. New connections to the Primary are rejected, and writes to the Primary are stopped.
2. On the Replica that will be promoted, switch the datasource offline. New connections are rejected, stopping reads on this Replica.
3. Kill any outstanding client connections to the Primary data source, except those belonging to the `tungsten` account.
4. Send a heartbeat transaction between the Primary and the Replica, and wait until this transaction has been received. Once received, the THL on Primary and Replica are up to date.
5. Perform the switch:
   - Configure all remaining replicators offline
   - Configure the selected Replica as the new Primary.

- Set the new Primary to the online state.
- New connections to the Primary are permitted.

6. Configure the remaining Replicas to use the new Primary as the Primary datasource.
7. Update the connector configurations and enable client connections to connect to the Primaries and Replicas.

The switching process is monitored by Tungsten Cluster, and if the process fails, either due to a timeout or a recoverable error occurs, the switch operation is rolled back, returning the dataservice to the original configuration. This ensures that the dataservice remains operational. In some circumstances, when performing a manual switch, the command may need to be repeated to ensure the requested switch operation completes.

The process takes a finite amount of time to complete, and the exact timing and duration will depend on the state, health, and database activity on the dataservice. The actual time taken will depend on how up to date the Replica being promoted is compared to the Primary. The switch will take place regardless of the current status after a delay period.

6.5.1. Automatic Primary Failover

When the dataservice policy mode is `AUTOMATIC`, the dataservice will automatically failover the Primary host when the existing Primary is identified as having failed or become unavailable.

For example, when the Primary host `host1` becomes unavailable because of a network problem, the dataservice automatically switches to `host2`. The dataservice status is updated accordingly, showing the automatically shunned `host1`:

```
[LOGICAL:EXPERT] /alpha > ls

COORDINATOR[host3:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@host2[28116](ONLINE, created=0, active=0)                         |
|connector@host3[1533](ONLINE, created=0, active=0)                          |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|host1(Master:SHUNNED(FAILED-OVER-TO-host2))                                 |
|STATUS [SHUNNED] [2013/05/14 12:18:54 PM BST]                               |
+----------------------------------------------------------------------------+
|  MANAGER(state=STOPPED)                                                    |
|  REPLICATOR(state=STATUS NOT AVAILABLE)                                    |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host2(Master:ONLINE, progress=156325, THL latency=0.606)                    |
|STATUS [OK] [2013/05/14 12:46:55 PM BST]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=Master, state=ONLINE)                                     |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+
```

The status for the original Primary (`host1`) identifies the datasource as shunned, and indicates which datasource was promoted to the Primary in the `FAILED-OVER-TO-host2`.

A automatic failover can be triggered by using the datasource fail command:

```
[LOGICAL:EXPERT] /alpha > datasource host1 fail
```

This triggers the automatic failover sequence, and simulates what would happen if the specified host failed.

If `host1` becomes available again, the datasource is not automatically added back to the dataservice, but must be explicitly re-added to the dataservice. The status of the dataservice once `host1` returns is shown below:

```
[LOGICAL:EXPERT] /alpha > ls

COORDINATOR[host3:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@host1[19869](ONLINE, created=0, active=0)                         |
|connector@host2[28116](ONLINE, created=0, active=0)                         |
|connector@host3[1533](ONLINE, created=0, active=0)                          |
```

```
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|host1(Master:SHUNNED(FAILED-OVER-TO-host2), progress=156323, THL            |
|latency=0.317)                                                              |
|STATUS [SHUNNED] [2013/05/14 12:30:21 PM BST]                               |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=Master, state=ONLINE)                                     |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+
```

Because `host1` was previously the Primary, the datasource recover command verifies that the server is available, configures the node as a Replica of the newly promoted Primary, and re-enables the services:

```
[LOGICAL:EXPERT] /alpha > datasource host1 recover
VERIFYING THAT WE CAN CONNECT TO DATA SERVER 'host1'
DATA SERVER 'host1' IS NOW AVAILABLE FOR CONNECTIONS
RECOVERING 'host1@alpha' TO A SLAVE USING 'host2@alpha' AS THE MASTER
SETTING THE ROLE OF DATASOURCE 'host1@alpha' FROM 'Master' TO 'slave'
RECOVERY OF 'host1@alpha' WAS SUCCESSFUL
```

If the command is successful, then the node should be up and running as a Replica of the new Primary.

The recovery process can fail if the THL data and dataserver contents do not match, for example when statements have been executed on a Replica. For information on recovering from failures that recover cannot fix, see Section 6.6.1.3, “Replica Datasource Extended Recovery” .

6.5.2. Manual Primary Switch

In a single data service dataservice configuration, the Primary can be switched between nodes within the dataservice manually using cctrl . The switch command performs the switch operation, annotating the progress.

```
[LOGICAL:EXPERT] /alpha > switch
SELECTED SLAVE: host2@alpha
PURGE REMAINING ACTIVE SESSIONS ON CURRENT MASTER 'host1@alpha'
PURGED A TOTAL OF 0 ACTIVE SESSIONS ON MASTER 'host1@alpha'
FLUSH TRANSACTIONS ON CURRENT MASTER 'host1@alpha'
PUT THE NEW MASTER 'host2@alpha' ONLINE
PUT THE PRIOR MASTER 'host1@alpha' ONLINE AS A SLAVE
RECONFIGURING SLAVE 'host3@alpha' TO POINT TO NEW MASTER 'host2@alpha'
SWITCH TO 'host2@alpha' WAS SUCCESSFUL
```

By default, switch chooses the most up to date Replica within the dataservice (`host2` in the above example), but an explicit Replica can also be selected:

```
[LOGICAL:EXPERT] /alpha > switch to host3
SELECTED SLAVE: host3@alpha
PURGE REMAINING ACTIVE SESSIONS ON CURRENT MASTER 'host2@alpha'
PURGED A TOTAL OF 0 ACTIVE SESSIONS ON MASTER 'host2@alpha'
FLUSH TRANSACTIONS ON CURRENT MASTER 'host2@alpha'
PUT THE NEW MASTER 'host3@alpha' ONLINE
PUT THE PRIOR MASTER 'host2@alpha' ONLINE AS A SLAVE
RECONFIGURING SLAVE 'host1@alpha' TO POINT TO NEW MASTER 'host3@alpha'
SWITCH TO 'host3@alpha' WAS SUCCESSFUL
```

With the previous example, the switch occurred specifically to the node `host3` .

6.6. Datasource Recovery Steps

When a datasource within the dataservice fails, the exact response by the dataservice is dependent on the dataservice policy mode. Different policy modes either cope with the failure or recovery process automatically, or a prescribed sequence must be followed.

Recovery can normally be achieved by following these basic steps:

- Use the recover command

  The recover command performs a number of steps to try and return the dataservice to the operational state, but works only if there is an existing Primary within the current configuration. Operations conducted automatically include Replica recovery, and reconfiguring roles. For example:

  ```
  [LOGICAL] /alpha > recover
  FOUND PHYSICAL DATASOURCE TO RECOVER: 'host2@alpha'
  VERIFYING THAT WE CAN CONNECT TO DATA SERVER 'host2'
  DATA SERVER 'host2' IS NOW AVAILABLE FOR CONNECTIONS
  RECOVERING 'host2@alpha' TO A SLAVE USING 'host3@alpha' AS THE MASTER
  DataSource 'host2' is now OFFLINE
  ```

```
RECOVERY OF DATA SERVICE 'alpha' SUCCEEDED
FOUND PHYSICAL DATASOURCE TO RECOVER: 'host1@alpha'
VERIFYING THAT WE CAN CONNECT TO DATA SERVER 'host1'
DATA SERVER 'host1' IS NOW AVAILABLE FOR CONNECTIONS
RECOVERING 'host1@alpha' TO A SLAVE USING 'host3@alpha' AS THE MASTER
DataSource 'host1' is now OFFLINE
RECOVERY OF DATA SERVICE 'alpha' SUCCEEDED
RECOVERED 2 DATA SOURCES IN SERVICE 'alpha'
```

- Replica failure, Primary still available

  Use the recover to bring all Replicas back into operation. To bring a single Replica, use the datasource recover :

  ```
  [LOGICAL:EXPERT] /alpha > datasource host1 recover
  VERIFYING THAT WE CAN CONNECT TO DATA SERVER 'host1'
  DATA SERVER 'host1' IS NOW AVAILABLE FOR CONNECTIONS
  RECOVERING 'host1@alpha' TO A SLAVE USING 'host2@alpha' AS THE MASTER
  RECOVERY OF 'host1@alpha' WAS SUCCESSFUL
  ```

  If recovery of the Replica fails with this method, you can try more advanced solutions for getting your Replica(s) working, including reprovisioning from another Replica.

  For more info, see Section 6.6.1, “Recover a failed Replica” .

- Primary failure

  If the most up to date Primary can be identified, use the recover using command to set the new Primary and recover the remaining Replicas. If this does not work, use the set Master command and then use the recover command to bring back as many possible Replicas, and then use a backup/restore operation to bring any other Replicas back into operation, or use the tungsten_provision_slave command. For more information, see Section 6.6.2, “Recover a failed Primary” .

A summary of these different scenarios and steps is provided in the following table:

Policy Mode	Scenario	Datasource State	Resolution
AUTOMATIC			
	Primary Failure		Automatic
	Primary Recovery	Master:SHUNNED(FAILED-OVER-TO-host2)	Section 6.6.2, “Recover a failed Primary”
	Replica Failure		Automatic
	Replica Recovery		Automatic
MANUAL			
	Primary Failure	Master:FAILED(NODE 'host1' IS UNREACHABLE))	Section 6.6.2.4, “Failing over a Primary”
	Primary Recovery	Master:SHUNNED(FAILED-OVER-TO-host2)	Section 6.6.2.2, “Recover a shunned Primary”
	Replica Failure	slave:FAILED(NODE 'host1' IS UNREACHABLE)	Automatically removed from service
	Replica Recovery	slave:FAILED(NODE 'host1' IS UNREACHABLE)	Section 6.6.1, “Recover a failed Replica”
MAINTENANCE			
	Primary Failure		Use Section 6.6.2.4, “Failing over a Primary” to promote a different Replica
	Primary Recovery		Section 6.6.2.3, “Manually Failing over a Primary in *MAINTENANCE* policy mode”
	Replica Failure		N/A
	Replica Recovery		N/A
Any			
	Replica Shunned	slave:SHUNNED(MANUALLY-SHUNNED)	Section 6.6.1, “Recover a failed Replica”
	No Primary	slave:SHUNNED(SHUNNED)	Section 6.6.2.1, “Recover when there are no Primaries”

6.6.1. Recover a failed Replica

A Replica that has failed but which has become available again can be recovered back into Replica mode using the recover command:

```
[LOGICAL:EXPERT] /alpha > recover
FOUND PHYSICAL DATASOURCE TO RECOVER: 'host2@alpha'
VERIFYING THAT WE CAN CONNECT TO DATA SERVER 'host2'
DATA SERVER 'host2' IS NOW AVAILABLE FOR CONNECTIONS
RECOVERING 'host2@alpha' TO A SLAVE USING 'host1@alpha' AS THE MASTER
DataSource 'host2' is now OFFLINE
RECOVERY OF DATA SERVICE 'alpha' SUCCEEDED
RECOVERED 1 DATA SOURCES IN SERVICE 'alpha'
```

The recover command will attempt to recover all the Replica resources in the cluster, bringing them all online and back into service. The command operates on all shunned or failed Replicas, and only works if there is an active Primary available.

To recover a single datasource back into the dataservice, use the explicit form:

```
[LOGICAL:EXPERT] /alpha > datasource host1 recover
VERIFYING THAT WE CAN CONNECT TO DATA SERVER 'host1'
DATA SERVER 'host1' IS NOW AVAILABLE FOR CONNECTIONS
RECOVERING 'host1@alpha' TO A SLAVE USING 'host2@alpha' AS THE MASTER
RECOVERY OF 'host1@alpha' WAS SUCCESSFUL
```

In some cases, the datasource may show as ONLINE and the recover command does not bring the datasource online, particularly with the following error:

```
The datasource 'host1' is not FAILED or SHUNNED and cannot be recovered.
```

Checking the datasource status in cctrl the replicator service has failed, but the datasource shows as online:

```
+----------------------------------------------------------------------------+
|host1 (slave:ONLINE, progress=-1, latency=-1.000)                           |
|STATUS [OK] [2013/06/24 12:42:06 AM BST]                                    |
+----------------------------------------------------------------------------+
| MANAGER(state=ONLINE)                                                      |
| REPLICATOR(role=slave, Master=host1, state=SUSPECT)                        |
| DATASERVER(state=ONLINE)                                                   |
+----------------------------------------------------------------------------+
```

In this case, the datasource can be manually shunned, which will then enable the recover command to operate and bring the node back into operation.

6.6.1.1. Provision or Reprovision a Replica

In the event that you cannot get the Replica to recover using the datasource recover command, you can re-provision the Replica from another Replica within your dataservice.

The command performs three operations automatically:

1. Performs a backup of a remote Replica
2. Copies the backup to the current host
3. Restores the backup

> **Warning**
>
> When using tungsten_provision_slave you must be logged in to the Replica that has failed or that you want to reprovision. You cannot reprovision a Replica remotely.
>
> When using tprovision you must be logged in to the Replica that has failed or that you want to reprovision. You cannot reprovision a Replica remotely.

To use tungsten_provision_slave :

1. Log in to the failed Replica.
2. Select the active Replica within the dataservice that you want to use to reprovision the failed Replica. You may use the Primary but this will impact performance on that host. If you use MyISAM tables the operation will create some locking in order to get a consistent snapshot.
3. Run tungsten_provision_slave specifying the source you have selected:

```
shell> tungsten_provision_slave --source=host2
  NOTE  >> Put alpha replication service offline
  NOTE  >> Create a mysqldump backup of host2 »
```

```
 in /opt/continuent/backups/provision_mysqldump_2013-11-21_09-31_52
 NOTE  >> host2 >> Create mysqldump in »
 /opt/continuent/backups/provision_mysqldump_2013-11-21_09-31_52/provision.sql.gz
 NOTE  >> Load the mysqldump file
 NOTE  >> Put the alpha replication service online
 NOTE  >> Clear THL and relay logs for the alpha replication service
```

The default backup service for the host will be used; mysqldump can be used by specifying the `--mysqldump` option.

tungsten_provision_slave handles the cluster status, backup, restore, and repositioning of the replication stream so that restored Replica is ready to start operating again.

Important

When using a Multi-Site/Active-Active topology the additional replicator must be put offline before restoring data and put online after completion.

```
shell> mm_trepctl offline
shell> tungsten_provision_slave --source=host2
shell> mm_trepctl online
shell> mm_trepctl status
```

For more information on using tungsten_provision_slave see Section 9.40, “The tungsten_provision_slave Script” .

6.6.1.2. Recover a Replica from manually shunned state

A Replica that has been manually shunned can be added back to the dataservice using the datasource recover command:

```
[LOGICAL:EXPERT] /alpha > datasource host3 recover
DataSource 'host3' is now OFFLINE
```

In *AUTOMATIC* policy mode, the Replica will automatically be recovered from OFFLINE to ONLINE mode.

In *MANUAL* or *MAINTENANCE* policy mode, the datasource must be manually switched to the online state:

```
[LOGICAL:EXPERT] /alpha > datasource host3 online
Setting server for data source 'host3' to READ-ONLY
+---------------------------------------------------------------------------+
|host3                                                                      |
+---------------------------------------------------------------------------+
|Variable_name  Value                                                       |
|read_only  ON                                                              |
+---------------------------------------------------------------------------+
DataSource 'host3@alpha' is now ONLINE
```

6.6.1.3. Replica Datasource Extended Recovery

If the current Replica will not recover, but the replicator state and sequence number are valid, the Replica is pointing to the wrong Primary, or still mistakenly has the Primary role when it should be a Replica, then the Replica can be forced back into the Replica state.

For example, in the output from ls in cctrl below, host2 is mistakenly identified as the Primary, even though host1 is correctly operating as the Primary.

```
COORDINATOR[host1:AUTOMATIC:ONLINE]

ROUTERS:
+---------------------------------------------------------------------------+
|connector@host1[1848](ONLINE, created=0, active=0)                         |
|connector@host2[4098](ONLINE, created=0, active=0)                         |
|connector@host3[4087](ONLINE, created=0, active=0)                         |
+---------------------------------------------------------------------------+

DATASOURCES:
+---------------------------------------------------------------------------+
|host1(Master:ONLINE, progress=23, THL latency=0.198)                       |
|STATUS [OK] [2013/05/30 11:29:44 AM BST]                                   |
+---------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
|  REPLICATOR(role=Master, state=ONLINE)                                    |
|  DATASERVER(state=ONLINE)                                                 |
|  CONNECTIONS(created=0, active=0)                                         |
+---------------------------------------------------------------------------+

+---------------------------------------------------------------------------+
|host2(slave:SHUNNED(MANUALLY-SHUNNED), progress=-1, latency=-1.000)        |
|STATUS [SHUNNED] [2013/05/30 11:23:15 AM BST]                              |
+---------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
|  REPLICATOR(role=Master, state=OFFLINE)                                   |
```

```
|  DATASERVER(state=ONLINE)                                                    |
|  CONNECTIONS(created=0, active=0)                                            |
+------------------------------------------------------------------------------+

+------------------------------------------------------------------------------+
|host3(slave:ONLINE, progress=23, latency=178877.000)                          |
|STATUS [OK] [2013/05/30 11:33:15 AM BST]                                      |
+------------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                       |
|  REPLICATOR(role=slave, Master=host1, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                    |
|  CONNECTIONS(created=0, active=0)                                            |
+------------------------------------------------------------------------------+
```

The datasource `host2` can be brought back online using this sequence:

1. Enable set force mode:

   ```
   [LOGICAL:EXPERT] /alpha > set force true
   FORCE: true
   ```

2. Shun the datasource:

   ```
   [LOGICAL:EXPERT] /alpha > datasource host2 shun
   DataSource 'host2' set to SHUNNED
   ```

3. Switch the replicator offline:

   ```
   [LOGICAL:EXPERT] /alpha > replicator host2 offline
   Replicator 'host2' is now OFFLINE
   ```

4. Set the replicator to *`Replica`* operation:

   ```
   [LOGICAL:EXPERT] /alpha > replicator host2 slave
   Replicator 'host2' is now a slave of replicator 'host1'
   ```

   In some instances you may need to explicitly specify which node is your Primary when you configure the Replica; appending the Primary hostname to the command specifies the Primary host to use:

   ```
   [LOGICAL:EXPERT] /alpha > replicator host2 slave host1
   Replicator 'host2' is now a slave of replicator 'host1'
   ```

5. Switch the replicator service online:

   ```
   [LOGICAL:EXPERT] /alpha > replicator host2 online
   Replicator 'host2' is now ONLINE
   ```

6. Ensure the datasource is correctly configured as a Replica:

   ```
   [LOGICAL:EXPERT] /alpha > datasource host2 slave
   Datasource 'host2' now has role 'slave'
   ```

7. Recover the Replica back to the dataservice:

   ```
   [LOGICAL:EXPERT] /alpha > datasource host2 recover
   DataSource 'host2' is now OFFLINE
   ```

Datasource `host2` should now be back in the dataservice as a working datasource.

Similar processes can be used to force a datasource back into the *`Primary`* role if a switch or recover operation failed to set the role properly.

If the recover command fails, there are a number of solutions that may bring the dataservice back to the normal operational state. The exact method will depend on whether there are other active Replicas (from which a backup can be taken) or recent backups of the Replica are available, and the reasons for the original failure. Some potential solutions include

- If there is a recent backup of the failed Replica, restore the Replica using that backup. The latest backup can be restored using Section 6.10, “Restoring a Backup” .
- If there is no recent backup, but have another Replica from which you can recover the failed Replica, the node should be rebuilt using the backup from another Replica. See Section 6.10.3, “Restoring from Another Replica” .

6.6.2. Recover a failed Primary

When a Primary datasource is automatically failed over in *`AUTOMATIC`* policy mode, the datasource can be brought back into the dataservice as a Replica by using the recover command:

```
[LOGICAL:EXPERT] /alpha > datasource host1 recover
VERIFYING THAT WE CAN CONNECT TO DATA SERVER 'host1'
```

```
DATA SERVER 'host1' IS NOW AVAILABLE FOR CONNECTIONS
RECOVERING 'host1@alpha' TO A SLAVE USING 'host2@alpha' AS THE MASTER
SETTING THE ROLE OF DATASOURCE 'host1@alpha' FROM 'Master' TO 'slave'
RECOVERY OF 'host1@alpha' WAS SUCCESSFUL
```

The recovered datasource will be added back to the dataservice as a Replica.

6.6.2.1. Recover when there are no Primaries

When there are no Primaries available, due to a failover of a Primary, or multiple host failure there are two options available. The first is to use the recover Master using , which sets the Primary to the specified host, and tries to automatically recover all the remaining nodes in the dataservice. The second is to manually set the Primary host, and recover the remainder of the datasources manually.

- Using recover Master using

Warning

This command should only be used in urgent scenarios where the most up to date Primary can be identified. If there are multiple failures or mismatches between Primaries and Replicas, the command may not be able to recover all services, but will always result in an active Primary being configured.

This command performs two distinct actions, first it calls set Master to select the new Primary, and then it calls datasource recover on each of the remaining Replicas. This attempts to recover the entire dataservice by switching the Primary and reconfiguring the Replicas to work with the new Primary.

To use, first you should examine the state of the dataservice and choose which datasource is the most up to date or canonical. For example, within the following output, each datasource has the same sequence number, so any datasource could potentially be used as the Primary:

```
[LOGICAL] /alpha > ls

COORDINATOR[host1:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@host1[18450](ONLINE, created=0, active=0)                         |
|connector@host2[8877](ONLINE, created=0, active=0)                          |
|connector@host3[8895](ONLINE, created=0, active=0)                          |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|host1(Master:SHUNNED(FAILSAFE AFTER Shunned by fail-safe procedure),        |
|progress=17, THL latency=0.565)                                             |
|STATUS [OK] [2013/11/04 04:39:28 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=Master, state=ONLINE)                                     |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host2(slave:SHUNNED(FAILSAFE AFTER Shunned by fail-safe procedure),         |
|progress=17, latency=1.003)                                                 |
|STATUS [OK] [2013/11/04 04:39:51 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, Master=host1, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host3(slave:SHUNNED(FAILSAFE AFTER Shunned by fail-safe procedure),         |
|progress=17, latency=1.273)                                                 |
|STATUS [OK] [2013/10/26 06:30:26 PM BST]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, Master=host1, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+
```

Once a host has been chosen, call the recover Master using command specifying the full servicename and hostname of the chosen datasource:

```
[LOGICAL] /alpha > recover Master using alpha/host1
```

```
This command is generally meant to help in the recovery of a data service
that has data sources shunned due to a fail-safe shutdown of the service or
under other circumstances where you wish to force a specific data source to become
the primary. Be forewarned that if you do not exercise care when using this command
you may lose data permanently or otherwise make your data service unusable.
Do you want to continue? (y/n)> y
DATA SERVICE 'alpha' DOES NOT HAVE AN ACTIVE PRIMARY. CAN PROCEED WITH 'RECOVER USING'
VERIFYING THAT WE CAN CONNECT TO DATA SERVER 'host1'
DATA SERVER 'host1' IS NOW AVAILABLE FOR CONNECTIONS
DataSource 'host1' is now OFFLINE
DATASOURCE 'host1@alpha' IS NOW A MASTER
FOUND PHYSICAL DATASOURCE TO RECOVER: 'host2@alpha'
VERIFYING THAT WE CAN CONNECT TO DATA SERVER 'host2'
DATA SERVER 'host2' IS NOW AVAILABLE FOR CONNECTIONS
RECOVERING 'host2@alpha' TO A SLAVE USING 'host1@alpha' AS THE MASTER
DataSource 'host2' is now OFFLINE
RECOVERY OF DATA SERVICE 'alpha' SUCCEEDED
FOUND PHYSICAL DATASOURCE TO RECOVER: 'host3@alpha'
VERIFYING THAT WE CAN CONNECT TO DATA SERVER 'host3'
DATA SERVER 'host3' IS NOW AVAILABLE FOR CONNECTIONS
RECOVERING 'host3@alpha' TO A SLAVE USING 'host1@alpha' AS THE MASTER
DataSource 'host3' is now OFFLINE
RECOVERY OF DATA SERVICE 'alpha' SUCCEEDED
RECOVERED 2 DATA SOURCES IN SERVICE 'alpha'
```

You will be prompted to ensure that you wish to choose the selected host as the new Primary. cctrl then proceeds to set the new Primary, and recover the remaining Replicas.

If this operation fails, you can try the manual process, using set Master and proceeding to recover each Replica manually.

- Using set Master

The set Master command forcibly sets the Primary to the specified host. It should only be used in the situation where no Primary is currently available within the dataservice, and recovery has failed. This command performs only one operation, and that is to explicitly set the new Primary to the specified host.

> **Warning**
>
> Using set Master is an expert level command and may lead to data loss if the wrong Primary is used. Because of this, the cctrl must be forced to execute the command by using set force true . The command will not be executed otherwise.

To use the command, pick the most up to date Primary, or the host that you want to use as the Primary within your dataservice, then issue the command:

```
[LOGICAL] /alpha > set Master host3
VERIFYING THAT WE CAN CONNECT TO DATA SERVER 'host3'
DATA SERVER 'host3' IS NOW AVAILABLE FOR CONNECTIONS
DataSource 'host3' is now OFFLINE
DATASOURCE 'host3@alpha' IS NOW A MASTER
```

This does not recover the remaining Replicas within the cluster, these must be manually recovered. This can be achieved either by using Section 6.6.1, “Recover a failed Replica” , or if this is not possible, using Section 6.6.1.1, “Provision or Reprovision a Replica” .

6.6.2.2. Recover a shunned Primary

When a Primary datasource fails in *MANUAL* policy mode, and the node has been failed over, once the datasource becomes available, the node can be added back to the dataservice by using the recover command, which enables the host as a Replica:

```
[LOGICAL:EXPERT] /alpha > datasource host1 recover
VERIFYING THAT WE CAN CONNECT TO DATA SERVER 'host1'
DATA SERVER 'host1' IS NOW AVAILABLE FOR CONNECTIONS
RECOVERING 'host1@alpha' TO A SLAVE USING 'host2@alpha' AS THE MASTER
SETTING THE ROLE OF DATASOURCE 'host1@alpha' FROM 'Master' TO 'slave'
RECOVERY OF 'host1@alpha' WAS SUCCESSFUL
```

The recovered Primary will added back to the dataservice as a Replica.

6.6.2.3. Manually Failing over a Primary in *MAINTENANCE* policy mode

If the dataservice is in *MAINTENANCE* mode when the Primary fails, automatic recovery cannot sensibly make the decision about which node should be used as the Primary. In that case, the datasource service must be manually reconfigured.

In the sample below, `host1` is the current Primary, and `host2` is a Replica. To manually update and switch `host1` to be the Replica and `host2` to be the Primary:

1. Shun the failed Primary (`host1`) and set the replicator offline:

```
[LOGICAL:EXPERT] /alpha > datasource host1 shun
DataSource 'host1' set to SHUNNED
[LOGICAL:EXPERT] /alpha > replicator host1 offline
Replicator 'host1' is now OFFLINE
```

2. Shun the Replica `host2` and set the replicator to the offline state:

```
[LOGICAL:EXPERT] /alpha > datasource host2 shun
DataSource 'host2' set to SHUNNED
[LOGICAL:EXPERT] /alpha > replicator host2 offline
Replicator 'host2' is now OFFLINE
```

3. Configure `host2`) as the Primary within the replicator service:

```
[LOGICAL:EXPERT] /alpha > replicator host2 Master
```

4. Set the replicator on `host2` online:

```
[LOGICAL:EXPERT] /alpha > replicator host2 online
```

5. Recover `host2` online and then set it online:

```
[LOGICAL:EXPERT] /alpha > datasource host2 welcome
[LOGICAL:EXPERT] /alpha > datasource host2 online
```

6. Switch the replicator to be in *`Replica`* mode:

```
[LOGICAL:EXPERT] /alpha > replicator host1 slave host2
Replicator 'host1' is now a slave of replicator 'host2'
```

7. Switch the replicator online:

```
[LOGICAL:EXPERT] /alpha > replicator host1 online
Replicator 'host1' is now ONLINE
```

8. Switch the datasource role for `host1` to be in Replica mode:

```
[LOGICAL:EXPERT] /alpha > datasource host1 slave
Datasource 'host1' now has role 'slave'
```

9. The configuration and roles for the host have been updated, the datasource can be added back to the dataservice and then put online:

```
[LOGICAL:EXPERT] /alpha > datasource host1 recover
DataSource 'host1' is now OFFLINE
[LOGICAL:EXPERT] /alpha > datasource host1 online
Setting server for data source 'host1' to READ-ONLY
+----------------------------------------------------------------------------+
|host1                                                                       |
+----------------------------------------------------------------------------+
|Variable_name  Value                                                        |
|read_only  ON                                                               |
+----------------------------------------------------------------------------+
DataSource 'host1@alpha' is now ONLINE
```

10. With the dataservice in automatic policy mode, the datasource will be placed online, which can be verified with `ls` :

```
[LOGICAL:EXPERT] /alpha > ls

COORDINATOR[host3:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@host1[19869](ONLINE, created=0, active=0)                         |
|connector@host2[28116](ONLINE, created=0, active=0)                         |
|connector@host3[1533](ONLINE, created=0, active=0)                          |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|host1(slave:ONLINE, progress=156325, latency=725.737)                       |
|STATUS [OK] [2013/05/14 01:06:08 PM BST]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, Master=host2, state=ONLINE)                        |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|host2(Master:ONLINE, progress=156325, THL latency=0.606)                    |
```

```
|STATUS [OK] [2013/05/14 12:53:41 PM BST]                                 |
+-------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                  |
|  REPLICATOR(role=Master, state=ONLINE)                                  |
|  DATASERVER(state=ONLINE)                                               |
|  CONNECTIONS(created=0, active=0)                                       |
+-------------------------------------------------------------------------+

+-------------------------------------------------------------------------+
|host3(slave:ONLINE, progress=156325, latency=1.642)                      |
|STATUS [OK] [2013/05/14 12:53:41 PM BST]                                 |
+-------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                  |
|  REPLICATOR(role=slave, Master=host2, state=ONLINE)                     |
|  DATASERVER(state=ONLINE)                                               |
|  CONNECTIONS(created=0, active=0)                                       |
+-------------------------------------------------------------------------+
```

6.6.2.4. Failing over a Primary

When a Primary datasource fails in *MANUAL* policy mode, the datasource must be manually failed over to an active datasource, either by selecting the most up to date Replica automatically:

```
[LOGICAL:EXPERT] /alpha > failover
```

Or to an explicit host:

```
[LOGICAL:EXPERT] /alpha > failover to host2
SELECTED SLAVE: host2@alpha
PURGE REMAINING ACTIVE SESSIONS ON CURRENT MASTER 'host1@alpha'
SHUNNING PREVIOUS MASTER 'host1@alpha'
PUT THE NEW MASTER 'host2@alpha' ONLINE
RECONFIGURING SLAVE 'host3@alpha' TO POINT TO NEW MASTER 'host2@alpha'
FAILOVER TO 'host2' WAS COMPLETED
```

For the failover command to work, the following conditions must be met:

- There must be a Primary or relay in the SHUNNED or FAILED state.
- There must be at least one Replica in the ONLINE state.

If there is not already a SHUNNED or FAILED Primary and a failover must be forced, use datasource shun on the Primary, or failover to a specific Replica.

6.6.2.5. Split-Brain Discussion

A split-brain occurs when a cluster which normally has a single write Primary, has two write-able Primaries.

This means that some writes which should go to the “real” Primary are sent to a different node which was promoted to write Primary by mistake.

Once that happens, some writes exist on one Primary and not the other, creating two broken Primaries. Merging the two data sets is impossible, leading to a full restore, which is clearly NOT desirable.

We can say that a split-brain scenario is to be strongly avoided.

A situation like this is most often encountered when there is a network partition of some sort, especially with the nodes spread over multiple availability zones in a single region of a cloud deployment.

This would potentially result in all nodes being isolated, without a clear majority within the voting quorum.

A poorly-designed cluster could elect more than one Primary under these conditions, leading to the split-brain scenario.

Since a network partition would potentially result in all nodes being isolated without a clear majority within the voting quorum, the default action of a Tungsten Cluster is to SHUN all of the nodes.

Shunning ALL of the nodes means that no client traffic is being processed by any node, both reads and writes are blocked.

When this happens, it is up to a human administrator to select the proper Primary and recover the cluster.

For more information, please see Section 6.6.2, “Recover a failed Primary”.

6.7. Composite Cluster Switching, Failover and Recovery

Switching of a dataservice is done to transfer the Active role from one cluster to another, usually in another datacenter site. This also has the effect of turning the original Primary node into a Relay node. The Active dataservice within a composite cluster can be forced to failover to the Passive dataservice in the event the Active dataservice is offline.

Switching the Active dataservice performs the following steps:

1. Set the Primary node to offline state. New connections to the Primary are rejected, and writes to the Primary are stopped.
2. On the relay in the target cluster, switch the datasource offline. New connections are rejected, stopping reads on this Primary.
3. Kill any outstanding client connections to the Primary data source, except those belonging to the `tungsten` account.
4. Send a heartbeat transaction between the old Primary and the new Primary, and wait until this transaction has been received. Once received, the THL on Primary and Replica are up to date.
5. Perform the switch:
   - Configure all remaining replicators offline
   - Configure the target cluster relay node as the new Primary.
   - Set the new Primary to the online state.
   - New connections to the Primary are permitted.
6. Configure the old Primary to be a relay datasource.
7. Configure the Replicas in the primary site to use the new Primary datasource.
8. Configure the Replicas in the Replica site to use the new relay datasource.
9. Update the connector configurations and enable client connections to connect to the Primaries and Replicas.

The switching process is monitoring by Tungsten Cluster, and if the process fails, either due to a timeout or a recoverable error occurs, the switch operation is rolled back, returning the dataservice to the original configuration. This ensures that the dataservice remains operational. In some circumstances, when performing a manual switch, the command may need to be repeated to ensure the requested switch operation completes.

The process takes a finite amount of time to complete, and the exact timing and duration will depend on the state, health, and database activity on the dataservice. The actual time taken will depend on how up to date the Replica being promoted is compared to the Primary. The switch will take place regardless of the current status after a delay period.

6.7.1. Composite Cluster Site Switch

Our example cluster has two sites, `east` and `west`. They are both members of composite cluster `global`. Site east has hosts db1, db2 and db3. Site west has hosts db4, db5 and db6.

Important

When working with composite clusters, you should use the `-multi` [285] option to cctrl. With this option enabled the prompt and information provided will be different. You can perform operations both on individual parts of the cluster, and on the entire composite cluster. This can be achieved by using the use COMPOSITESERVICE command. Tab completion is also available within cctrl when using this mode.

```
shell> cctrl -multi
Tungsten Cluster 5.4.1 build 41
east: session established
[LOGICAL] / > ls
+----------------------------------------------------------------------------+
|DATA SERVICES:                                                              |
+----------------------------------------------------------------------------+
east
global
west

[LOGICAL] / > use global
[LOGICAL] /global > ls

COORDINATOR[db1:AUTOMATIC:ONLINE]

DATASOURCES:
+----------------------------------------------------------------------------+
|east(composite master:ONLINE)                                               |
|STATUS [OK] [2015/04/14 01:26:27 AM UTC]                                    |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|west(composite slave:ONLINE)                                                |
|STATUS [OK] [2015/04/14 01:26:26 AM UTC]                                    |
```

```
+----------------------------------------------------------------------------+
```

Composite Active Dataservice (Primary) - `east`

```
[LOGICAL] /global > use east
[LOGICAL] /east > ls

COORDINATOR[db1:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@db1[9745](ONLINE, created=1, active=0)             |
|connector@db2[9911](ONLINE, created=1, active=0)             |
|connector@db3[9775](ONLINE, created=1, active=0)             |
|connector@db4[9757](ONLINE, created=1, active=0)             |
|connector@db5[9781](ONLINE, created=1, active=0)             |
|connector@db6[9944](ONLINE, created=1, active=0)             |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|db1(master:ONLINE, progress=6, THL latency=0.814)                          |
|STATUS [OK] [2015/04/14 01:46:54 AM UTC]                                   |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
|  REPLICATOR(role=master, state=ONLINE)                                    |
|  DATASERVER(state=ONLINE)                                                 |
|  CONNECTIONS(created=6, active=0)                                         |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|db2(slave:ONLINE, progress=6, latency=0.857)                               |
|STATUS [OK] [2015/04/14 01:46:59 AM UTC]                                   |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                         |
|  DATASERVER(state=ONLINE)                                                 |
|  CONNECTIONS(created=0, active=0)                                         |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|db3(slave:ONLINE, progress=6, latency=0.887)                               |
|STATUS [OK] [2015/04/14 01:46:59 AM UTC]                                   |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                         |
|  DATASERVER(state=ONLINE)                                                 |
|  CONNECTIONS(created=0, active=0)                                         |
+----------------------------------------------------------------------------+
```

Composite Passive Dataservice (DR) - `west`

```
[LOGICAL] /east > use west
[LOGICAL] /west > ls

COORDINATOR[db4:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@db1[9745](ONLINE, created=0, active=0)             |
|connector@db2[9911](ONLINE, created=0, active=0)             |
|connector@db3[9775](ONLINE, created=0, active=0)             |
|connector@db4[9757](ONLINE, created=0, active=0)             |
|connector@db5[9781](ONLINE, created=0, active=0)             |
|connector@db6[9944](ONLINE, created=0, active=0)             |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|db4(relay:ONLINE, progress=6, latency=5.050)                               |
|STATUS [OK] [2015/04/14 01:46:59 AM UTC]                                   |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
|  REPLICATOR(role=relay, master=db1, state=ONLINE)                         |
|  DATASERVER(state=ONLINE)                                                 |
|  CONNECTIONS(created=0, active=0)                                         |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|db5(slave:ONLINE, progress=6, latency=5.522)                               |
|STATUS [OK] [2015/04/14 01:46:59 AM UTC]                                   |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
```

```
|  REPLICATOR(role=slave, master=db4, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|db6(slave:ONLINE, progress=6, latency=5.501)                                |
|STATUS [OK] [2015/04/14 01:46:59 AM UTC]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=db4, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+
```

Manually switch the composite Primary role to the other site:

```
[LOGICAL] / > use global
[LOGICAL] /global > switch
SELECTED SLAVE: 'west@global'
FLUSHING TRANSACTIONS THROUGH 'db1@east'
REPLICATOR 'db1' IS NOW USING MASTER CONNECT URI 'thl://db4:2112/'
composite data source 'west@global' is now OFFLINE
PUT THE NEW MASTER 'west@global' ONLINE
PUT THE PRIOR MASTER 'east@global' ONLINE AS A SLAVE
REVERT POLICY: MAINTENANCE => AUTOMATIC
SWITCH TO 'west@global' WAS SUCCESSFUL

[LOGICAL] /global > ls

COORDINATOR[db1:AUTOMATIC:ONLINE]

DATASOURCES:
+----------------------------------------------------------------------------+
|east(composite slave:ONLINE)                                                |
|STATUS [OK] [2015/04/14 01:45:48 AM UTC]                                    |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|west(composite master:ONLINE)                                               |
|STATUS [OK] [2015/04/14 01:45:47 AM UTC]                                    |
+----------------------------------------------------------------------------+
```

Composite Passive Dataservice (DR) - `east`

```
[LOGICAL] /global > use east
[LOGICAL] /east > ls

COORDINATOR[db1:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@db1[9745](ONLINE, created=1, active=0)              |
|connector@db2[9911](ONLINE, created=1, active=0)              |
|connector@db3[9775](ONLINE, created=1, active=0)              |
|connector@db4[9757](ONLINE, created=1, active=0)              |
|connector@db5[9781](ONLINE, created=1, active=0)              |
|connector@db6[9944](ONLINE, created=1, active=0)              |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|db1(relay:ONLINE, progress=3, latency=4.000)                                |
|STATUS [OK] [2015/04/14 01:45:47 AM UTC]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=relay, master=db4, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=6, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|db2(slave:ONLINE, progress=3, latency=5.188)                                |
|STATUS [OK] [2015/04/14 01:45:48 AM UTC]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|db3(slave:ONLINE, progress=3, latency=5.249)                                |
```

```
|STATUS [OK] [2015/04/14 01:45:48 AM UTC]                                 |
+-------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                  |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                       |
|  DATASERVER(state=ONLINE)                                               |
|  CONNECTIONS(created=0, active=0)                                       |
+-------------------------------------------------------------------------+
```

Composite Active Dataservice (Primary) - `west`

```
[LOGICAL] /east > use west
west: session established
[LOGICAL] /west > ls

COORDINATOR[db4:AUTOMATIC:ONLINE]

ROUTERS:
+-------------------------------------------------------------------------+
|connector@db1[9745](ONLINE, created=0, active=0)             |
|connector@db2[9911](ONLINE, created=0, active=0)             |
|connector@db3[9775](ONLINE, created=0, active=0)             |
|connector@db4[9757](ONLINE, created=0, active=0)             |
|connector@db5[9781](ONLINE, created=0, active=0)             |
|connector@db6[9944](ONLINE, created=0, active=0)             |
+-------------------------------------------------------------------------+

DATASOURCES:
+-------------------------------------------------------------------------+
|db4(master:ONLINE, progress=3, THL latency=0.671)                        |
|STATUS [OK] [2015/04/14 01:45:42 AM UTC]                                 |
+-------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                  |
|  REPLICATOR(role=master, state=ONLINE)                                  |
|  DATASERVER(state=ONLINE)                                               |
|  CONNECTIONS(created=0, active=0)                                       |
+-------------------------------------------------------------------------+

+-------------------------------------------------------------------------+
|db5(slave:ONLINE, progress=3, latency=1.581)                             |
|STATUS [OK] [2015/04/14 01:45:48 AM UTC]                                 |
+-------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                  |
|  REPLICATOR(role=slave, master=db4, state=ONLINE)                       |
|  DATASERVER(state=ONLINE)                                               |
|  CONNECTIONS(created=0, active=0)                                       |
+-------------------------------------------------------------------------+

+-------------------------------------------------------------------------+
|db6(slave:ONLINE, progress=3, latency=1.559)                             |
|STATUS [OK] [2015/04/14 01:45:47 AM UTC]                                 |
+-------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                  |
|  REPLICATOR(role=slave, master=db4, state=ONLINE)                       |
|  DATASERVER(state=ONLINE)                                               |
|  CONNECTIONS(created=0, active=0)                                       |
+-------------------------------------------------------------------------+
```

6.7.2. Composite Cluster Site Failover (Forced Switch)

In the event the Active site goes down, and a graceful manual switch is not possible, the composite Active role can be failed over to the Passive cluster using cctrl. The failover command performs the forced switch operation. It will try to update the configuration of the east data service but will not fail if not successful.

In this example, hosts db1 (the composite Primary), db2 and db3 in cluster east have been shut down. To force dataservice `west` to become the primary, login to a node in that cluster and get into cctrl:

```
shell> cctrl -multi
Tungsten Cluster 5.4.1 build 41
west: session established
[LOGICAL] / > use global
[LOGICAL] /global > ls

COORDINATOR[db4:AUTOMATIC:ONLINE]

DATASOURCES:
+-------------------------------------------------------------------------+
|east(composite master:SHUNNED(FAILSAFE_SHUN))                            |
|STATUS [SHUNNED] [2015/04/14 01:46:59 AM UTC]                            |
+-------------------------------------------------------------------------+

+-------------------------------------------------------------------------+
```

```
|west(composite slave:ONLINE)                                                |
|STATUS [OK] [2015/04/14 01:46:59 AM UTC]                                    |
+----------------------------------------------------------------------------+
```

Mark the `east` data service as failed to prevent further actions:

```
[LOGICAL] /global > datasource east fail

WARNING: This is an expert-level command:
Incorrect use may cause data corruption
or make the cluster unavailable.

Do you want to continue? (y/n)> y
WARNING: UNABLE TO REACH PHYSICAL DATA SERVICE 'east' AT THIS TIME.
EXCEPTION: Unable to unable to continue with command because no manager is available in service 'east'.

CONTINUING WITH COMMAND
COMPOSITE DATA SOURCE 'east' IS NOW IN THE FAILED STATE

[LOGICAL] /global > ls

COORDINATOR[db4:AUTOMATIC:ONLINE]

DATASOURCES:
+----------------------------------------------------------------------------+
|east(composite master:FAILED(MANUALLY-FAILED))                              |
|STATUS [CRITICAL] [2015/04/14 03:11:27 PM UTC]                              |
|REASON[MANUALLY-FAILED]                                                     |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|west(composite slave:ONLINE)                                                |
|STATUS [OK] [2015/04/14 02:37:32 PM UTC]                                    |
+----------------------------------------------------------------------------+
```

Issue the failover command to force the `west` dataservice to become the composite Primary:

```
[LOGICAL] /global > failover
WARNING: DATA SERVICE 'east' IS NOT AVAILABLE. CANNOT GET STATE
WARNING: CAN'T GET POLICY MODE FOR SERVICE 'east'. CONTINUING.
WARNING: CAN'T SET POLICY MODE 'maintenance' FOR SERVICE 'east'. CONTINUING.
SELECTED SLAVE: 'west@global'
WARNING: UNABLE TO REACH PHYSICAL DATA SERVICE 'east' AT THIS TIME.
EXCEPTION: Unable to unable to continue with command because no manager is available in service 'east'.

CONTINUING WITH COMMAND
ENSURING THAT WE CATCH UP WITH THE MOST ADVANCED RELAY
composite data source 'west@global' is now OFFLINE
WARNING: UNABLE TO REACH PHYSICAL DATA SERVICE 'west' AT THIS TIME.
EXCEPTION: Unable to unable to continue with command because no manager is available in service 'east'.

CONTINUING WITH COMMAND
PUT THE NEW MASTER 'west@global' ONLINE
WARNING: CAN'T SET POLICY MODE 'AUTOMATIC' FOR SERVICE 'east'. CONTINUING.
REVERT POLICY: MAINTENANCE => AUTOMATIC
FAILOVER TO 'west@global' WAS SUCCESSFUL
[LOGICAL] /global > ls

COORDINATOR[db4:AUTOMATIC:ONLINE]

DATASOURCES:
+----------------------------------------------------------------------------+
|east(composite master:SHUNNED(MANUAL-FAILOVER))                             |
|STATUS [SHUNNED] [2015/04/14 02:13:18 AM UTC]                               |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|west(composite master:ONLINE)                                               |
|STATUS [OK] [2015/04/14 02:13:23 AM UTC]                                    |
+----------------------------------------------------------------------------+
```

Composite Active Dataservice (Primary) - `west`

```
[LOGICAL] /global > use west
[LOGICAL] /west > ls

COORDINATOR[db4:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@db4[9757](ONLINE, created=0, active=0)             |
|connector@db5[9781](ONLINE, created=0, active=0)             |
|connector@db6[9944](ONLINE, created=0, active=0)             |
```

```
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|db4(master:ONLINE, progress=7, THL latency=0.110)                           |
|STATUS [OK] [2015/04/14 02:13:23 AM UTC]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=master, state=ONLINE)                                     |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|db5(slave:ONLINE, progress=7, latency=0.172)                                |
|STATUS [OK] [2015/04/14 02:13:23 AM UTC]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=db4, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|db6(slave:ONLINE, progress=7, latency=0.173)                                |
|STATUS [OK] [2015/04/14 02:13:23 AM UTC]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=db4, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+
```

6.7.3. Composite Cluster Site Recovery

The first step in recovering the SHUNNED dataservice is to re-provision the nodes if the data has gotten out of sync. See Section 6.6.1.1, “Provision or Reprovision a Replica” for more information.

Once the failed site has been restored, the shunned/superseded dataservice can be brought back online using cctrl . The recover command performs this operation, annotating the progress.

```
shell> cctrl -multi
Tungsten Cluster 5.4.1 build 41
west: session established
[LOGICAL] / > use global
[LOGICAL] /global > ls

COORDINATOR[db4:AUTOMATIC:ONLINE]

DATASOURCES:
+----------------------------------------------------------------------------+
|east(composite master:SHUNNED(SUPERSEDED))                                  |
|STATUS [SHUNNED] [2015/04/14 02:28:53 AM UTC]                               |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|west(composite master:ONLINE)                                               |
|STATUS [OK] [2015/04/14 02:13:23 AM UTC]                                    |
+----------------------------------------------------------------------------+
```

SHUNNED(SUPERSEDED) Composite Active Dataservice - `east`

```
[LOGICAL] / > use east
[LOGICAL] /east > ls

COORDINATOR[db2:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@db1[10051](ONLINE, created=0, active=0)             |
|connector@db2[16111](ONLINE, created=0, active=0)             |
|connector@db3[16036](ONLINE, created=0, active=0)             |
|connector@db4[9757](ONLINE, created=1, active=0)              |
|connector@db5[9781](ONLINE, created=1, active=0)              |
|connector@db6[9944](ONLINE, created=1, active=0)              |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|db1(master:SHUNNED(SUPERSEDED), progress=7, THL latency=0.934)              |
|STATUS [SHUNNED] [2015/04/14 02:28:53 AM UTC]                               |
```

```
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=master, state=ONLINE)                                     |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=3, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|db2(slave:SHUNNED(SUPERSEDED), progress=7, latency=6.488)                   |
|STATUS [SHUNNED] [2015/04/14 02:28:53 AM UTC]                               |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|db3(slave:SHUNNED(SUPERSEDED), progress=7, latency=11.164)                  |
|STATUS [SHUNNED] [2015/04/14 02:28:53 AM UTC]                               |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+
```

Use the recover to bring the SHUNNED dataservice back online as a composite Replica:

```
[LOGICAL] /global > recover
IDENTIFIED DATASOURCE 'east@global' FOR RECOVERY
COULD NOT IDENTIFY ACTIVE PRIMARY FOR SERVICE 'east'
ATTEMPTING TO IDENTIFY A FAILED PRIMARY FOR 'east'
PHYSICAL DATA SERVICE 'east' DOES NOT HAVE AN ACTIVE RELAY
FORCING THE PHYSICAL RELAY TO BE 'db1'
DATASOURCE 'db1@east' IS NOW A RELAY
RECOVERED 2 DATA SOURCES IN SERVICE 'east'
composite data source 'east@global' role is now SLAVE
composite data source 'east' is now OFFLINE
REVERT SET POLICY AUTOMATIC
RECOVERY OF COMPOSITE SERVICE 'global' IS COMPLETE

[LOGICAL] /global > ls

COORDINATOR[db2:AUTOMATIC:ONLINE]

DATASOURCES:
+----------------------------------------------------------------------------+
|east(composite slave:ONLINE)                                                |
|STATUS [OK] [2015/04/14 04:12:01 AM UTC]                                    |
+----------------------------------------------------------------------------+

+----------------------------------------------------------------------------+
|west(composite master:ONLINE)                                               |
|STATUS [OK] [2015/04/14 02:28:53 AM UTC]                                    |
+----------------------------------------------------------------------------+
```

Recovered Composite Passive Dataservice (DR) - **east**

```
[LOGICAL] /global > use east
[LOGICAL] /east > ls

COORDINATOR[db2:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@db1.vagrant-erics[10051](ONLINE, created=0, active=0)             |
|connector@db2.vagrant-erics[16111](ONLINE, created=0, active=0)             |
|connector@db3.vagrant-erics[16036](ONLINE, created=0, active=0)             |
|connector@db4.vagrant-erics[9757](ONLINE, created=1, active=0)              |
|connector@db5.vagrant-erics[9781](ONLINE, created=1, active=0)              |
|connector@db6.vagrant-erics[9944](ONLINE, created=1, active=0)              |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|db1(relay:ONLINE, progress=7, latency=0.000)                                |
|STATUS [OK] [2015/04/14 04:11:52 AM UTC]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=relay, master=db4, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=3, active=0)                                          |
```

```
+---------------------------------------------------------------------------+

+---------------------------------------------------------------------------+
|db2(slave:ONLINE, progress=7, latency=6.000)                               |
|STATUS [OK] [2015/04/14 04:11:56 AM UTC]                                   |
+---------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                         |
|  DATASERVER(state=ONLINE)                                                 |
|  CONNECTIONS(created=0, active=0)                                         |
+---------------------------------------------------------------------------+

+---------------------------------------------------------------------------+
|db3(slave:ONLINE, progress=7, latency=11.000)                              |
|STATUS [OK] [2015/04/14 04:12:01 AM UTC]                                   |
+---------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                    |
|  REPLICATOR(role=slave, master=db1, state=ONLINE)                         |
|  DATASERVER(state=ONLINE)                                                 |
|  CONNECTIONS(created=0, active=0)                                         |
+---------------------------------------------------------------------------+
```

6.7.4. Composite Cluster Relay Recovery

If the Relay node in a Composite cluster should ever point to the incorrect Primary node, you can perform the following procedure to re-point the replicator to the desired Primary node.

For example, say we have a composite cluster `global`, with nodes db1, db2 and db3 in `east` and db4, db5 and db6 in `west`. db1 is the Primary and db4 is the Relay.

In the output below, the Relay node db4 shows that its replicator is using db2 as the Primary instead of db1:

```
+---------------------------------------------------------------------------+
|db4(relay:ONLINE, progress=2034642966, latency=2.456) |
|STATUS [OK] [2017/03/20 05:57:49 AM GMT+00:00] |
+---------------------------------------------------------------------------+
| MANAGER(state=ONLINE) |
| REPLICATOR(role=relay, master=db2, state=ONLINE) |
| DATASERVER(state=ONLINE) |
| CONNECTIONS(created=8108, active=0) |
+---------------------------------------------------------------------------+
```

Use the cctrl replicator command to adjust the relay source:

```
shell> cctrl -multi
Tungsten Cluster 5.4.1 build 41
west: session established
[LOGICAL] / > use west
[LOGICAL] /west > set policy maintenance
[LOGICAL] /west > replicator db4 offline
[LOGICAL] /west > replicator db4 relay east/db1
[LOGICAL] /west > set policy automatic
[LOGICAL] /west > ls
+---------------------------------------------------------------------------+
|db4(relay:ONLINE, progress=2034642966, latency=2.456) |
|STATUS [OK] [2017/03/20 05:57:49 AM GMT+00:00] |
+---------------------------------------------------------------------------+
| MANAGER(state=ONLINE) |
| REPLICATOR(role=relay, master=db1, state=ONLINE) |
| DATASERVER(state=ONLINE) |
| CONNECTIONS(created=8108, active=0) |
+---------------------------------------------------------------------------+
```

6.8. Managing Transaction Failures

Inconsistencies between a Primary and Replica dataserver can occur for a number of reasons, including:

- An update or insertion has occurred on the Replica independently of the Primary. This situation can occur if updates are allowed on a Replica that is acting as a read-only Replica for scale out, or in the event of running management or administration scripts on the Replica
- A switch or failover operation has lead to inconsistencies. This can happen if client applications are still writing to the Replica or Primary at the point of the switch.
- A database failure causes a database or table to become corrupted.

When a failure to apply transactions occurs, the problem must be resolved, either by skipping or ignoring the transaction, or fixing and updating the underlying database so that the transaction can be applied.

When a failure occurs, replication is stopped immediately at the first transaction that caused the problem, but it may not be the only transaction and this may require extensive examination of the pending transactions to determine what caused the original database failure and then to fix and address the error and restart replication.

6.8.1. Identifying a Transaction Mismatch

When a mismatch occurs, the replicator service will indicate that there was a problem applying a transaction on the Replica. The replication process stops applying changes to the Replica when the first transaction fails to be applied to the Replica. This prevents multiple-statements from failing

Within cctrl the status of the datasource will be marked as DIMINISHED [171], and the replicator state as SUSPECT:

```
LOGICAL] /alpha > ls

COORDINATOR[host3:AUTOMATIC:ONLINE]
...
+----------------------------------------------------------------------------+
|host2(slave:ONLINE, progress=-1, latency=-1.000)                            |
|STATUS [DIMINISHED] [2013/06/26 10:14:12 AM BST]                            |
|REASON[FAILED TO RECOVER REPLICATOR 'host2']                                |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=slave, master=host1, state=SUSPECT)                       |
|  DATASERVER(state=ONLINE)                                                  |
|  CONNECTIONS(created=0, active=0)                                          |
+----------------------------------------------------------------------------+
...
```

More detailed information about the status and the statement that failed can be obtained within cctrl using the replicator command:

```
[LOGICAL] /alpha > replicator host2 status
+----------------------------------------------------------------------------+
|replicator host2 status                                                     |
+----------------------------------------------------------------------------+
|            appliedLastEventId:    NONE                                     |
|              appliedLastSeqno:    -1                                       |
|                appliedLatency:    -1.0                                     |
|                      channels:    -1                                       |
|                   clusterName:    firstcluster                             |
|               currentEventId:    NONE                                     |
|             currentTimeMillis:    1372238640236                            |
|                dataServerHost:    host2                                    |
|                    extensions:                                             |
|             latestEpochNumber:    -1                                       |
|              masterConnectUri:    thl://host1/                             |
|               masterListenUri:    thl://host2:2112/                        |
|            maximumStoredSeqNo:    -1                                       |
|            minimumStoredSeqNo:    -1                                       |
|               offlineRequests:    NONE                                     |
|pendingError:    Event application failed: seqno=120 fragno=0               |
|message=java.sql.SQLException: Statement failed on slave but succeeded on   |
|master                                                                      |
|              pendingErrorCode:    NONE                                     |
|           pendingErrorEventId:    mysql-bin.000012:0000000000012967;0      |
|             pendingErrorSeqno:    120                                      |
|pendingExceptionMessage:    java.sql.SQLException: Statement failed on      |
|slave but succeeded on master                                               |
|insert into messages values (0,'Trial message','Jack','Jill',now())         |
|                pipelineSource:    UNKNOWN                                  |
|              relativeLatency:    -1.0                                     |
|            resourcePrecedence:    99                                       |
|                        rmiPort:    10000                                    |
|                           role:    slave                                    |
|                     seqnoType:    java.lang.Long                           |
|                   serviceName:    firstcluster                             |
|                   serviceType:    unknown                                  |
|             simpleServiceName:    firstcluster                             |
|                      siteName:    default                                  |
|                      sourceId:    host2                                    |
|                         state:    OFFLINE:ERROR                            |
|            timeInStateSeconds:    587.806                                  |
|               transitioningTo:                                             |
|                 uptimeSeconds:    61371.957                                |
|                       version:    Continuent Tungsten 5.4.1 build 41       |
+----------------------------------------------------------------------------+
```

The trepsvc.log log file will also contain the error information about the failed statement. For example:

```
...
INFO   | jvm 1    | 2013/06/26 10:14:12 | 2013-06-26 10:14:12,423 [firstcluster -
```

```
    q-to-dbms-0] INFO  pipeline.SingleThreadStageTask Performing emergency
    rollback of applied changes
INFO   | jvm 1    | 2013/06/26 10:14:12 | 2013-06-26 10:14:12,424 [firstcluster -
    q-to-dbms-0] INFO  pipeline.SingleThreadStageTask Dispatching error event:
    Event application failed: seqno=120 fragno=0 message=java.sql.SQLException:
    Statement failed on slave but succeeded on master
INFO   | jvm 1    | 2013/06/26 10:14:12 | 2013-06-26 10:14:12,424 [firstcluster -
    pool-2-thread-1] ERROR management.OpenReplicatorManager Received error notification,
    shutting down services :
INFO   | jvm 1    | 2013/06/26 10:14:12 | Event application failed: seqno=120 fragno=0
    message=java.sql.SQLException: Statement failed on slave but succeeded on master
INFO   | jvm 1    | 2013/06/26 10:14:12 | insert into messages values (0,'Trial message',
    'Jack','Jill',now())
INFO   | jvm 1    | 2013/06/26 10:14:12 | com.continuent.tungsten.replicator.applier.ApplierException:
    java.sql.SQLException: Statement failed on slave but succeeded on master
...
```

Once the error or problem has been found, the exact nature of the error should be determined so that a resolution can be identified:

1. Identify the reason for the failure by examining the full error message. Common causes are:

   - Duplicate primary key

     A row or statement is being inserted or updated that already has the same insert ID or would generate the same insert ID for tables that have auto increment enabled. The insert ID can be identified from the output of the transaction using thl. Check the Replica to identify the faulty row. To correct this problem you will either need to skip the transaction or delete the offending row from the Replica dataserver.

     The error will normally be identified due to the following error message when viewing the current replicator status, for example:

     ```
     [LOGICAL] /alpha > replicator host3 status
     ...
     pendingError           : Event application failed: seqno=10 fragno=0 »
         message=java.sql.SQLException: Statement failed on slave but succeeded on master
     pendingErrorCode       : NONE
     pendingErrorEventId    : mysql-bin.000032:0000000000001872;0
     pendingErrorSeqno      : 10
     pendingExceptionMessage: java.sql.SQLException: Statement failed on slave but succeeded on master
                              insert into myent values (0,'Test Message')
     ...
     ```

     The error can be generated when an insert or update has taken place on the Replica rather than on the Primary.

     To resolve this issue, check the full THL for the statement that failed. The information is provided in the error message, but full examination of the THL can help with identification of the full issue. For example, to view the THL for the sequence number:

     ```
     shell> thl list -seqno 10
     SEQ# = 10 / FRAG# = 0 (last frag)
     - TIME = 2014-01-09 16:47:40.0
     - EPOCH# = 1
     - EVENTID = mysql-bin.000032:0000000000001872;0
     - SOURCEID = host1
     - METADATA = [mysql_server_id=1;dbms_type=mysql;service=firstcluster;shard=test]
     - TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
     - SQL(0) = SET INSERT_ID = 2
     - OPTIONS = [##charset = UTF-8, autocommit = 1, sql_auto_is_null = 0, foreign_key_checks = 1, »
         unique_checks = 1, sql_mode = '', character_set_client = 33, collation_connection = 33, »
         collation_server = 8]
     - SCHEMA = test
     - SQL(1) = insert into myent values (0,'Test Message')
     ```

     In this example, an `INSERT` operation is inserting a new row. The generated insert ID is also shown [in line 9, `SQL(0))...` Check the destination database and determine the what the current value of the corresponding row:

     ```
     mysql> select * from myent where id = 2;
     +----+---------------+
     | id | msg           |
     +----+---------------+
     |  2 | Other Message |
     +----+---------------+
     1 row in set (0.00 sec)
     ```

     The actual row values are different, which means that either value may be correct. In complex data structures, there may be multiple statements or rows that trigger this error if following data also relies on this value.

     For example, if multiple rows have been inserted on the Replica, multiple transactions may be affected. In this scenario, checking multiple sequence numbers from the THL will highlight this information.

   - Missing table or schema

If a table or database is missing, this should be reported in the detailed error message. For example:

```
Caused by: java.sql.SQLSyntaxErrorException: Unable to switch to database »
    'contacts'Error was: Unknown database 'contacts'
```

This error can be caused when maintenance has occurred, a table has failed to be initialized properly, or the

- Incompatible table or schema

  A modified table structure on the Replica can cause application of the transaction to fail if there are missing or different column specifications for the table data.

  This particular error can be generated when changes to the table definition have been made, perhaps during a maintenance window.

  Check the table definition on the Primary and Replica and ensure they match.

2. Choose a resolution method:

   Depending on the data structure and environment, resolution can take one of the following forms:

   - Skip the transaction on the Replica

     If the data on the Replica is considered correct, or the data in both tables is the same or similar, the transaction from the Primary to the Replica can be skipped. This process involves placing the replicator online and specifying one or more transactions to be skipped or ignored. At the end of this process, the replicator should be in the `ONLINE` state.

     For more information on skipping single or multiple transactions, see Section 6.8.2, “Skipping Transactions”.

   - Delete the offending row or rows on the Replica

     If the data on the Primary is considered canonical, then the data on the Replica can be removed, and the replicator placed online.

     > **Warning**
     >
     > Deleting data on the Replica may cause additional problems if the data is used by other areas of your application, relations to foreign tables.

     For example:

     ```
     mysql> delete from myent where id = 2;
     Query OK, 1 row affected (0.01 sec)
     ```

     Now place the replicator online and check the status:

     ```
     [LOGICAL] /alpha > replicator host3 online
     ```

   - Restore or reprovision the Replica

     If the transaction cannot be skipped, or the data safely deleted or modified, and only a single Replica is affected, a backup of an existing, working, Replica can be taken and restored to the broken Replica.

     The tungsten_provision_slave command automates this process. See Section 6.6.1.1, “Provision or Reprovision a Replica” for more information on reprovisioning.

     To perform a backup and restore, see Section 6.9, “Creating a Backup”, or Section 6.10, “Restoring a Backup”. To reprovision a Replica from the Primary or another Replica, see tungsten_provision_slave.

6.8.2. Skipping Transactions

When a failure caused by a mismatch or failure to apply one or more transactions, the transaction(s) can be skipped. Transactions can either be skipped one at a time, through a specific range, or a list of single and range specifications.

> **Warning**
>
> Skipping over events can easily lead to Replica inconsistencies and later replication errors. Care should be taken to ensure that the transaction(s) can be safely skipped without causing problems. See Section 6.8.1, “Identifying a Transaction Mismatch”.

- Skipping a Single Transaction

  If the error was caused by only a single statement or transaction, the transaction can be skipped using trepctl online:

```
shell> trepctl online -skip-seqno 10
```

The individual transaction will be skipped, and the next transaction (11), will be applied to the destination database.

- Skipping a Transaction Range

  If there is a range of statements that need to be skipped, specify a range by defining the lower and upper limits:

```
shell> trepctl online -skip-seqno 10-20
```

  This skips all of the transaction within the specified range, and then applies the next transaction (21) to the destination database.

- Skipping Multiple Transactions

  If there are transactions mixed in with others that need to be skipped, the specification can include single transactions and ranges by separating each element with a comma:

```
shell> trepctl online -skip-seqno 10,12-14,16,19-20
```

  In this example, only the transactions 11, 15, 17 and 18 would be applied to the target database. Replication would then continue from transaction 21.

Regardless of the method used to skip single or multiple transactions, the status of the replicator should be checked to ensure that replication is online.

6.9. Creating a Backup

The datasource backup command for a datasource within cctrl backs up a datasource using the default backup tool. During installation, xtrabackup-full will be used if xtrabackup has been installed. Otherwise, the default backup tool used is mysqldump .

> **Important**
>
> For consistency, all backups should include a copy of all `tungsten_SERVICE` schemas. This ensures that when the Tungsten Replicator service is restarted, the correct start points for restarting replication are recorded with the corresponding backup data. Failure to include the `tungsten_SERVICE` schemas may prevent replication from being restart effectively.

Backing up a datasource can occur while the replicator is online:

```
[LOGICAL:EXPERT] /alpha > datasource host3 backup
Using the 'mysqldump' backup agent.
Replicator 'host3' starting backup
Backup of dataSource 'host3' succeeded; uri=storage://file-system/store-0000000001.properties
```

By default the backup is created on the local filesystem of the host that is backed up in the `backups` directory of the installation directory. For example, using the standard installation, the directory would be `/opt/continuent/backups` . An example of the directory content is shown below:

```
total 130788
drwxrwxr-x 2 tungsten tungsten      4096 Apr  4 16:09 .
drwxrwxr-x 3 tungsten tungsten      4096 Apr  4 11:51 ..
-rw-r--r-- 1 tungsten tungsten        71 Apr  4 16:09 storage.index
-rw-r--r-- 1 tungsten tungsten 133907646 Apr  4 16:09 store-0000000001-mysqldump_2013-04-04_16-08_42.sql.gz
-rw-r--r-- 1 tungsten tungsten       317 Apr  4 16:09 store-0000000001.properties
```

For information on managing backup files within your environment, see Section D.1.1, “The `backups` Directory” .

The `storage.index` contains the backup file index information. The actual backup data is stored in the GZipped file. The properties of the backup file, including the tool used to create the backup, and the checksum information, are location in the corresponding `.properties` file. Note that each backup and property file is uniquely numbered so that it can be identified when restoring a specific backup.

A backup can also be initiated and run in the background by adding the & (ampersand) to the command:

```
[LOGICAL:EXPERT] /alpha > datasource host3 backup &
[1] datasource host3 backup - RUNNING

YOU MUST BE USING A DATA SERVICE TO EXECUTE THIS COMMAND
EXECUTE 'use <data service name>' TO SET YOUR CONTEXT.

[1] datasource host3 backup - SUCCESS
```

6.9.1. Using a Different Backup Tool

If xtrabackup is installed when the dataservice is first created, xtrabackup will be used as the default backup method. Four built-in backup methods are provided:

- mysqldump — SQL dump to a single file. This is the easiest backup method but it is not appropriate for large data sets.
- xtrabackup — Full backup to a single tar file. This will take longer to take the backup and to restore.
- xtrabackup-full — Full backup to a directory (this is the default if xtrabackup is available and the backup method is not explicitly stated).
- xtrabackup-incremental — Incremental backup from the last xtrabackup-full or xtrabackup-incremental backup.

The default backup tool can be changed, and different tools can be used explicitly when the backup command is executed. The Percona xtrabackup tool can be used to perform both full and incremental backups. Use of the this tool is optional and can configured during installation, or afterwards by updating the configuration using tpm .

To update the configuration to use xtrabackup , install the tool and then follow the directions for tpm update to apply the `--repl-backup-method=xtrabackup-full` [434] setting.

To use xtrabackup-full without changing the configuration, specify the backup agent to the datasource backup command within cctrl :

```
[LOGICAL:EXPERT] /alpha > datasource host2 backup xtrabackup-full
Replicator 'host2' starting backup
Backup of dataSource 'host2' succeeded; uri=storage://file-system/store-0000000006.properties
```

6.9.2. Automating Backups

Backups cannot be automated within Tungsten Cluster, instead a cron job should be used to automate the backup process. cluster_backup is packaged with Tungsten Cluster to provide a convenient interface with cron. The cron entry should be added to every datasource or active witness in the cluster. The command includes logic to ensure that it will only take one backup per cluster by only running on the current coordinator. See Section 9.8, “The cluster_backup Command” for more information.

```
shell> /opt/continuent/tungsten/cluster-home/bin/cluster_backup -v >> »
/opt/continuent/service_logs/cluster_backup.log
```

The command output will be appended to `/opt/continuent/service_logs/cluster_backup.log` for later review. Use your preferred mechanism to configure cron to execute this command on the desired schedule.

An example cron entry:

```
shell> crontab -l
00 00 * * * /opt/continuent/tungsten/cluster-home/bin/cluster_backup >> /opt/continuent/service_logs/cluster_backup.log 2>&1
```

All output will be appended to `/opt/continuent/service_logs/cluster_backup.log`.

Alternatively, you can call the backup command directly through cctrl. This method does not ensure the named datasource is `ONLINE` or even available to be backed up.

```
shell> echo "datasource host2 backup" | /opt/continuent/tungsten/tungsten-manager/bin/cctrl -expert
```

6.9.3. Using a Different Directory Location

The default backup location the `backups` directory of the Tungsten Cluster installation directory. For example, using the recommended installation location, backups are stored in `/opt/continuent/backups` .

See Section D.1.1.4, “Relocating Backup Storage” for details on changing the location where backups are stored.

6.9.4. Creating an External Backup

There are several considerations to take into account when you are using a tool other than Tungsten Cluster to take a backup. We have taken great care to build all of these into our tools. If the options provided do not meet your needs, take these factors into account when taking your own backup.

- How big is your data set?

  The mysqldump tool is easy to use but will be very slow once your data gets too large. We find this happens around 1GB. The xtrabackup tool works on large data sets but requires more expertise. Choose a backup mechanism that is right for your data set.

- Is all of your data in transaction-safe tables?

  If all of your data is transaction-safe then you will not need to do anything special. If not then you need to take care to lock tables as part of the backup. Both mysqldump and xtrabackup take care of this. If you are using other mechanisms you will need to look at stopping the replicator, stopping the database. If you are taking a backup of the Primary then you may need to stop all access to the database.

- Are you taking a backup of the Primary?

The Tungsten Replicator stores information in a schema to indicate the restart position for replication. On the Primary there can be a slight lag between this position and the actual position of the Primary. This is because the database must write the logs to disk before Tungsten Replicator can read them and update the current position in the schema.

When taking a backup from the Primary, you must track the actual binary log position of the Primary and start replication from that point after restoring it. See Section 6.10.2, "Restoring an External Backup" for more details on how to do that. When using mysqldump use the `--master-data=2` option. The xtrabackup tool will print the binary log position in the command output.

Using mysqldump can be a very simple way to take consistent backup. Be aware that it can cause locking on MyISAM tables so running it against your Primary will cause application delays. The example below shows the bare minimum for arguments you should provide:

```
shell> mysqldump --opt --single-transaction --all-databases --add-drop-database --master-data=2
```

6.10. Restoring a Backup

If a restore is being performed as part of the recovery procedure, consider using the tungsten_provision_slave tool. This will work for restoring from the Primary or a Replica and is faster when you do not already have a backup ready to be restored. For more information, see Section 6.6.1.1, "Provision or Reprovision a Replica".

To restore a backup, use the restore command to a datasource within cctrl :

1. Shun the datasource to be restored, and put the replicator service offline using cctrl :

   ```
   [LOGICAL] /alpha > datasource host2 shun
   [LOGICAL] /alpha > replicator host2 offline
   ```

2. Restore the backup using cctrl :

   ```
   [LOGICAL] /alpha > datasource host2 restore
   ```

By default, the restore process takes the latest backup available for the host being restored. Tungsten Cluster *does not* automatically locate the latest backup within the dataservice across all datasources.

Restoring within Multi-Active environments

The steps above cover a basic restore process in a single cluster, however, if the topology in use is a Multi-Active Topology, a few additional steps need to be taken

Multi-Site/Active-Active: Prior to issuing the restore command, the additional sub-services and cross-site replicators need to be stopped, using the following examples as a guide:

```
host2-shell> trepctl -all-services offline
host2-shell> mm_trepctl offline
```

After restoring the database, explicitly restart the cross site replicator:

```
host2-shell> mm_trepctl online
```

6.10.1. Restoring a Specific Backup

To restore a specific backup, specify the location of the corresponding properties file using the format:

```
storage://storage-type/location
```

For example, to restore the backup from the filesystem using the information in the properties file `store-0000000004.properties` , login to the failed host:

1. Shun the datasource to be restored, and put the replicator service offline using cctrl :

   ```
   [LOGICAL] /alpha > datasource host2 shun
   [LOGICAL] /alpha > replicator host2 offline
   ```

2. Restore the backup using cctrl :

   ```
   [LOGICAL] /alpha > datasource host2 restore storage://file-system/store-0000000004.properties
   ```

   The supplied location is identical to that returned when a backup is performed.

6.10.2. Restoring an External Backup

If a backup has been performed outside of Tungsten Cluster, for example from filesystem snapshot or a backup performed outside of the dataservice, follow these steps:

1. Shun the datasource to be restored, and put the replicator service offline using cctrl :

```
[LOGICAL:EXPERT] /alpha > datasource host2 shun
[LOGICAL:EXPERT] /alpha > replicator host2 offline
```

2. Reset the THL, either using thl or by deleting the files directly :

```
shell> thl -service alpha purge
```

3. Restore the data or files using the external tool. This may require the database server to be stopped. If so, you should restart the database server before moving to the next step.

> **Note**
>
> The backup must be complete and the `tungsten` specific schemas must be part of the recovered data, as they are required to restart replication at the correct point. See Section 6.9.4, "Creating an External Backup" for more information on creating backups.

4. There is some additional work if the backup was taken of the Primary server. There may be a difference between the binary log position of the Primary and what is represented in the `trep_commit_seqno`. If these values are the same, you may proceed without further work. If not, the content of `trep_commit_seqno` must be updated.

   - Retrieve the contents of `trep_commit_seqno` :

```
shell> echo "select seqno,source_id, eventid from tungsten_alpha.trep_commit_seqno" | tpm mysql
seqno source_id eventid
32033674 host1 mysql-bin.000032:0000000473860407;-1
```

   - Compare the results to the binary log position of the restored backup. For this example we will assume the backup was taken at `mysql-bin.000032:473863524`. Return to the Primary and find the correct sequence number for that position :

```
shell> ssh host1

shell> thl dsctl -event mysql-bin.000032:0000000473863524
dsctl -service alpha set -reset -seqno 7748 -epoch 0 -event-id "mysql-bin.000032:0000000473863524" -source-id "db1-east.continuent.com"

~OR~

shell> thl list -event mysql-bin.000032:0000000473863524 -headers
SEQ# = 7748 / FRAG# = 0 (last frag)
- FILE = thl.data.0000000010
- TIME = 2014-10-17 16:58:11.0
- EPOCH# = 0
- EVENTID = mysql-bin.000032:0000000473863524;-1
- SOURCEID = db1-east.continuent.com

shell> exit
```

   - Return to the Replica node and run dsctl set to update the `trep_commit_seqno` table :

```
shell> dsctl -service alpha set -reset \
     -seqno 7748 \
     -epoch 0 \
     -source-id db1-east.continuent.com \
     -event-id mysql-bin.000032:0000000473863524
```

5. Recover the datasource using cctrl :

```
[LOGICAL] /alpha > datasource host2 recover
```

   The recover command will start the dataserver if it was left running and then bring the replicator and other operations online.

6.10.3. Restoring from Another Replica

If a restore is being performed as part of the recovery procedure, consider using the tungsten_provision_slave tool. This is will work for restoring from the Primary or a Replica and is faster if you do not already have a backup ready to be restored. For more information, see Section 6.6.1.1, "Provision or Reprovision a Replica".

Data can be restored to a Replica by performing a backup on a different Replica, transferring the backup information to the Replica you want to restore, and then running restore process.

For example, to restore the `host3` from a backup performed on `host2` :

1. Run the backup operation on `host2` :

```
[LOGICAL:EXPERT] /alpha > datasource host2 backup
```

```
Using the 'xtrabackup' backup agent.
Replicator 'host2' starting backup
Backup of dataSource 'host2' succeeded; uri=storage://file-system/store-0000000006.properties
```

2. Copy the backup information from host2 to host3. See Section D.1.1.3, "Copying Backup Files" for more information on copying backup information between hosts. If you are using xtrabackup there will be additional files needed before the next step. The example below uses scp to copy a mysqldump backup:

```
shell> cd /opt/continuent/backups
shell> scp store-[0]*6[\.-]* host3:$PWD/
store-0000000006-mysqldump-812096863445699665.sql                    100%  234MB  18.0MB/s   00:13
store-0000000006.properties                                          100%  314     0.3KB/s   00:00
```

   If you are using xtrabackup:

```
shell> cd /opt/continuent/backups/xtrabackup
shell> rsync -aze ssh full_xtrabackup_2014-08-16_15-44_86 host3:$PWD/
```

3. Shun the datasource to be restored, and put the replicator service offline using cctrl :

```
[LOGICAL] /alpha > datasource host2 shun
  [LOGICAL] /alpha > replicator host2 offline
```

4. Restore the backup using cctrl :

```
[LOGICAL] /alpha > datasource host2 restore
```

   Once the restore operation has completed, the datasource will be placed into the online state.

> **Note**
>
> Check the ownership of files if you have trouble transferring files or restoring the backup. They should be owned by the Tungsten system user to ensure proper operation.

6.10.4. Manually Recovering from Another Replica

In the event that a restore operation fails, or due to a significant failure in the dataserver, an alternative option is to seed the failed dataserver directly from an existing running Replica.

For example, on the host host2 , the data directory for MySQL has been corrupted, and mysqld will no longer start. This status can be seen from examining the MySQL error log in /var/log/mysql/error.log:

```
130520 14:37:08 [Note] Recovering after a crash using /var/log/mysql/mysql-bin
130520 14:37:08 [Note] Starting crash recovery...
130520 14:37:08 [Note] Crash recovery finished.
130520 14:37:08 [Note] Server hostname (bind-address): '0.0.0.0'; port: 13306
130520 14:37:08 [Note]   - '0.0.0.0' resolves to '0.0.0.0';
130520 14:37:08 [Note] Server socket created on IP: '0.0.0.0'.
130520 14:37:08 [ERROR] Fatal error: Can't open and lock privilege tables: Table 'mysql.host' doesn't exist
130520 14:37:08 [ERROR] /usr/sbin/mysqld: File '/var/run/mysqld/mysqld.pid' not found (Errcode: 13)
130520 14:37:08 [ERROR] /usr/sbin/mysqld: Error reading file 'UNKNOWN' (Errcode: 9)
130520 14:37:08 [ERROR] /usr/sbin/mysqld: Error on close of 'UNKNOWN' (Errcode: 9)
```

Performing a restore operation on this Replica may not work. To recover from another running Replica, host3 , the MySQL data files can be copied over to host2 directly using the following steps:

1. Shun the host2 datasource to be restored, and put the replicator service offline using cctrl :

```
[LOGICAL] /alpha > datasource host2 shun
  [LOGICAL] /alpha > replicator host2 offline
```

2. Shun the host3 datasource to be restored, and put the replicator service offline using cctrl :

```
[LOGICAL] /alpha > datasource host3 shun
  [LOGICAL] /alpha > replicator host3 offline
```

3. Stop the mysqld service on host2:

```
shell> sudo /etc/init.d/mysql stop
```

4. Stop the mysqld service on host3:

```
shell> sudo /etc/init.d/mysql stop
```

5. Delete the mysqld data directory on host2 :

```
shell> sudo rm -rf /var/lib/mysql/*
```

6. If necessary, ensure the `tungsten` user can write to the MySQL directory:

```
shell> sudo chmod 777 /var/lib/mysql
```

7. Use rsync on `host3` to send the data files for MySQL to `host2` :

```
shell> rsync -aze ssh /var/lib/mysql/* host2:/var/lib/mysql/
```

You should synchronize all locations that contain data. This includes additional folders such as `innodb_data_home_dir` or `innodb_log_group_home_dir`. Check the `my.cnf` file to ensure you have the correct paths.

Once the files have been copied, the files should be updated to have the correct ownership and permissions so that the Tungsten service can read them.

8. Recover `host3` back to the dataservice:

```
[LOGICAL:EXPERT] /alpha > datasource host3 recover
```

9. Update the ownership and permissions on the data files on `host2`:

```
host2 shell> sudo chown -R mysql:mysql /var/lib/mysql
host2 shell> sudo chmod 770 /var/lib/mysql
```

10. Clear out the THL files on the target node `host2` so the Replica replicator service may start cleanly:

```
host2 shell> thl purge
```

11. Recover `host2` back to the dataservice:

```
[LOGICAL:EXPERT] /alpha > datasource host2 recover
```

The recover command will start MySQL and ensure that the server is accessible before restarting replication. if the MySQL instance does not start; correct any issues and attempt the recover command again.

6.10.5. Reprovision a MySQL Replica using rsync

The steps below will guide you through the process of restoring a MySQL Replica node by using rsync.

The following process has the following caveats:

- You can sustain downtime on the node used as a source.
- You can either ssh between hosts as root, or have root level access to temporarily change file ownership.

Steps

1. Establish `ssh` as root between hosts, or if you can't set up ssh as root, on the target host, `chown` ownership of mysql target directories to tungsten, then run rysnc as command in Step 3 as the tungsten user.
2. On failed host:
   - Shut down mysql if it is still running.
   - Determine all mysql data directories (datadir, binary log dir, etc) e.g. `/var/lib/mysql`
   - Clear out database files from the failed host.

```
shell> rm -rf /var/lib/mysql/*
```

3. On Source host:
   - Within cctrl, shun the node that will used as the source.

```
cctrl> datasource sourcenode shun
```

   - Shut down mysql.
   - Use rsync to copy the datafiles to the target (specify 'z' if CPU available for compression)

```
sourcehost> rsync -avz --progress /source/dir/ targetHost:/target/dir/
```

4. Wait for the rsync to complete.
5. On Source host:

- Restart mysql.
- Bring the replicator online.

```
shell> trepctl online
```

- Wait for replication to catch up, then use cctrl to recover the node.

```
cctrl> datasource sourcenode recover
```

6. On restored, target, host:
   - Fix the ownership on ALL data directories, e.g.

```
shell> chown -R mysql: /var/lib/mysql
```

   - Start mysql.
   - Bring the replicator online.

```
shell> trepctl online
```

   - Wait for replication to catch up, then use cctrl to recover the node

```
cctrl> datasource targetnode recover
```

6.10.6. Rebuilding a Lost Datasource

If a datasource has been lost within the dataservice, for example, a complete hardware failure or disk crash, the datasource can be added back to the cluster once the operating system and other configuration have been completed. Essentially, the process is the same as when initially setting up your node, with the node being re-confirmed as part of the running service, installing and configuring only the returning node to the cluster.

In the following steps, the host `host3` is being recovered into the cluster:

1. Setup the host with the pre-requisites, as described in Appendix B, *Prerequisites* .
2. Restore a snapshot of the data taken from another Replica into the dataserver. If you have existing backups of this Replica or another, they should be used. If not, take a snapshot of an existing Replica and use this to apply the data to the Replica. This will need to be performed outside of the Tungsten Cluster service using the native restore method for the backup method you have chosen. The backup must include the entire schema of your database, including the `tungsten` schemas for your services.
3. The next steps depend on the availability of the hostname. If the hostname of the datasource that was lost can be reused, then the host can be reconfigured within the existing service. If the hostname is not available, the service must be reconfigured to remove the old host, and add the new host.

   Reusing an Existing Hostname

   a. Login in to the server used for staging your Tungsten Cluster installation, and change to the staging directory. To determine the staging directory, use:

```
shell> tpm query staging
```

   b. Repeat the installation of the service on the host being brought back:

```
shell> ./tools/tpm update svc_name --hosts=host3
```

   The update process will re-install Tungsten Cluster on the host specified without reacting to the existence of the `tungsten` schema in the database.

   Removing and Adding a new Host

   a. Remove the existing (lost) datasource from the cluster using cctrl . First switch to administrative mode:

```
[LOGICAL] /alpha > admin
```

   Remove the host from the dataservice:

```
[ADMIN] /alpha > rm host3

WARNING: This is an expert-level command:
Incorrect use may cause data corruption
or make the cluster unavailable.
```

```
Do you want to continue? (y/n)>
```

b. Login in to the server used for staging your Tungsten Cluster installation, and change to the staging directory. To determine the staging directory, use:

```
shell> tpm query staging
```

c. Update the dataservice configuration with the new datasource, the example below uses `host4` as the replacement datasource. The `--dataservice-master-host` [454] should be used to specify the current Primary in the cluster:

```
shell> ./tools/tpm configure svc_name --dataservice-hosts=host1,host2,host4 \
  --dataservice-connectors=host1,host2,host4 \
  --dataservice-master-host=host4
```

d. Update the installation across all the hosts:

```
shell> ./tools/tpm update svc_name
```

4. Use cctrl to check and confirm the operation of the restore datasource.

The restored host should be part of the cluster and accepting events from the Primary as configured.

6.10.7. Resetting an Entire Dataservice from Filesystem Snapshots

To restore an entire dataservice from filesystem snapshots, the steps below should be followed. The same snapshot should be used on each host so that data on each host is the same. The following steps should be followed:

1. Set the dataservice into the *MAINTENANCE* policy mode:

```
[LOGICAL:EXPERT] /alpha > set policy maintenance
```

2. The following steps must be completed on each server before completing the next step:

   a. Stop the Tungsten Cluster services:

```
shell> stopall
```

   b. Stop MySQL:

```
shell> sudo /etc/init.d/mysql stop
```

   c. Replace the MySQL data files with the filesystem or snapshot data.

   d. Delete the THL files for each of the services that need to be reset:

```
shell> rm /opt/continuent/thl/alpha/*
```

   e. Start MySQL to perform maintenance on the Tungsten schemas:

```
shell> sudo /etc/init.d/mysql start
```

   f. Delete any Tungsten service schemas:

```
mysql> DROP DATABASE tungsten_alpha;
```

   Once these steps have been executed on all the servers in the cluster, the services can be restarted.

3. On the current Primary, start the Tungsten Cluster services:

```
shell> startall
```

   Now start the services using the same command on each of the remaining servers.

6.11. Migrating and Seeding Data

6.11.1. Migrating from MySQL Native Replication 'In-Place'

If you are migrating an existing MySQL native replication deployment to use Tungsten Cluster or the standalone Tungsten Replicator the configuration of the must be updated to match the status of the Replica.

1. Deploy Tungsten Cluster using the model or system appropriate according to Chapter 2, *Deployment*. Ensure that the Tungsten Cluster is not started automatically by excluding the `--start` [466] or `--start-and-report` [466] options from the tpm commands.

2. On each Replica

   Confirm that native replication is working on all Replica nodes :

   ```
   shell> echo 'SHOW SLAVE STATUS\G' | tpm mysql | \
   egrep ' Master_Host| Last_Error| Slave_SQL_Running'
                  Master_Host: tr-ssl1
             Slave_SQL_Running: Yes
                    Last_Error:
   ```

3. On the Primary and each Replica

   Reset the Tungsten Replicator position on all servers :

   ```
   shell> replicator start offline
   shell> trepctl -service alpha reset -all -y
   ```

4. On the Primary

   Login and start Tungsten Cluster services and put the Tungsten Replicator online:

   ```
   shell> startall
   shell> trepctl online
   ```

5. On the Primary

   Put the cluster into maintenance mode using cctrl to prevent Tungsten Cluster automatically reconfiguring services:

   ```
   cctrl > set policy maintenance
   ```

6. On each Replica

   Record the current Replica log position (as reported by the `Master_Log_File` and `Exec_Master_Log_Pos` output from `SHOW SLAVE STATUS`. Ideally, each Replica should be stopped at the same position:

   ```
   shell> echo 'SHOW SLAVE STATUS\G' | tpm mysql | \
   egrep ' Master_Host| Last_Error| Master_Log_File| Exec_Master_Log_Pos'
                  Master_Host: tr-ssl1
               Master_Log_File: mysql-bin.000025
                    Last_Error: Error executing row event: 'Table 'tungsten_alpha.heartbeat' doesn't exist'
           Exec_Master_Log_Pos: 181268
   ```

   If you have multiple Replicas configured to read from this Primary, record the Replica position individually for each host. Once you have the information for all the hosts, determine the earliest log file and log position across all the Replicas, as this information will be needed when starting replication. If one of the servers does not show an error, it may be replicating from an intermediate server. If so, you can proceed normally and assume this server stopped at the same position as the host is replicating from.

7. On the Primary

   Take the replicator offline and clear the THL:

   ```
   shell> trepctl offline
   shell> trepctl -service alpha reset -all -y
   ```

8. On the Primary

   Start replication, using the *lowest* binary log file and log position from the Replica information determined previously.

   ```
   shell> trepctl online -from-event 000025:181268
   ```

   Tungsten Replicator will start reading the MySQL binary log from this position, creating the corresponding THL event data.

9. On each Replica

   a. Disable native replication to prevent native replication being accidentally started on the Replica.

      On MySQL 5.0 or MySQL 5.1:

      ```
      shell> echo "STOP SLAVE; CHANGE MASTER TO MASTER_HOST='';" | tpm mysql
      ```

      On MySQL 5.5 or later:

      ```
      shell> echo "STOP SLAVE; RESET SLAVE ALL;" | tpm mysql
      ```

   b. If the final position of MySQL replication matches the lowest across all Replicas, start Tungsten Cluster services :

      ```
      shell> trepctl online
      ```

```
shell> startall
```

The Replica will start reading from the binary log position configured on the Primary.

If the position on this Replica is different, use trepctl online -from-event to set the online position according to the recorded position when native MySQL was disabled. Then start all remaining services with startall.

```
shell> trepctl online -from-event 000025:188249
shell> startall
```

10. Check that replication is operating correctly by using trepctl status on the Primary and each Replica to confirm the correct position.
11. Use cctrl to confirm that replication is operating correctly across the dataservice on all hosts.
12. Put the cluster back into automatic mode:

```
cctrl> set policy automatic
```

13. Update your applications to use the installed connector services rather than a direct connection.
14. Remove the `master.info` file on each Replica to ensure that when a Replica restarts, it does not connect up to the Primary MySQL server again.

Once these steps have been completed, Tungsten Cluster should be operating as the replication service for your MySQL servers. Use the information in Chapter 6, *Operations Guide* to monitor and administer the service.

6.11.2. Migrating from MySQL Native Replication Using a New Service

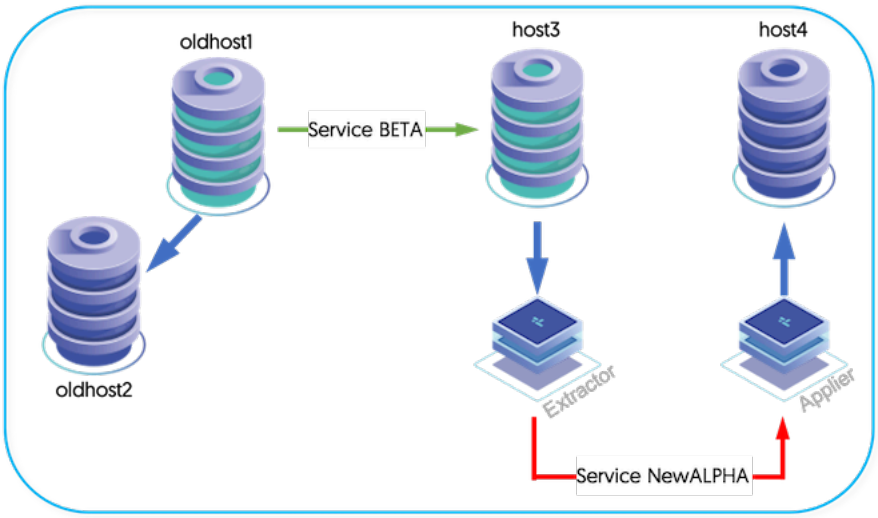
When running an existing MySQL native replication service that needs to be migrated to a Tungsten Cluster service, one solution is to create the new Tungsten Cluster service, synchronize the content, and then install a service that migrates data from the existing native service to the new service while applications are reconfigured to use the new service. The two can then be executed in parallel until applications have been migrated.

The basic structure is shown in Figure 6.1, "Migration: Migrating Native Replication using a New Service". The migration consists of two steps:

- Initializing the new service with the current database state.
- Creating a Tungsten Replicator deployment that continues to replicate data from the native MySQL service to the new service.

Once the application has been switched and is executing against the new service, the secondary replication can be disabled by shutting down the Tungsten Replicator in `/opt/replicator`.

Figure 6.1. Migration: Migrating Native Replication using a New Service



To configure the service:

1. Stop replication on a Replica for the existing native replication installation :

```
mysql> STOP SLAVE;
```

Obtain the current Replica position within the Primary binary log :

```
mysql> SHOW SLAVE STATUS\G
...
                Master_Host: host3
            Master_Log_File: mysql-bin.000002
        Exec_Master_Log_Pos: 559
...
```

2. Create a backup using any method that provides a consistent snapshot. The MySQL Primary may be used if you do not have a Replica to backup from. Be sure to get the binary log position as part of your back. This is included in the output to Xtrabackup or using the `--master-data=2` option with mysqldump.

3. Restart the Replica using native replication :

```
mysql> START SLAVE;
```

4. On the Primary and each Replica within the new service, restore the backup data and start the database service

5. Setup the new Tungsten Cluster deployment using the MySQL servers on which the data has been restored. For clarity, this will be called `newalpha`.

6. Configure a second replication service, `beta` to apply data using the existing MySQL native replication server as the Primary, and the Primary of `newalpha`.

   For more information, see Section 3.6, “Replicating Data Into an Existing Dataservice”.

   Do not start the new service.

7. Set the replication position for `beta` using the dsctl set command to set the position to the point within the binary logs where the backup was taken:

```
shell> /opt/replicator/tungsten/tungsten-replicator/bin/dsctl -service beta set -reset \
    -seqno 0 -epoch 0 \
    -source-id host3 -event-id mysql-bin.000002:559
```

8. Start replicator service `beta`:

```
shell> /opt/replicator/tungsten/tungsten-replicator/bin/replicator start
```

Once replication has been started, use trepctl to check the status and ensure that replication is operating correctly.

The original native MySQL replication Primary can continue to be used for reading and writing from within your application, and changes will be replicated into the new service on the new hardware. Once the applications have been updated to use the new service, the old servers can be decommissioned and replicator service `beta` stopped and removed.

6.12. Resetting a Tungsten Cluster Dataservice

Follow these steps to reset replication for an entire dataservice. The current Primary will remain the Primary. Use the switch after completion to change the Primary.

> **Warning**
>
> The procedures in this section are designed for the Multi-Site/Active-Active topology ONLY. Do NOT use these procedures with the Composite Active/Active topology.
>
> For Composite Active/Active Clustering, please refer to Deploying Composite Active/Active Clustering.

See Section 6.10.7, “Resetting an Entire Dataservice from Filesystem Snapshots” if you would like to restore a file system snapshot to every server as part of this process.

1. Put the dataservice into *`MAINTENANCE`* mode. This ensures that Tungsten Cluster will not attempt to automatically recover the service.

```
cctrl> set policy maintenance
```

2. Enable force mode:

```
cctrl> set force true
```

3. Shun each datasource:

```
cctrl> datasource Primary shun
```

```
cctrl> datasource Replica1 shun
cctrl> datasource Replica2 shun
```

4. Put each Tungsten Connector offline:

```
cctrl> router * offline
```

5. On each datasource, reset the service:

```
shell> trepctl -service east offline
shell> trepctl -service east reset -all -y
```

6. Reconfigure the replicator and datasource configuration on each host, starting with the Primary:

```
cctrl> set force true
cctrl> replicator new-Primary master
cctrl> replicator new-Primary online
cctrl> datasource new-Primary master
cctrl> datasource new-Primary online

cctrl> replicator Replica1 slave new-Primary
cctrl> replicator Replica1 online
cctrl> datasource Replica1 slave
cctrl> datasource Replica1 online

cctrl> replicator Replica2 slave new-Primary
cctrl> replicator Replica2 online
cctrl> datasource Replica2 slave
cctrl> datasource Replica2 online
```

7. The connector can now be re-enabled and the cluster returned to operational state:

```
cctrl> router * online
cctrl> set policy automatic
cctrl> cluster heartbeat
```

Any servers not matching the Primary must be reprovisioned. Use the tungsten_provision_slave tool to reprovision from the Primary or valid Replica server.

6.12.1. Reset a Single Site in a Multi-Site/Active-Active Topology

Warning

The procedures in this section are designed for the Multi-Site/Active-Active topology ONLY. Do NOT use these procedures with version 6.x Composite Active/Active.

For version 6.x Composite Active/Active, please refer to Deploying Composite Active/Active Clustering.

Under certain conditions, dataservices in a Multi-Site/Active-Active configuration may drift and/or become inconsistent with the data in another dataservice. If this occurs, you may need to re-provision the data on one or more of the dataservices after first determining the definitive source of the information.

In the following example the `west` service has been determined to be the definitive copy of the data. To fix the issue, all the datasources in the `east` service will be reprovisioned from one of the datasources in the `west` service.

The following is a guide to the steps that should be followed. In the example procedure it is the *`east`* service that has failed:

1. Put the dataservice into *`MAINTENANCE`* mode. This ensures that Tungsten Cluster will not attempt to automatically recover the service.

```
cctrl [east]> set policy maintenance
```

2. Put the Tungsten Connector for the dataservice offline:

```
cctrl [east]> router * offline
```

3. Stop all services running in `east`:

```
shell east> /opt/continuent/tungsten/cluster-home/bin/stopall
shell east> /opt/replicator/tungsten/cluster-home/bin/stopall
```

4. Disable cross-site replication and reset the replication position:

```
shell west> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service east offline
shell west> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service east reset -all -y
```

5. Reprovision the Primary node in `east`:

```
shell east{Primary}> /opt/continuent/tungsten/tungsten-replicator/scripts/tungsten_provision_slave --source west{Replica}
```

6. Restart the services in `east`:

```
shell east> /opt/continuent/tungsten/cluster-home/bin/startall
shell east> /opt/continuent/tungsten/tungsten-replicator/bin/trepctl online
shell east> /opt/replicator/tungsten/cluster-home/bin/startall
```

7. Ensure that the new service is functioning normally:

```
shell east> echo ls | /opt/continuent/tungsten/tungsten-manager/bin/cctrl
shell east> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl status
```

8. Bring the remote replicators back ONLINE

```
shell west> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service east online
```

Set the cluster to normal operational state:

```
cctrl> router * online
cctrl> set policy automatic
```

9. Reprovision the remaining nodes in the `east` cluster

```
shell east{Replica1}> /opt/continuent/tungsten/tungsten-replicator/scripts/tungsten_provision_slave \
    --source east{Primary}
shell east{Replica1}> /opt/continuent/tungsten/cluster-home/bin/startall
shell east{Replica1}> /opt/replicator/tungsten/cluster-home/bin/startall

shell east{Replica2}> /opt/continuent/tungsten/tungsten-replicator/scripts/tungsten_provision_slave \
    --source east{Replica1}
shell east{Replica2}> /opt/continuent/tungsten/cluster-home/bin/startall
shell east{Replica2}> /opt/replicator/tungsten/cluster-home/bin/startall
```

6.12.2. Reset All Sites in a Multi-Site/Active-Active topology

Warning

The procedures in this section are designed for the Multi-Site/Active-Active topology ONLY. Do NOT use these procedures with the Composite Active/Active topology.

For Composite Active/Active Clustering, please refer to Deploying Composite Active/Active Clustering.

To reset all of the dataservices and restart the Tungsten Cluster and Tungsten Replicator services:

1. Put the both dataservices into *`MAINTENANCE`* mode. This ensures that Tungsten Cluster will not attempt to automatically recover the service.

```
cctrl [east]> set policy maintenance
```

```
cctrl [west]> set policy maintenance
```

2. Put the Tungsten Connector for both dataservices offline:

```
cctrl [east]> router * offline
```

```
cctrl [west]> router * offline
```

3. Stop the services on each server in the east region (`east{1,2,3}`):

```
shell east> /opt/continuent/tungsten/cluster-home/bin/stopall
shell east> /opt/replicator/tungsten/cluster-home/bin/stopall
```

4. Stop the services on each server in the west region (`west{1,2,3}`):

```
shell west> /opt/continuent/tungsten/cluster-home/bin/stopall
shell west> /opt/replicator/tungsten/cluster-home/bin/stopall
```

5. Reset the cluster on `east{1,2,3}`:

```
shell east> /opt/continuent/tungsten/tools/tpm reset
shell east> /opt/replicator/tungsten/tools/tpm reset
```

6. Reset the cluster on `west{1,2,3}`:

```
shell west> /opt/continuent/tungsten/tools/tpm reset
shell west> /opt/replicator/tungsten/tools/tpm reset
```

7. Reset the replication services on `east{1,2,3}`:

```
shell east> /opt/continuent/tungsten/tungsten-replicator/bin/replicator start offline
shell east> /opt/continuent/tungsten/tungsten-replicator/bin/trepctl -service east reset -all -y
shell east> /opt/replicator/tungsten/tungsten-replicator/bin/replicator start offline
shell east> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service west reset -all -y
```

8. Reset the replication services on `west{1,2,3}`:

```
shell west> /opt/continuent/tungsten/tungsten-replicator/bin/replicator start offline
shell west> /opt/continuent/tungsten/tungsten-replicator/bin/trepctl -service west reset -all -y
shell east> /opt/replicator/tungsten/tungsten-replicator/bin/replicator start offline
shell east> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service east reset -all -y
```

9. Restart the services on each server in the east region (`east{1,2,3}`):

```
shell east> /opt/continuent/tungsten/cluster-home/bin/startall
```

10. Restart the services on each server in the west region (`west{1,2,3}`):

```
shell west> /opt/continuent/tungsten/cluster-home/bin/startall
```

11. Place all the Tungsten Replicator services on `east{1,2,3}` back online:

```
shell east> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service west online
```

12. Place all the Tungsten Replicator services on `west{1,2,3}` back online:

```
shell west> /opt/replicator/tungsten/tungsten-replicator/bin/trepctl -service east online
```

6.13. Replicator Fencing

Tungsten Cluster can be configured to handle failures during replication automatically and to fence the failure so that the issues do not lead to issues with the rest of the cluster, which may lead to problems with applications operating against the cluster. By default, the cluster is designed to take no specific action aside from indicating and registering the replicator so that the node will be identified as being within the `DIMINISHED` [171] or `CRITICAL` state.

This behavior can be changed so that the failed replicator failure is fenced, with configuration operating on either the Primary, or Replica replicators. When fencing has been enabled, the node will be placed into either the `OFFLINE` state if the node is a Replica or a failover will occur if the node is a Primary.

6.13.1. Fencing a Replica Node Due to a Replication Fault

If the replicator should be placed into the `OFFLINE` state when replicator stops or raises an error, the following option can be set through tpm on the cluster configuration to set the *`policy.fence.slaveReplicator`* to true:

```
shell> tpm update alpha --property=policy.fence.slaveReplicator=true
```

The delay before the fencing operation takes place can be configured using the *`policy.fence.slaveReplicator.threshold`* parameter, which configures the delay before taking action, with the value multiplied by 10. For example, a setting of 6 implies a delay of 60 seconds. The delay enables transient errors, such as network failures, to be effectively managed without automatically fencing the Replica.

```
shell> tpm update alpha --property=policy.fence.slaveReplicator.threshold=6
```

Once a Replica has been fenced, the state will automatically be cleared when the replicator returns to the `ONLINE` state. Once this has been identified, the node will be placed in the `ONLINE` state.

6.13.2. Fencing Primary Replicators

In the event of a Primary replicator failure, the fencing operation places the datasource into the `FAILED` state, triggering an automatic failover (see Section 6.5.1, “Automatic Primary Failover”. Because this triggers a failover in the event of fencing the replicator, the configuration should only be enabled if it critical for your business that replication errors/stops should trigger a significant operation as failover.

To enable fencing of the Primary node due to replication faults, use the *`policy.fence.MasterReplicator`* configuration property when configuring the cluster:

```
shell> tpm update alpha --property=policy.fence.MasterReplicator=true
```

The delay before the fencing operation takes place can be configured using the *`policy.fence.MasterReplicator.threshold`* property. The default value is 3, or 30 seconds.

```
shell> tpm update alpha --property=policy.fence.MasterReplicator.threshold=6
```

When the replicator is identified as available, the Primary datasource is not placed back into the online state. Instead, the failed datasource and must be explicitly recovered using the recover or datasource host recover commands.

6.14. Performing Database or OS Maintenance

When performing database or operating system maintenance, datasources should be temporarily removed from the dataservice and the replicator should be disabled. Follow these rules for the best results. Detailed steps are provided below for different scenarios.

> **Important**
>
> If you are upgrading MySQL from any 5.x release to version 8.x, and plan to maintain replication, you may encounter errors due to differences in SQL_MODEs and collations. To avoid such errors you will need to make temporary use of two additional filters, `dropsqlmode` and `mapcharset`
>
> After ALL nodes are running the same release of MySQL these filters can be removed.
>
> For a full explanation of this, see Section 6.14.6, “Upgrading between MySQL 5.x and MySQL 8.x”

- For maintenance operations on a Primary, the current Primary should be switched, the required maintenance steps performed, and then the Primary switched back.
- Disable a datasource using the datasource shun command.
- Put the replicator offline using trepctl offline.
- If you are using the Multi-Site/Active-Active topology, put the extra replicator offline using mm_trepctl offline. The mm_trepctl alias will only work if you configured Tungsten Replicator with the `--executable-prefix=mm` [449] option.
- When making changes to a MySQL system the binary log should be disabled for your session. This will prevent corrective actions from replicating to other servers. Ignore this suggestion if you are making changes to a Primary that should be replicated.

```
mysql> SET SESSION SQL_LOG_BIN=0;
```

- Restart replication and recover the datasource after maintenance is complete using datasource recover, trepctl online and optionally mm_trepctl online.

6.14.1. Performing Maintenance on a Single Replica

Performing maintenance on a single Replica can be achieved by temporarily shunning the Replica (while in *AUTOMATIC* policy mode) and doing the necessary maintenance. Shunning a datasource in this way will temporarily remove it from the dataservice, and prevent active and new connections from using the datasource for operations.

The steps are:

1. Shun the Replica:

   ```
   [LOGICAL:EXPERT] /alpha > datasource host2 shun
   ```

   Shunning a datasource does not put the replicator offline, so the replicator should also be put in the offline state to prevent replication and changes being applied to the database:

   ```
   [LOGICAL:EXPERT] /alpha > replicator host2 offline
   ```

2. Perform the required maintenance, including updating the operating system, software or hardware changes.
3. Validate the server configuration :

   ```
   shell> tpm validate
   ```

4. Recover the Replica back to the dataservice:

   ```
   [LOGICAL:EXPERT] /alpha > datasource host2 recover
   ```

Once the datasource is added back to the dataservice, the status of the node should be checked to ensure that the datasource has been correctly added back, and the node is `ONLINE` and up to date.

While the datasource is shunned, the node can be shutdown, restarted, upgraded, or any other maintenance. Throughout the process, the Replica should be monitored to ensure that the datasource is correctly added back into the dataservice, and has caught up with the Primary. Any problems should be addressed immediately.

6.14.2. Performing Maintenance on a Primary

Primary maintenance must be carried out when the Primary has been switched to a Replica, and then shunned. The Primary can be temporarily switched to a Replica, taken out of the dataservice through shunning, and then added back to the dataservice and then switched back again to be the Primary.

> **Important**
>
> Maintenance on the dataserver should be performed directly on the corresponding server, not through the connector.

The complete sequence and commands required to perform maintenance on an active Primary are shown in the table below. The table assumes a dataservice with three datasources:

Step	Description	Command	host1	host2	host3
1	Initial state		Primary	Replica	Replica
2	Set the maintenance policy	set policy maintenance	Primary	Replica	Replica
3	Switch Primary	switch to host2	Replica	Primary	Replica
4	Shun `host1`	datasource host1 shun	Shunned	Primary	Replica
5	Perform maintenance		Shunned	Primary	Replica
6	Validate the `host1` server configuration	tpm validate	Shunned	Primary	Replica
7	Recover the Replica (`host1`) back	datasource host1 recover	Replica	Primary	Replica
8	Ensure the Replica has caught up		Replica	Primary	Replica
9	Switch Primary back to `host1`	switch to host1	Primary	Replica	Replica
10	Set automatic policy	set policy automatic	Primary	Replica	Replica

6.14.3. Performing Maintenance on an Entire Dataservice

To perform maintenance on all of the machines within a dataservice, a rolling sequence of maintenance must be performed carefully on each machine in a structured way. In brief, the sequence is as follows

1. Perform maintenance on each of the current Replicas
2. Switch the Primary to one of the already maintained Replicas
3. Perform maintenance on the old Primary (now in Replica state)
4. Switch the old Primary back to be the Primary again

A more detailed sequence of steps, including the status of each datasource in the dataservice, and the commands to be performed, is shown in the table below. The table assumes a three-node dataservice (one Primary, two Replicas), but the same principles can be applied to any Primary/Replica dataservice:

Step	Description	Command	host1	host2	host3
1	Initial state		Primary	Replica	Replica
2	Set maintenance policy	set policy maintenance	Primary	Replica	Replica
3	Shun Replica `host2`	datasource host2 shun	Primary	Shunned	Replica
4	Perform maintenance		Primary	Shunned	Replica
5	Validate the `host2` server configuration	tpm validate	Primary	Shunned	Replica
6	Recover the Replica `host2` back	datasource host2 recover	Primary	Replica	Replica
7	Ensure the Replica (`host2`) has caught up		Primary	Replica	Replica
8	Shun Replica `host3`	datasource host3 shun	Primary	Replica	Shunned
9	Perform maintenance		Primary	Replica	Shunned

Step	Description	Command	host1	host2	host3
10	Validate the `host3` server configuration	tpm validate	Primary	Replica	Shunned
11	Recover Replica `host3` back	datasource host3 recover	Primary	Replica	Replica
12	Ensure the Replica (`host3`) has caught up		Primary	Replica	Replica
13	Switch Primary to `host2`	switch to host2	Replica	Primary	Replica
14	Shun `host1`	datasource host1 shun	Shunned	Primary	Replica
15	Perform maintenance		Shunned	Primary	Replica
16	Validate the `host1` server configuration	tpm validate	Shunned	Primary	Replica
17	Recover the Replica `host1` back	datasource host1 recover	Replica	Primary	Replica
18	Ensure the Replica (`host1`) has caught up		Primary	Replica	Replica
19	Switch Primary back to `host1`	switch to host1	Primary	Replica	Replica
20	Set automatic policy	set policy automatic	Primary	Replica	Replica

6.14.4. Making Schema Changes

Similar to the maintenance procedure, schema changes to an underlying dataserver may need to be performed on dataservers that are not part of an active dataservice. Although many schema changes, such as the addition, removal or modification of an existing table definition will be correctly replicated to Replicas, other operations, such as creating new indexes, adding/removing columns or migrating table data between table definitions, is best performed individually on each dataserver while it has been temporarily taken out of the dataservice.

As with all maintenance operations it is advisable to have fully tested your DDL in a staging environment. In some cases, the imapct of DDL change is minimal and therefore can safely applied to the Primary node and allowing the change to be replicated down to the Replicas.

In situations where the overhead of the DDL change would cause an outage to your application through table locking, use the rolling maintenance procedure below which is specific for DDL changes.

The basic process comprises of a number of steps, these are as follows:

1. If the DDL adds or removes columns, then enable the `colnames` and `dropcolumn` filters
2. If the DDL adds or removes tables, and you do not want to simply apply to the Primary and allow replication to handle it, then enable the `replicate` filters
3. Perform schema changes following the process summarised in the table below
4. Optionally, remove the filters enabled in the first step

> **Note**
>
> The first two steps listed above are optional for Multi-Site/Active-Active topologies, the process will still work without this step however this may cause cross-site replication to go into an error state until the DDL changes have been applied to all hosts.
>
> Therefore, within Multi-Site/Active-Active environments, instead of using the `colnames` and `dropcolumn` filters mentioned above, you may choose to temporarily stop the cross site replicators. Doing so will reduce the risk of errors in the replication flow whilst the maintenance is in progress, however you will introduce latency between clusters for the duration of the time the replicators are offline.
>
> For Composite Active/Active topologies, it is not possible to isolate the cross-site replictions in the same way, therefore these steps are strongly advised as the resulting error state of the cross-site replicator may prevent a successful switch between Primary and Replica nodes.

Enable filters for column changes

The use of the `colnames` and `dropcolumn` filters allow you to make changes to the structure of tables, without impacting the flow of replication.

> **Important**
>
> During these schema changes, and whilst the filters are in place, applications *MUST* be forwards and backwards compatible, but *MUST NOT* alter data within any columns that are filtered out from replication until after the process

has been completed on all hosts, and the filters disabled. Data changes to filtered columns will cause data drift and inconsistencies, resulting in potentially unexpected behaviour

- To enable the filters, first create a file called `schemachange.json` in a directory accessible by the OS user that the software is running as.

  Typically, this will be the `tungsten` user and the default location for this file will be `/opt/continuent/share`

  The file needs to contain a JSON block outlining ALL the columns being added and removed from all tables affected by the changes.

  In the example below, we are removing the column, `operator_code` and adding `operator_desc` to the `system_operators` table and adding the column `action_date` to the `system_actions` table:

```
[
    {
      "schema": "ops",
      "table": "system_operators",
      "columns": ["operator_code","operator_desc"]
    },
    {
      "schema": "ops",
      "table": "system_actions",
      "columns": ["action_date"]
    }
  ]
```

- Place your cluster into `maintenance` mode

```
shell> cctrl
cctrl> set policy maintenance
```

> **Note**
>
> If running a Composite Active/Passive or Composite Active/Active topology, issue the command at the top global level to place all clusters in maintenance, or execute individually within each cluster

- Next, enable the filters within your configuration by adding the following two parameters to the `tungsten.ini` (if running in INI method) to the [defaults] section on EVERY cluster node:

```
svc-extractor-filters=colnames,dropcolumn
property=replicator.filter.dropcolumn.definitionsFile=/opt/continuent/share/schemachange.json
```

  Followed by tpm update to apply the changes:

- Or, if running as a staging install:

```
shell> cd staging_dir
shell> tools/tpm update alpha \
  --svc-extractor-filters=colnames,dropcolumn \
  --property=replicator.filter.dropcolumn.definitionsFile=/opt/continuent/share/schemachange.json
```

- Monitor replication to ensure there are no errors before continuing

Enable filters for adding/removing tables

The optional use of the `replicate` filter allows you to add and remove tables without impacting the flow of replication.

> **Important**
>
> During these schema changes, and whilst the filter is in place, applications *MUST* be forwards and backwards compatible, but *MUST NOT* modify data in any new tables until after the process has been completed on all hosts, and the filters disabled. Data changes to filtered tables will cause data drift and inconsistencies, resulting in potentially unexpected behaviour.

- Place your cluster into `maintenance` mode.

```
shell> cctrl
cctrl> set policy maintenance
```

> **Note**
>
> If running a Composite Active/Active or Composite Active/Passive topology, issue the command at the top global level to place all clusters in maintenance, or individually within each cluster.

- Next, enable the filters within your configuration by adding the following two parameters to the `tungsten.ini` (if running in INI method) to the `[defaults]` section on EVERY cluster node.

  In this example we plan to ADD the table `system_actions` and REMOVE the table `system_operations`, both within the `ops` schema:

```
svc-extractor-filters=replicate
property=replicator.filter.replicate.ignore=ops.system_actions,ops.system_operations
```

Followed by tpm update to apply the changes

- Or, if running as a staging install:

```
shell> cd staging_dir
shell> tools/tpm update alpha \
  --svc-extractor-filters=replicate \
  --property=replicator.filter.replicate.ignore=ops.system_actions,ops.system_operations
```

- Monitor replication to ensure there are no errors before continuing.

Apply DDL Changes

- Follow the steps outlined in the table below to make the DDL changes to all nodes, in all clusters.
- If filtering columns, once all the changes have been complete, edit the `schemachange.json` to contain an empty document:

```
shell> echo "[]" > /opt/continuent/share/schemachange.json
```

Then, restart the replicators:

```
shell> replicator restart
```

- If filtering tables, repeat the process of adding the replicate filter removing any tables from the ignore parameter that you have ADDED to your database.
- You can optionally fully remove the filters if you wish by removing the entries from the configuration and re-running tpm update however it is also perfectly fine to leave them in place. There is a potentially small CPU overhead in very busy clusters by having the filters in place, but otherwise should not have any impact.

  It is advisable to monitor the system usage and make the decision based on your own business needs.

> **Note**
>
> Leaving the `colnames` filter in place will increase the size of THL on disk, therefore if disk space is limited in your environment, it would be avisable to remove these filters.

The following method assumes a schema update on the entire dataservice by modifying the schema on the Replicas first. The schema shows three datasources being updated in sequence, Replicas first, then the Primary.

Step	Description	Command	host1	host2	host3
1	Initial state		Primary	Replica	Replica
2	Set the Replica `host2` offline	trepctl -host host2 offline	Primary	Offline	Replica
3	Connect to dataserver for `host2` and update schema	set sql_log_bin=0; run ddl statements	Primary	Offline	Replica
4	Set the Replica online	trepctl -host host2 online	Primary	Replica	Replica
5	Ensure the Replica (`host2`) has caught up	trepctl -host host2 status	Primary	Replica	Replica
6	Set the Replica `host3` offline	trepctl -host host3 offline	Primary	Replica	Offline
7	Connect to dataserver for `host3` and update schema	set sql_log_bin=0; run ddl statements	Primary	Replica	Offline
8	Set the Replica (`host3`) online	trepctl -host host3 online	Primary	Replica	Replica
9	Ensure the Replica (`host3`) has caught up	trepctl -host host3 status	Primary	Replica	Replica
10	Switch Primary to `host2`	See Section 6.5, “Switching Primary Hosts”	Replica	Primary	Replica
11	Set the Replica `host1` offline	trepctl -host host1 offline	Offline	Primary	Replica
12	Connect to dataserver for `host1` and update schema	set sql_log_bin=0; run ddl statements	Offline	Primary	Replica

Step	Description	Command	host1	host2	host3
13	Set the Replica `host1` online	trepctl -host host1 online	Replica	Primary	Replica
14	Ensure the Replica (`host1`) has caught up	trepctl -host host1 status	Primary	Replica	Replica
15	Switch Primary back to `host1`	See Section 6.5, "Switching Primary Hosts"	Primary	Replica	Replica

Note

With any schema change to a database, the database performance should be monitored to ensure that the change is not affecting the overall dataservice performance.

6.14.5. Upgrading or Updating your JVM

When upgrading your JVM version or installation, care should be taken as changing the JVM will momentarily remove and replace required libraries and components which may upset the operation of Tungsten Cluster while the upgrade or update takes place.

For this reason, JVM updates or changes must be treated as an OS upgrade or event, requiring a Primary switch and controlled stopping/shunning of services during the update process.

A sample sequence for this in a 3-node cluster is described below:

Step	Description	Command	host1	host2	host3
1	Initial state		Primary	Replica	Replica
2	Shun Replica `host2`	datasource host2 shun	Primary	Shunned	Replica
3	Stop all services on `host2`.	stopall	Primary	Stopped	Replica
4	Update the JVM		Primary	Stopped	Replica
5	Start all services on `host2` Replica.	startall	Primary	Replica	Replica
6	Recover Replica back	datasource host2 recover	Primary	Replica	Replica
7	Ensure the Replica (`host2`) has caught up	ls	Primary	Replica	Replica
8	Shun Replica `host3`	datasource host3 shun	Primary	Replica	Shunned
9	Stop all services on `host3`.	stopall	Primary	Replica	Stopped
10	Update the JVM		Primary	Replica	Stopped
11	Start all services on `host3` Replica.	startall	Primary	Replica	Replica
12	Recover Replica back	datasource host3 recover	Primary	Replica	Replica
13	Ensure the Replica (`host3`) has caught up	ls	Primary	Replica	Replica
14	Switch Primary to `host2`	switch to host2	Replica	Primary	Replica
15	Shun `host1`	datasource host1 shun	Shunned	Primary	Replica
16	Stop all services on `host1`.	stopall	Stopped	Primary	Replica
17	Update the JVM		Stopped	Primary	Replica
18	Start all services on `host1` Replica.	startall	Replica	Primary	Replica
19	Recover `host1` back	datasource host1 recover	Replica	Primary	Replica
20	Ensure the Replica (`host1`) has caught up	ls	Replica	Primary	Replica
21	Switch Primary back to `host1`	switch to host1	Primary	Replica	Replica

6.14.6. Upgrading between MySQL 5.x and MySQL 8.x

As is common when providers release new versions of their software, there are often small subtle changes that often go unnoticed, and then there are some changes which can completely break your application. The latter is quite common when moving between major versions of MySQL.

In MySQL 8.x this is no different, and for the most part these changes won't impact your Tungsten Cluster or your Replication.

To allow, and enable, you to upgrade your underlying database whilst maintaining your application's availability, having your topology running with different versions of MySQL on each node is perfectly normal and supported.

Between versions 5.x and 8.x of MySQL, a number of changes were made to the SQL_MODES - some that existed in 5.7 were removed, and some new ones added in MySQL 8, additionally there are some collation (or Character Set) changes. Within your applications, you may not even notice this, but this can cause an issue with replication. Part of the workflow when Tungsten Replicator applies is to ensure the same SQL_MODES and collations that were in play when the original transaction was written in the source, are enabled when we write into the target, by extracting this information as part of the metadata. If we try to enable a SQL_MODE or enable a collation that doesn't exist, then your replicators will go into an error state, with a message similar to the following:

```
java.sql.SQLSyntaxErrorException: Variable 'sql_mode' can't be set to the value of 'NO_AUTO_CREATE_USER'
```

or

```
pendingError : Event application failed: seqno=2915 fragno=0 message=Failed to apply session variables
```

or

```
Caused by: java.sql.SQLException: Unknown collation: '255'
```

The SQL_MODE exceptions may happen when replicating between two different versions in either direction, i.e. from 5.x to 8.x or vice versa. The collation mapping error is only an issue when replicating down versions, i.e. from 8.x to 5.x

So that you can seamlessly upgrade your underlying MySQL databases, and avoid this particular error, you will need to temporarily enable up to two additional filters and leave running whilst you have a mix of MySQL versions replicating to each other.

When replicating between lower to higher versions (MySQL 5.x to MySQL 8.x), you need to enable the `dropsqlmode` filter using the following syntax and then by running tpm update:

```
svc-applier-filters=dropsqlmode
```

When replicating between higher to lower versions (MySQL 8.x to MySQL 5.x), you need to enable both the `dropsqlmode` filter and the `mapcharset` filter, additionally you will need to configure the `dropsqlmode` filter differently, the following syntax can be used:

```
svc-applier-filters=dropsqlmode,mapcharset
property=replicator.filter.dropsqlmode.modes=TIME_TRUNCATE_FRACTIONAL
```

Once all nodes have been upgraded, simply reverse the process by removing the syntax from the configuration and re-running tpm update.

> **Important**
>
> The `mapcharset` MUST be removed when replicating between the same MySQL versions

For more information on the filters mentioned, see Section 11.4.15, "`dropsqlmode.js` Filter" and ???

6.15. Performing Tungsten Cluster Maintenance

Changes to the configuration should be made with tpm update. This continues the procedure of using tpm install during installation. See Section 10.5.16, "tpm update Command" for more information on using tpm update.

For information on performing upgrades to new versions of the product with the existing configuration, see Section 4.4, "Upgrading Tungsten Cluster".

6.16. Monitoring Tungsten Cluster

It is your responsibility to properly monitor your deployments of Tungsten Cluster and Tungsten Replicator. The minimum level of monitoring must be done at three levels. Additional monitors may be run depending on your environment but these three are required in order to ensure availability and uptime.

1. Make sure the appropriate Tungsten Cluster and Tungsten Replicator services are running.
2. Make sure all datasources and replication services are `ONLINE`.
3. Make sure replication latency is within an acceptable range.

> **Important**
>
> Special consideration must be taken if you have multiple installations on a single server. That applies for clustering and replication or multiple replicators.

These three points must be checked for all directories where Tungsten Cluster or Tungsten Replicator are installed. In addition, all servers should be monitored for basic health of the processors, disk and network. Proper alerting and graphing will prevent many issues that will cause system failures.

6.16.1. Managing Log Files with logrotate

You can manage the logs generated by Tungsten Cluster using logrotate.

- `connector.log`

```
/opt/continuent/tungsten/tungsten-connector/log/connector.log {
        notifempty
        daily
        rotate 3
        missingok
        compress
        copytruncate
}
```

- `tmsvc.log`

```
/opt/continuent/tungsten/tungsten-manager/log/tmsvc.log {
        notifempty
        daily
        rotate 3
        missingok
        compress
        copytruncate
}
```

- `trepsvc.log`

```
/opt/continuent/tungsten/tungsten-replicator/log/trepsvc.log {
        notifempty
        daily
        rotate 3
        missingok
        compress
        copytruncate
}
```

6.16.2. Monitoring Status Using cacti

Graphing Tungsten Replicator data is supported through Cacti extensions. These provide information gathering for the following data points:

- Applied Latency
- Sequence Number (Events applied)
- Status (Online, Offline, Error, or Other)

To configure the Cacti services:

1. Download both files from https://github.com/continuent/monitoring/tree/master/cacti
2. Place the PHP script into `/usr/share/cacti/scripts`.
3. Modify the installed PHP file with the appropriate `$ssh_user` and `$tungsten_home` location from your installation:
   - `$ssh_user` should match the `user` used during installation.
   - `$tungsten_home` is the installation directory and the `tungsten` subdirectory. For example, if you have installed into `/opt/continuent`, use `/opt/continuent/tungsten`.

   Add SSH arguments to specify the correct `id_rsa` file if needed.
4. Ensure that the configured `$ssh_user` has the correct SSH authorized keys to login to the server or servers being monitored. The user must also have the correct permissions and rights to write to the cache directory.
5. Test the script by running it by hand:

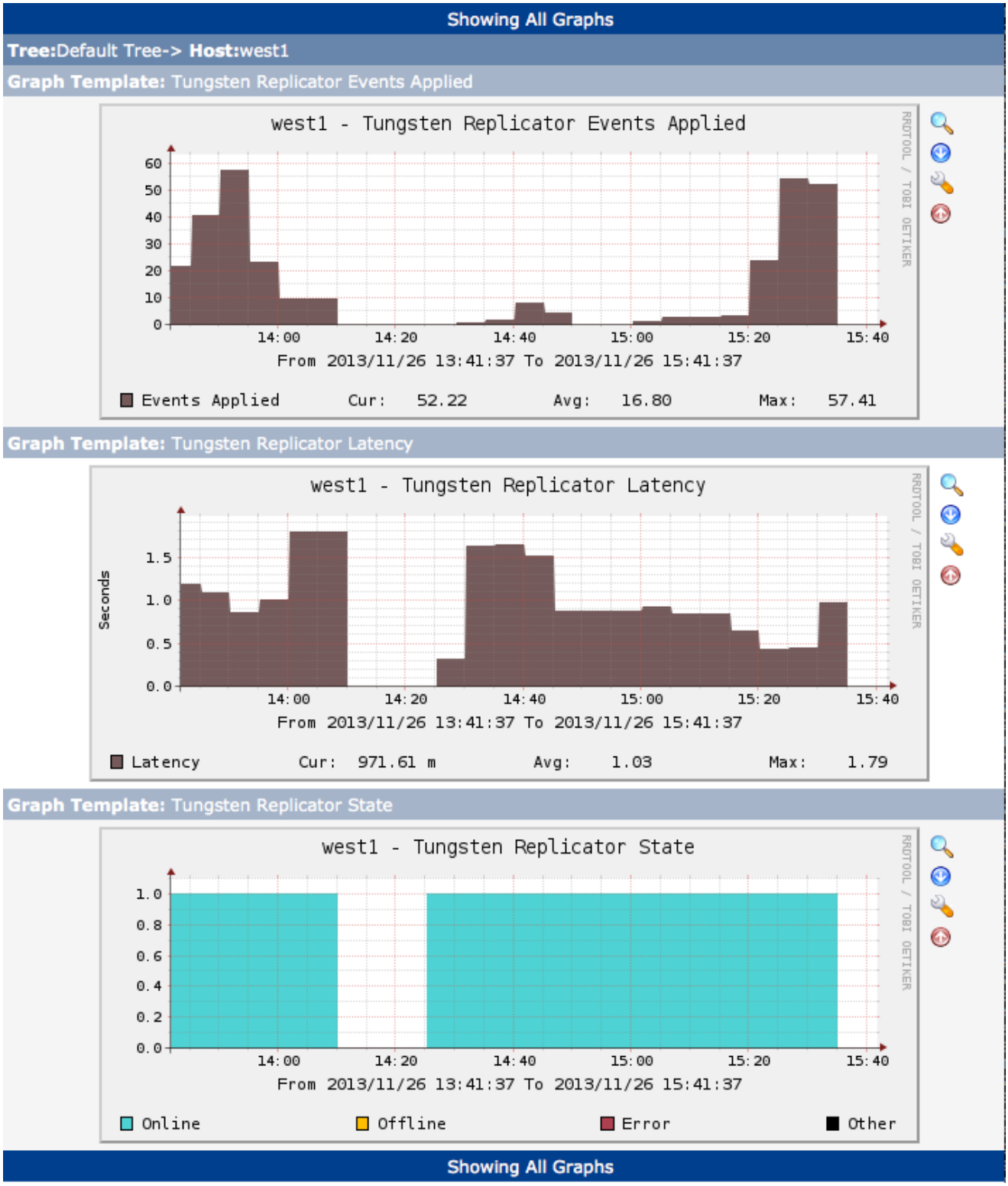
   ```
   shell> php -q /usr/share/cacti/scripts/get_replicator_stats.php --hostname replserver
   ```

   If you are using multiple replication services, add `--service servicename` to the command.
6. Import the XML file as a Cacti template.

7. Add the desired graphs to your servers running Tungsten Cluster. If you are using multiple replications services, you'll need to specify the desired service to graph. A graph must be added for each individual replication service.

Once configured, graphs can be used to display the activity and availability.

Figure 6.2. Cacti Monitoring: Example Graphs



6.16.3. Monitoring Status Using nagios

Integration with Nagios is supported through a number of scripts that output information in a format compatible with the Nagios NRPE plugin. Using the plugin the check commands, such as check_tungsten_latency can be executed and the output parsed for status information.

The available commands are:

- check_tungsten_latency
- check_tungsten_online
- check_tungsten_policy
- check_tungsten_progress
- check_tungsten_services

To configure the scripts to be executed through NRPE:

1. Install the Nagios NRPE server.
2. Start the NRPE daemon:

   ```
   shell> sudo /etc/init.d/nagios-nrpe-server start
   ```

3. Add the IP of your Nagios server to the `/etc/nagios/nrpe.cfg` configuration file. For example:

   ```
   allowed_hosts=127.0.0.1,192.168.2.20
   ```

4. Add the Tungsten check commands that you want to execute to the `/etc/nagios/nrpe.cfg` configuration file. For example:

   ```
   command[check_tungsten_online]=/opt/continuent/tungsten/cluster-home/bin/check_tungsten_online
   ```

5. Restart the NRPE service:

   ```
   shell> sudo /etc/init.d/nagios-nrpe-server start
   ```

6. If the commands need to be executed with superuser privileges, the `/etc/sudo` or `/etc/sudoers` file must be updated to enable the commands to be executed as root through sudo as the `nagios` user. This can be achieved by updating the configuration file, usually performed by using the visudo command:

   ```
   nagios          ALL=(tungsten)  NOPASSWD: /opt/continuent/tungsten/cluster-home/bin/check*
   ```

   In addition, the sudo command should be added to the Tungsten check commands within the Nagios `nrpe.cfg`, for example:

   ```
   command[check_tungsten_online]=/usr/bin/sudo -u tungsten /opt/continuent/tungsten/cluster-home/bin/check_tungsten_online
   ```

   Restart the NRPE service for these changes to take effect.

7. Add an entry to your Nagios `services.cfg` file for each service you want to monitor:

   ```
   define service {
           host_name database
           service_description     check_tungsten_online
           check_command           check_nrpe! -H $HOSTADDRESS$  -t 30 -c check_tungsten_online
           retry_check_interval    1
           check_period            24x7
           max_check_attempts      3
           flap_detection_enabled  1
           notifications_enabled   1
           notification_period     24x7
           notification_interval   60
           notification_options    c,f,r,u,w
           normal_check_interval   5
   }
   ```

The same process can be repeated for all the hosts within your environment where there is a Tungsten service installed.

6.17. Rebuilding THL on the Primary

If THL is lost on a Primary before the events contained within it have been applied to the Replica(s), the THL will need to be rebuilt from the existing MySQL binary logs.

> **Important**
>
> If the MySQL binary logs no longer exist, then recovery of the lost transactions in THL will NOT be possible.

The basic sequence of operation for recovering the THL on both Primary and Replicas is:

1. Gather the failing requested sequence numbers from all Replicas:

```
shell> trepctl status

pendingError           : Event extraction failed
pendingErrorCode       : NONE
pendingErrorEventId    : NONE
pendingErrorSeqno      : -1
pendingExceptionMessage: Client handshake failure: Client response validation failed:
Master log does not contain requested transaction:
master source ID=db1 client source ID=db2 requested seqno=4 client epoch number=0 master min seqno=8 master max seqno=8
```

   In the above example, when Replica db2 comes back online, it requests a copy of the last seqno in local thl [4] from the Primary db1 to compare for data integrity purposes, which the Primary no longer has.

   Keep a note of the lowest sequence number and the host that it is on across all Replicas for use in the next step.

2. On the Replica with the lowest failing requested seqno, get the epoch, source-id and event-id [binlog position] from the THL using the command thl list -seqno [328] specifying the sequence number above. This information will be needed on the extractor [Primary] in a later step. For example:

```
tungsten@db2:/opt/replicator> thl list -seqno 4

SEQ# = 4 / FRAG# = 0 (last frag)
- TIME = 2017-07-14 14:49:00.0
- EPOCH# = 0
- EVENTID = mysql-bin.000009:0000000000001844;56
- SOURCEID = db1
- METADATA = [mysql_server_id=33155307;dbms_type=mysql;tz_aware=true;is_metadata=true; »
              service=east;shard=#UNKNOWN;heartbeat=NONE]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
- OPTIONS = [##charset = UTF-8, autocommit = 1, sql_auto_is_null = 0,
             foreign_key_checks = 1, unique_checks = 1, time_zone = '+00:00',
             sql_mode = 'NO_ENGINE_SUBSTITUTION,STRICT_TRANS_TABLES,IGNORE_SPACE',
             character_set_client = 33, collation_connection = 33, collation_server = 8]
- SCHEMA = tungsten_east
- SQL(0) = UPDATE tungsten_east.heartbeat SET source_tstamp= '2017-07-14 14:49:00', $raquo;
           salt= 5, name= 'NONE'  WHERE id= 1
```

   There are two more ways of getting the same information using the dsctl command, so use the one you are most comfortable with:

```
tungsten@db2:/opt/replicator> dsctl get
[{"extract_timestamp":"2017-07-14 14:49:00.0","eventid":"mysql-bin.000009:0000000000001844;56",»
  "fragno":0,"last_frag":true,"seqno":4,"update_timestamp":"2017-07-14 14:49:00.0",»
  "shard_id":"#UNKNOWN","applied_latency":0,"epoch_number":0,"task_id":0,"source_id":"db1"}]
```

```
tungsten@db2:/opt/replicator> dsctl get -ascmd
dsctl set -seqno 4 -epoch 0 -event-id "mysql-bin.000009:0000000000001844;56;566" -source-id "db1"
```

3. Clear all THL on the Primary since it is no longer needed by any Replicas:

```
shell> thl purge
```

4. Use the dsctl command on the Primary with the values we got from the Replica with the lowest seqno to tell the Primary replicator to begin generating THL starting from that event in the MySQL binary logs:

   Note: If you used the dsctl get -ascmd earlier, you may use that provided command now, just add the `-reset` argument at the end.

```
shell> dsctl set -seqno 4 -epoch 0 -event-id "mysql-bin.000009:0000000000001844;56;566" -source-id "db1" -reset
```

5. Switch the Primary to online state:

```
shell> trepctl online
```

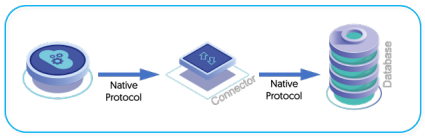
6. Switch the Replicas to online state once the Primary is fully online:

```
shell> trepctl online
```

Chapter 7. Tungsten Connector

Tungsten Connector acts as a proxy service, sitting between client applications and datasources in order to balance the load and provide high availability (HA) support. The service works by accepting raw packets from clients, and then forwarding them to the datasource. The process is reversed when packets are sent back from the datasource and then redirected back to the clients.

Figure 7.1. Tungsten Connector Basic Architecture



In addition to this basic structure, Tungsten Connector also works with the other components of Tungsten Cluster to handle some specific scenarios and situations:

- The connector works in harmony with the Tungsten Manager as part of Tungsten Cluster and enables the connector to redirect queries between known datasources within a given dataservice. For example, when the manager identifies a failed datasource, queries to that datasource are redirected to an alternative datasource without the application being aware of the change.
- The connector works with the Tungsten Cluster configuration and a number of implied or explicit directives that enable the connector to redirect requests within different datasources within the network. For example, the connector can be configured to automatically forward write requests to a database to the active Primary within the dataservice and reads to active Replicas.

Throughout this process the connector is redirecting the network packets sent by application servers to the appropriate host. The contents and individual statements are not processed or accessed. At all times applications and clients using the connector do not need modification as to them it will appear as a MySQL server.

To start using the connector run the tpm connector command. This will open a connection with the MySQL CLI. See Section 7.3, "Clients and Deployment" for more detail on configuring your application to use the connector.

Important

After installation the connector will only work with the `--application-user` [433] and `--application-password` [432] that were provided during installation. See Section 7.6, "User Authentication" if you need more information on adding users to `user.map`.

```
shell > tpm connector
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 93422
Server version: 5.5.34-log-tungsten MySQL Community Server (GPL)

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affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql>
```

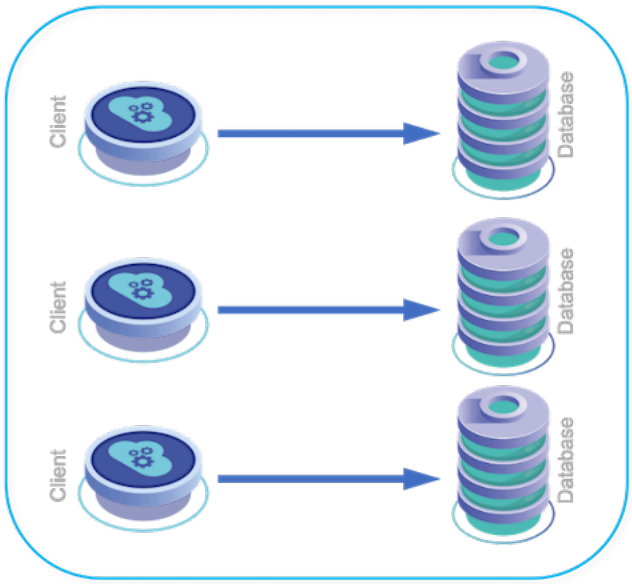
7.1. Connector/Application Basics

Within any typical database deployment there will be two primary considerations:

- High Availability — redirecting requests to alternative servers in the event of a failure.
- Scalability — distributing reads and writes across servers in a replication architecture.

Within a typical basic database deployment clients and application servers will connect directly to databases, as shown in Figure 7.2, "Basic MySQL/Application Connectivity".

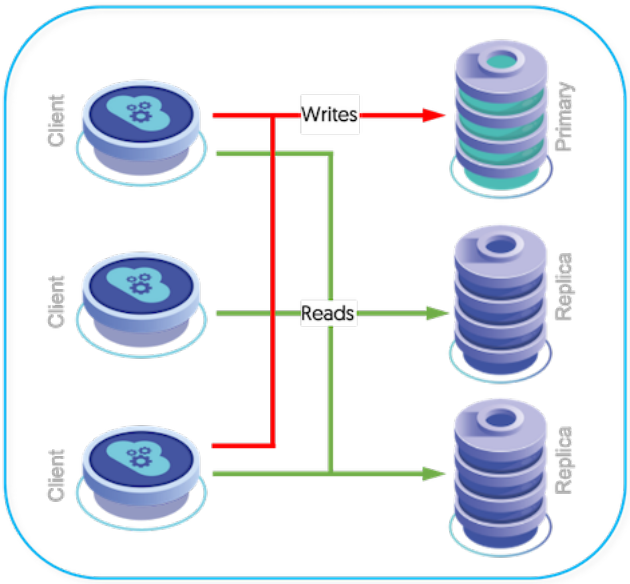
Figure 7.2. Basic MySQL/Application Connectivity



The problem with this deployment model is that it is not able to cope with changes or problems. If one or more of your database servers fails, then the application servers must be reconfigured individually to point to an alternative server. In addition, when considering scalability, there is no provision for redirecting reads and writes to Primaries or Replicas.

In an advanced application deployment, individual servers may have been configured to connect to Primaries and Replicas and configured your application to talk directly to the Primary and/or Replicas within the database infrastructure to handle the scalability offered by using replication [Figure 7.3, “Advanced MySQL/Application Connectivity”]. For this to work the application must have been modified and be read/write aware, and it must have been configured to manually connect to the different databases according to the operation being performed.

Figure 7.3. Advanced MySQL/Application Connectivity



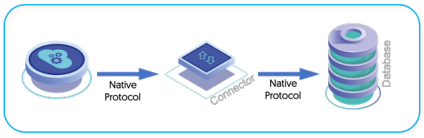
Although this handles the read/write splitting, enabling servers to write to the Primary and read from one or more Replicas, changes to this architecture and structure are not handled. If the Primary fails, application servers must be manually updated to direct their queries to an alternative host.

When deploying Tungsten Cluster the connector takes over the role of primary connection from your application to the database server, and it handles the redirection of requests to the appropriate database server. Depending on your application configuration and architecture, the connector can be used in two ways:

- As a complete solution for redirecting queries between the Primary and Replica hosts within a dataservice, including HA events.
- As an HA solution redirecting queries to the Primary and Replicas within a dataservice, but with application driven Primary/Replica selection.

When deploying your application with Tungsten Cluster through Tungsten Connector, the application server connectivity is through the connector. The connector takes on the role of primary connection for all requests, while routing and distributing those requests to the active datasources within the dataservice.

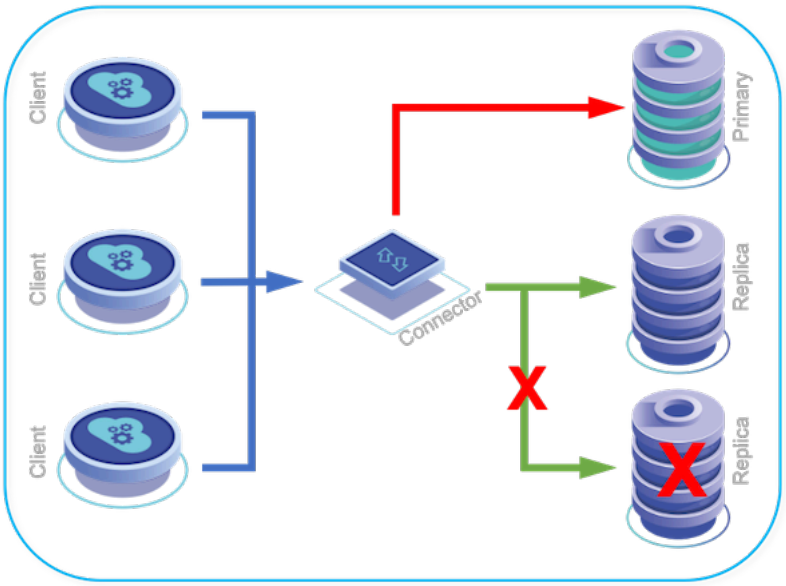
Figure 7.4. Using Tungsten Connector for MySQL/Application Connectivity



The Tungsten Connector is located between the clients and the database servers, providing a single connection point, while routing queries to the database servers. In the event of a failure, the Tungsten Connector can automatically route queries away from the failed server and towards servers that are still operating. During the routing process, Tungsten Connector communicates with the Tungsten Manager to determine which datasources are the most up to date, and their current role so that the packets can be routed properly.

Because the connectivity is between the application service and the Tungsten Connector, the connection to the Tungsten Connector remains constant. Changes to the datasources, including failures, role changes, and expansion or removal of datasources from the dataservice do not require any modification of the application configuration or operation.

Figure 7.5. Tungsten Connector during a failed datasource



For example, in Figure 7.5, "Tungsten Connector during a failed datasource", the Replica datasource has failed. While this would break the connection between the Tungsten Connector and the datasource, the connection between the application and Tungsten Connector remains available, and Tungsten Connector will re-route queries to an available datasource without reconfiguring the application server connectivity.

7.1.1. Connector Control Flow

The Connector makes a TCP connection to any available Manager, then all command-and-control traffic uses that channel. The Manager never initiates a connection to the Connector.

When there is a state change (i.e. shun, welcome, failover, etc.), the Manager will communicate to the Connector over the existing channel.

The Connector will re-establish a channel to an available Manager if the Manager it is connected to is stopped or lost.

7.2. Basic Connector Configuration

By default, the Tungsten Connector listens on port `9999` so as to avoid conflicting with the default MySQL listener port of `3306`.

The best practice is the change the MySQL port to `13306` and the Tungsten Connector port to `3306`.

For example, modify `my.cnf` to define the port, then restart MySQL:

```
port = 13306
```

For more information, see Section B.3.2, "MySQL Configuration".

Configure the the Tungsten Connector to listen on port `3306`:

```
shell > tpm update alpha --application-port=3306
```

> **Important**
>
> This change is especially important if the Tungsten Connector will be installed directly on the database nodes. ALL traffic needs to flow through the Tungsten Connector, so hiding the actual MySQL port prevents mistaken connections directly to the database.

7.3. Clients and Deployment

In order to get the benefits of Tungsten Cluster your application must use the Tungsten Connector. The connector is compatible with MySQL drivers and applications. Use the tpm connector --samples command to see examples of how you can invoke a connection on your own. You may need to adapt these examples to your application and configuration method but the connection details should be the same.

```
shell > tpm connector --samples
Bash                          mysql -hconnector1 -P3306 -uappuser -ppassword
Perl::dbi
                              $dbh=DBI->connecti('DBI:mysql:host=connector1;port=3306',
                              'appuser', 'password')
PHP::mysqli
                              $dbh = new mysqli('connector1',
                              'appuser', 'password', 'schema', '3306');
PHP::pdo
                              $dbh = new
                              PDO('mysql:host=connector1;port=3306',
                              'appuser', 'password');
Python::mysql.connector
                              dbh = mysql.connector.connect(user='appuser',
                              password='password',
                              host='connector1', port=3306,
                              database='schema')
Java::DriverManager
                              dbh=DriverManager.getConnection("jdbc:mysql://connector1:3306/schema",
                              "appuser", "password")
```

After installation the connector will only work with the `--application-user` [433] and `--application-password` [432] options that were provided during installation. See Section 7.6, "User Authentication" if you need more information on adding users to `user.map`.

By default the connection will always be sent to the current Primary. This behavior can be modified by implementing one of the routing methods to send some traffic to Replica datasources.

7.3.1. Connection Pools

Tungsten Connector can work behind a connection pool without any issue.

Upon switch or failover, all connections in the pool will be broken but not closed. The very next time one of these pooled connections is used, it will be transparently reconnected unless autoReconnect has been disabled by the tpm installation flag:

```
shell > tpm update alpha --connector-autoreconnect=false
```

> **Important**
>
> When using a connection pool mechanism in applications, the dynamic connection setting `maxAppliedLatency` should not be used. This setting is only meaningful at connection time; since connection pools open a set of connections, the applied latency will most probably be outdated when the application will actually use the pooled connection

7.4. Routing Methods

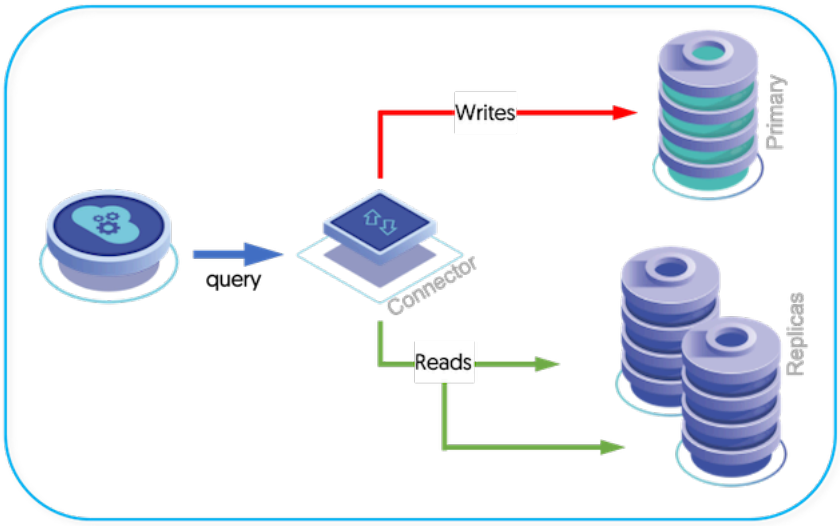
Bridge mode is the default connector routing method if no other routing method is explicitly stated. The bridge-mode does not use the `user.map` file which reflects other changes to take a more secure default deployment. A warning will be displayed during the validation process to tell you if bridge-mode is being enabled. It will not be enabled in the following cases:

- The `--connector-smartscale` [440] option is set to `true`.
- The `user.map` file contains `@direct` entries.
- The `user.map` file contains `@hostoption` entries.
- The `--property=selective.rwsplitting` [405] connector option is set to `true`.

Tungsten Connector routes connections between client connections and datasources using a number of different routing methods. These routing methods affect how client applications and datasources are connected to each other, and control the level of inspection by Tungsten Connector of the connections and statements as they pass through the connector service.

The Tungsten Connector works with Tungsten Manager to automatically route clients connected to the connector to an appropriate server, balancing the load when communicating with Replicas. The different methods are involved in effective read/write splitting, i.e. the ability to correctly route requests to the Primaries or Replicas within the network according to the type of operation being performed by the client. This can be performed automatically, or manually, or through a series of specific configurable routing methods.

Figure 7.6. Tungsten Connector routing architecture



Routing selection is made by the connector based on the availability information using a combination of different settings and parameters. Each level overrides or augments the previous level, and each can be specified in different locations, such as the `user.map`, connecting string, or within individual supplied statements. The settings are processed in the order shown below; later setting override earlier settings.

For example, selecting the SQL routing method defines the default behavior. Specifying the QoS in the `user.map` file supercedes the SQL routing; setting QoS in a comment before the SQL statement supercedes the user and default behavior. Specifying an affinity in the comments overrides both the user and default configuration settings.

- Selected routing method, see Section 7.4.1, “Connector Routing Methods”
- Quality of Service (QoS) specification, see Section 7.4.2, “Primary/Replica Selection”
- Load balancer selection (implied by QoS), see Section 7.4.3, “Connector Load Balancers”
- Replica latency, including optional maximum latency setting, see Section 7.4.4, “Specifying Required Latency”
- Affinity specification, see Section 7.4.5, “Setting Read Affinity and Direct Reads”

These different routing configurations can be selected according to the global configuration, and customization at different points in the communication channel. For example, SQL-based routing configures basic load-balancing, but allows SQL comments to be used to change the default QoS mode and affinity.

	Routing Method	QoS	Latency	Affinity
Global Configuration	Yes	Implied	Yes	Yes
Connection String	Yes	Yes	Yes	Yes
`user.map`	Yes	Yes	Yes	Yes

	Routing Method	QoS	Latency	Affinity
SQL statement	Yes (with SQL routing enabled)	Yes (with SQL routing enabled)	No	No

At all times, the connector uses the current status of the MySQL servers to make decisions about where queries and connections should be routed. Changes to the Primary, and availability or accessibility of individual dataservers will always be taken into account when routing the queries. For information on what happens if failure occurs during an operation or transaction, see Section 7.8, "Connector Operational States".

The routing methods can either involve direct reads, SmartScale, host-based routing, or SQL inspection-based routing to redirect reads and writes to the appropriate server. In addition to these implied routing methods, clients can also specifically select which host to communicate with through the use of tags and options provided through the connection string.

The selection of a datasource occurs at the point the client connects, and this datasource connection choice remains in effect until the client disconnects, unless a failover or switch occurs.

7.4.1. Connector Routing Methods

The supported routing methods, typical uses and use cases are listed in Table 7.1, "Routing Method Selection".

Table 7.1. Routing Method Selection

Routing Method	Host Selection	Auto R/W Splitting	Replica Latency	Maximum Applied Latency
Smartscale	By Session	Yes (by SQL statement)	Lazy	Yes
Direct Reads	By Content	Yes (by SQL statement)	Lazy	Yes
Host-based	By Hostname	No	Yes	Yes
Port-based	By Network Port	No	No	Yes
SQL-based	By SQL comment	No	No	Yes

Important

Both SmartScale and R/W splitting cannot be enabled at the same time. This is because they are two sides of the basic functionality. R/W splitting and SmartScale both use SQL introspection to determine whether a query should be directed to a Primary or a Replica. SmartScale combines this with an intelligent load-balancer. R/W splitting uses a simpler direct redirection.

In addition to the selection and configuration mechanisms supported, a routing method should be chosen based on your application abilities:

- If the application is replication-aware, and can already direct queries to Primary or Replicas based on the operation type, use Section 7.4.11, "Host-based Routing" or Section 7.4.12, "Port-based Routing"
- If the application has full control of the SQL statements submitted (i.e. not through a third-party tool, or Object-Relational Modeling library), and can already direct queries to Primary or Replicas based on the operation type, use Section 7.4.10, "SQL Routing".
- If the application uses non-auto-commit statements (for example, Hibernate), Section 7.4.11, "Host-based Routing", or Section 7.4.10, "SQL Routing".
- If the application does not fit any of these categories, or is not replication aware use either either Section 7.4.9, "Direct Routing" or Section 7.4.8, "Smartscale Routing".

7.4.2. Primary/Replica Selection

Depending on the chosen routing and authentication method, the selection of the Primary or Replica node can be controlled by the use of the `qos` (Quality Of Service) syntax as outlined below:

- *`RO_RELAXED`* [224]

  This setting enables the connector to redirect the query as if it were read-only, and therefore prefer a Replica over a Primary, but will choose a Primary if no Replica is available.

- *`RW_STRICT`* [224]

  This setting indicates that the query is a write and should be directed to a Primary. In Active-Active setups, where multiple Primaries exist, affinity determines in which site the primary should be selected.

Configuring the use of these properties can be controlled in a number of ways, as follows:

- SQL Based Routing (See Section 7.4.10, “SQL Routing”)
- Host based Routing (See Section 7.4.11, “Host-based Routing”)
- Embedded as part of Schema Name when specifying the database to connect to.

  For example, the following connect string would prefer a Replica for its connection:

```
jdbc:mysql://connector1:3306/mydb@qos=RO_RELAXED?autoreconnect=true
```

Further, connectivity can be influenced by setting a suitable latency (See Section 7.4.4, “Specifying Required Latency”) value, or an explicit affinity (See Section 7.4.5, “Setting Read Affinity and Direct Reads”.

The rules for selection of whether a connection is made to a Primary or a Replica is therefore controlled by comparing all of these settings and the selected routing mechanism together.

QoS	Primary Selected	Replica Selected	
RW_STRICT [224]	Yes, always	No.	
RO_RELAXED [224]	Only if no Replica available	Yes, if below max applied latency.	

For further reading on how nodes are chosen, see Section 7.4.3, “Connector Load Balancers”

7.4.3. Connector Load Balancers

The load balancing model used, according to the selected QoS is defined by a number of different load balancing classes. These are configured automatically when different QoS is selected, be explicitly changed by altering the configuration file. The supported load balancers are detailed in the table below:

Load Balancer	Default QoS	Description
DefaultLoadBalancer	*RW_STRICT* [224]	Always selects the Primary data source
MostAdvancedSlaveLoadBalancer	*RO_RELAXED* [224]	Selects the Replica that has replicated the most events, by comparing data sources "high water" marks. If no Replica is available, the Primary will be returned.
LowestLatencySlaveLoadBalancer		Selects the Replica data source that has the lowest replication lag, or *appliedLatency* in ls -l within cctrl output. If no Replica data source is eligible, the Primary data source will be selected.
RoundRobinSlaveLoadBalancer		Selects a Replica in a round robin manner, by iterating through them using internal index. Returns the Primary if no Replica is found online
HighWaterSlaveLoadBalancer	*RW_SESSION*	Given a session high water (usually the high water mark of the update event), selects the first Replica that has higher or equal high water, or the Primary if no Replica is online or has replicated the given session event. This is the default used when SmartScale is enabled.

The default setting is `MostAdvancedSlaveLoadBalancer`.

To change the Connector load balancer, specify the property in the configuration, i.e to use Round Robin:

```
shell> ./tools/tpm update alpha \
--property=dataSourceLoadBalancer_RO_RELAXED=com.continuent.tungsten.router.resource.loadbalancer.RoundRobinSlaveLoadBalancer
```

7.4.4. Specifying Required Latency

Depending on the selected routing method, load balancer and QoS setting, a Replica will automatically be chosen when the host connects. The maximum allowed latency can be set to limit the connection to only use a Replica that is within the specified maximum applied latency limit.

This can be specified in the connection string, and enables Replica selection based on the Replica which has a latency within the specified limit. Connector specific URL parameters have to be passed inside the database name, otherwise they might be ignored/stripped by the application driver.

```
jdbc:mysql://connector1:3306/<databasename here>@maxAppliedLatency=5?<mysqlSpeficOptionHere>
```

For example:

```
jdbc:mysql://connector1:3306/mydb@maxAppliedLatency=5?autoreconnect=true
```

Will specify that a host with a replication latency of less than 5 seconds should be selected, with autoreconnet enabled.

The option can be set globally by configuring the JDBC options used by the connector via the `--connector-max-slave-latency` [439] option to tpm (in seconds):

```
shell> ./tools/tpm update alpha --connector-max-slave-latency=10
```

Warning

The Connector computes latency by polling the Replicator every 3 seconds for the current replication-view latency.

This gives the Connector an accuracy of +/- 3 seconds, which means that values of 3 or less will not function as expected.

For any queries that have a very low tolerance for replication latency, we strongly suggest you read directly from the Primary database server only. This ensures the latest data is being read.

Important

The `--connector-max-slave-latency` [439] flag does not ensure the Replica has applied the latest sequence number, just that its latency at the last commit was under the specified number. This behavior can be adjusted by specifying `--use-relative-latency=true` [441] in the configuration.

NOTE: `--use-relative-latency=true` [441] is a cluster-wide setting, cctrl and trepctl will also report relative latency based on this setting.

7.4.4.1. Applied and Relative Latency Comparison

- Applied Latency

  The appliedLatency is the latency between the commit time of the source event and the time the last committed transaction reached the end of the corresponding pipeline within the replicator. Within a Primary, this indicates the latency between the transaction commit time and when it was written to the THL. In a Replica, it indicates the latency between the commit time on the Primary database and when the transaction has been committed to the destination database. Clocks must be synchronized across hosts for this information to be accurate. appliedLatency : 0.828 The latency is measured in seconds. Increasing latency may indicate that the destination database is unable to keep up with the transactions from the Primary. In replicators that are operating with parallel apply, appliedLatency indicates the latency of the trailing channel. Because the parallel apply mechanism does not update all channels simultaneously, the figure shown may trail significantly from the actual latency.

  See Section E.2.8, "Terminology: Fields *appliedLatency*" for more information.

- Relative Latency

  The relativeLatency is the latency between now and timestamp of the last event written into the local THL. This information gives an indication of how fresh the incoming THL information is. On a Primary, it indicates whether the Primary is keeping up with transactions generated on the Primary database. On a Replica, it indicates how up to date the THL read from the Primary is. A large value can either indicate that the database is not busy, that a large transaction is currently being read from the source database, or from the Primary replicator, or that the replicator has stalled for some reason. An increasing relativeLatency on the Replica may indicate that the replicator may have stalled and stopped applying changes to the dataserver.

  See Section E.2.70, "Terminology: Fields *relativeLatency*" for more information.

- Comparing Relative and Applied Latencies

  Both relative and applied latency are visible via the trepctl status. Relative indicates the latency since the last time the appliedLastSeqno advanced; for example:

```
shell> trepctl status

Processing status command...
NAME                     VALUE
----                     -----
appliedLastEventId     : mysql-bin.000211:0000000020094766;0
appliedLastSeqno       : 78022
appliedLatency         : 0.571
...
relativeLatency        : 8.944
Finished status command...
```

  In this example the last transaction had an applied latency (time to write to the Replica DB) of 0.571 seconds from the time it committed on the Primary, and last committed something to the Replica DB 8.944 seconds ago.

  If relative latency increases significantly in a busy system, it may be a sign that replication is stalled. This is a good parameter to check in monitoring scripts.

- For more information,see:

  `--connector-max-slave-latency` [439]

  `--use-relative-latency` [441]

  Section 4.1.6.3, “Relative Latency”

7.4.4.2. Advanced Troubleshooting for Latency-based Routing

To troubleshoot the latency-based routing decisions the connector makes, and uncomment the below lines in `/opt/continuent/tungsten/tungsten-connector/conf/log4j.properties`

```
#log4j.logger.com.continuent.tungsten.router.resource.loadbalancer=debug, stdout
#log4j.additivity.com.continuent.tungsten.router.resource.loadbalancer=false
```

The log will then show and explain what node the connector choose and why.

> **Important**
>
> No connector restart is required to enable logging. If you re-comment the lines, a restart will be required. To disable without a connector restart, replace the word `debug` with the word `info`.

7.4.5. Setting Read Affinity and Direct Reads

Affinity enables you to specify at connection time that the connector should forward the connection to a particular host or service for reads, if the service is available. For example, within `user.map`:

```
user password east_west east
```

Defines a user that uses the `east_west` service, but prefers being routed to the `east` service for reading from a Replica.

Affinity can also specified within the connection string:

```
jdbc:mysql://connector1:3306/database?affinity=host3&qos=RO_RELAXED
```

Additionally, affinity JDBC options can be set globally via the tpm command option `connector-affinity` [437].

Affinity can also be combined with other node selection, such as QoS. For example, by combining the affinity and *`RO_RELAXED`* [224], then the specified Replica will be used first, if the load-balancer setting matches, then another Replica within the same service, and finally the Primary. For example, in a dataservice with three nodes, where `node1` is the Primary:

```
shell> mysql -h127.0.0.1 -P3306 databasename@qos=RO_RELAXED\&affinity=node2
```

Would use `node2` first, then `node3`, and finally `node1` if the others are not available.

> **Note**
>
> Within a composite dataservice, you cannot specify a specific host. You can only specify a physical dataservice within the composite dataservice. For example in a composite service with east and west physical dataservices:
>
> ```
> shell> mysql -h127.0.0.1 -P3306 databasename@qos=RO_RELAXED\&affinity=east
> ```

Additionally, the `user.map` can be configured to direct specific users to a Replica by using the `@direct` keyword. For example, the following line in `user.map` will always direct the user to a Replica, ignoring latency and load balancing settings:

```
@direct readme
```

7.4.6. Setting Negative Affinity

Negative Affinity can be enabled with both Read and Write affinity but has the opposite affect, namely ensuring Reads or Writes do NOT get routed to a specific service.

This feature can be configured in exactly the same way, just with the addition of - in front of the service name. Below is an examples using `east` and `west` as the example service names.

Allow writes to east but not west, allow reads from both, with preference to east:

```
affinity=east,-west:east
```

A typical use case for this feature would be when you want the flexibility of a Composite Active/Active topology but do not want writes into both clusters. This can be useful when you are unable to avoid potential write conflicts.

7.4.7. Routing using embedded syntax in connect string

> **Note**
>
> This feature will not work when using Bridge mode, this only applies to connectors running in Proxy mode.

It is possible to embed syntax as part of the schema name in your connection string (`-D` switch if using the mysql CLI) to route the connector. Such as using the `@qos` syntax to direct the connection to a Primary or a Replica.

Additionally, you can also pass other properties such as affinity and maxAppliedLatency, as shown in the MySQL CLI example below.

```
mysql -hhost -pport -uuser -ppass -Dtest@qos=RO_RELAXED\&affinity=europe\&maxAppliedLatency=15
```

The following shows a java connect string example:

```
connection = DriverManager.getConnection("jdbc:mysql://host:port/schema@qos=RO_RELAXED&affinity=europe&maxAppliedLatency=15", "user", "pass")
```

7.4.8. Smartscale Routing

SmartScale allows you to read your data, as much as possible, from a Replica data source.

In this read-write splitting mode, the connector intelligently determines if Replicas are up-to-date with respect to the Primary, and selects them in such a way that read operations are always strictly consistent with the last write of their current session. Sessions are per-connector-instance, in-memory objects that allow different connections to share SmartScale benefits: by providing the same session id, two connections will be able to see each other's write operations consistently.

Possible session ids are:

- DATABASE: applications will see write operations made to the same database as it is connected to. Reads from other databases might be outdated depending on the Replica latency
- USER: all connections that use the same user will read data consistent with the writes made by the current user. Other users data might be outdated.
- CONNECTION: only writes made by the current connection are guaranteed to be read consistently. Writes from other connections might be outdated
- PROVIDED_IN_DBNAME: Allows you to specify a variable sessionid in the database connection string . An application, typically PHP, can pass its own session id to make smart scale even more efficient.

Typical use cases

- Applications which can use this level of consistency typically do relatively few writes and many reads. The writes that are performed can be considered to be in a 'silo' of their own, that is, a given application 'session' only writes and reads its own data and is not concerned with the data read/written by other application 'sessions'.
- PHP applications are good candidates for SmartScale since PHP has embedded session IDs that can be passed at connection time.
- Web based applications with user profiles match the scenario where users will update their own profile and want to see their modifications right away, but can accept latency on other users profiles.

Comparison with Direct Reads

- Smart Scale allow session consistency, while Direct Reads always read from Replica, no matter whether data is up-to-date.
- However, the cost for consistency appears at the performance level, since the Connector constantly needs to check Replica progress.
- If your application needs to see the data it just wrote, use SmartScale
- If your application does a lot of small reads that do not need to be up-to-date, use Direct Reads

Limitations

- Prepared Statements - Prepared statements will need to be enclosed between transaction boundaries in order to work correctly with read/write splitting. This way, they will always execute on the Primary. Note that all prepared statements will become invalid upon switches or failover

- Ephemeral objects - Temporary tables, session variables and other objects that are connection specific will not be accessible when reading data using SmartScale. If you need to use these ephemeral object, you should either add a "for update" statement in you selects or avoid using SmartScale
- Read/write functions - Functions that create or modify data in the database should never be called with a simple SELECT statement. Always add "for update" a the end of the select call. Example:

```
SELECT my_function_that_writes('param') FOR UPDATE
```

- Currently, it is not recommended to use SMARTSCALE in conjunction with Parallel Apply. This is due to progress only being measured against the slowest channel.

  It is hoped that this will be resolved in a future release.

7.4.8.1. Specifying the Session ID

While the three first keywords (DATABASE, USER and CONNECTION) are connector-wide (a single connector instance will use these session ids for all connections), it is possible to configure the connector to allow a free string session ID. This string will have to be passed through the database name as `{db_name}?sessionId={sessionID}`. For example, when using a database named "test" and a session ID number 1234, the database name passed to the connector will be:

```
test?sessionId=1234
```

With mysql command line utility, the connection command will look like:

```
mysql -h connectorHost -u user -ppass -P 3306 test?sessionId=1234
```

JDBC clients will have to pass this session ID with a special tag, as follows:

```
jdbc:mysql://connector_host:3306/dbname@sessionId=1234?otherJdbcDriverOption=value
```

In order to use this feature, the special session id PROVIDED_IN_DBNAME needs to be specified at installation time

Also note that a session ID specified in the database name string will override the default provided in the connector configuration file. You can thus have a default session ID set for applications that can't specify it dynamically, and still allow other applications to connect with their own session ID variable.

7.4.8.2. Enabling SmartScale Routing

To enable SmartScale routing, configure the dataservice using the `--connector-smartscale` [440] option. The session ID identification should also be specified by using the `--connector-smartscale-sessionid` [440] option with one of the following values `DATABASE`, `USER`, `CONNECTION` or `PROVIDED_IN_DBNAME`:

```
shell> tpm configure alpha \
... \
--connector-smartscale=true \
--connector-smartscale-sessionid={DATABASE|USER|CONNECTION|PROVIDED_IN_DBNAME}
```

In this mode, any client application can open a connection to the connector, and queries will automatically be redirected according to the SQL statement content.

In addition, all users that connect to the database must be granted the `REPLICATION CLIENT` privilege so that the user can compare the current replicator progress for session information. This can be granted using:

```
mysql> GRANT REPLICATION CLIENT ON *.* to app_user@'%'
```

7.4.8.3. Disabling SmartScale Routing

To disable SmartScale routing if it has been previously configured:

```
shell> tpm configure alpha --connector-smartscale=false
```

7.4.8.4. SmartScale Exploit

When using DATABASE session ID, you can bypass session consistency to read from available Replicas by simply connecting to one database and reading from another. For example:

```
shell> mysql -u... -p... -P3306 db1
mysql> select * from db2.user
```

As long as no update is made on db1 in the meantime, the select will be executed on a Replica (if available)

7.4.9. Direct Routing

Auto Read/Write Splitting	Yes
Primary Selection	Automatically, by SQL examination
Replica Selection	Automatically, by SQL examination
QoS Compatibility	None
SmartScale Compatibility	None

Direct routing is a simplified form of SmartScale that uses a highly-efficient automated read/write splitting system, where of all auto-committed read-only transactions are routed to a pool of read-only Replica datasources. Unlike SmartScale, Direct routing pays no attention to the session state, or replicated data consistency.

This means that performing a write and immediately trying to read the information through a Direct routing connection may fail, because the Connector does not ensure that the written transaction exists on the selected Replica.

Direct routing is therefore ideal in applications where:

- Applications perform few writes, but a high number of reads.
- High proportion of reads on 'old' data. For example, blogs, stores, or machine logging information

Where applications are performing writes, followed by immediate reads of this data, for example conferencing and discussion systems, where reading stale data that has recently been written would create significant application failures, the solution should use should use SmartScale.

Read/Write splitting is supported through examination of the submitted SQL statement:

- If the statement contains `SELECT` and does not contain `FOR UPDATE`, the query is routed to an available Replica.
- If the statement starts `SHOW ...` then it is routed to a Replica.
- All other queries are routed to the Primary.

7.4.9.1. Enabling Direct Routing

To enable direct routing for a specific user, the `user.map` must be modified. Update the file with the `@direct` directive on every host running a connector. The connector will automatically read the changes after the file is saved.For example:

```
@direct sales
```

In this mode, any client application can open a connection to the connector, and queries will automatically be redirected according to the SQL statement content.

7.4.9.2. Limitations of Direct Routing

- Prepared statements must be enclosed within an explicit transaction boundary in order to be correctly routed to a Primary. For example:

```
BEGIN
PREPARE...
EXECUTE...
COMMIT
```

- Ephemeral objects (i.e. anything that is not replicated), will not be available on the Replica. Session variables are an excellent example of this.
- Stored procedures that update data in the database should never be called using a basic `SELECT` statement:

```
mysql> SELECT update_function('data');
```

Instead, add the `FOR UPDATE` keywords to ensure it is routed to the Primary:

```
mysql> SELECT update_function('data') FOR UPDATE;
```

7.4.10. SQL Routing

Auto Read/Write Splitting	No

Primary Selection	Manually, by SQL comments
Replica Selection	Manually, by SQL comments
QoS Compatibility	Supported
SmartScale Compatibility	Yes
Direct Compatibility	Yes

With SQL-based routing, the redirection of queries and operations through the Connector is controlled by hints on the QoS provided in the comments of individual statements. Note that this is explicit routing using SQL comments, not the automated read/write splitting supported by Direct or SmartScale routing.

Unless otherwise specified, statements will go to the current Primary to be executed, or whatever Replica is selected by the read-write splitting configuration, if enabled. To specify that a statement can be executed on the Replica, place a comment before the statement:

```
/* TUNGSTEN USE qos=RO_RELAXED */ SELECT * FROM TABLENAME
```

This style of comment indicates to the connector that the specific query that follows should go to a Replica. If unavailable, the query may still be executed on the Primary.

```
-- TUNGSTEN USE qos=RO_RELAXED
```

This style of comment indicates to the connector that all queries that follow should go to a Replica. If unavailable, any query may still be executed on the Primary.

> **Warning**
>
> If you force the Connector to send traffic to a Replica using qos=RO_RELAXED, then any write operations that follow will also go to the Replica until you tell the Connector to go back to the Primary by indicating qos=RW_STRICT. The application is fully responsible for where the traffic is routed to. if care is not taken, the application could send writes to a Replica this way which is unacceptable from a clustering perspective. All writes must go to the Primary or they will be lost to a non-authoritative node, and may corrupt the data badly.

The below forces all following queries to go to the Primary directly, effectively "turning off" reads from the Replica.

```
-- TUNGSTEN USE qos=RW_STRICT
```

> **Important**
>
> Please note that employing the `--` style will override any `/* */` comments.

7.4.10.1. Enabling SQL Routing

To enable SQL routing, use the following operations with tpm:

```
shell> tpm configure alpha
    --property=selective.rwsplitting=true
```

7.4.10.2. Limitations of SQL Routing

- Read/write splitting must be handled entirely by the client application using the comments to specify which statements are Replica safe. Unless applications explicit make the decision to write and read to the hosts using the comment system, operations may go to the wrong hosts.
- Prepared statements must be executed against the Primary.
- When testing the operation of the read/write splitting through the mysql client, ensure that command-line client is called using the `-c` option to ensure that comments are preserved:

```
shell> mysql -c -h host -u tungsten -ppassword -P3306 test
```

7.4.11. Host-based Routing

Auto Read/Write Splitting	No
Primary Selection	Manually, by hostname/IP address
Replica Selection	Manually, by hostname/IP address
QoS Compatibility	None

SmartScale Compatibility	None

Host-based routing uses specific hostnames to provide the distinction between read and write availability within the connector. Two different hostnames and associated IP addresses need to be created on each connector host. Clients connecting to one host will be routed to the current Primary for writing, and connections to the other host will be redirected to a current Replica using the current load-balancing algorithm.

Once enabled, a client can open a connection directly to a Primary or Replica by connecting to the appropriate IP address or hostname. For example:

```
shell> mysql -hmaster.localhost
```

Will connect to the currently active Primary, while:

```
shell> mysql -hslave.localhost
```

Would connect to any currently available Replica.

7.4.11.1. Enabling Host-based Routing

To enable host-based routing requires both operating system and Connector based configuration changes:

1. The following steps must be made to the operating system configuration for each Connector host that will be configured within the dataservice:

   a. Add a second IP address to the host. This can be achieved either by adding or exposing a second physical ethernet device, or by exposing an alias on an existing hardware interface.

      For example, to add a second IP address to the physical `eth0` interface:

      ```
      shell> sudo ifconfig eth0:1 192.168.2.24
      ```

      To ensure this is retained during a restart, update your network configuration with the additional physical interface and IP address.

   b. Update the `/etc/hosts` file to reflect both addresses and appropriate hostnames. For example:

      ```
      192.168.2.20 host1 Primary.host1
      192.168.2.21 Replica.host1
      ```

   c. When using DNS to resolve addresses, the DNS should also be updated with hostnames to match those configured for each IP interface.

2. Update the `user.map` file on every host running a connector to reflect the the desired QoS for each hostname. The connector will automatically read the changes after the file is saved.

   ```
   @hostoption Primary.host1 qos=RW_STRICT
   @hostoption Primary.host2 qos=RW_STRICT
   @hostoption Primary.host3 qos=RW_STRICT
   @hostoption Replica.host1 qos=RO_RELAXED
   @hostoption Replica.host2 qos=RO_RELAXED
   @hostoption Replica.host3 qos=RO_RELAXED
   ```

Once configured, client applications must be configured to select the appropriate host based on the operation they are performing.

7.4.11.2. Limitations of Host-based Routing

- Prepared statements must be executed on the Primary.
- Smartscale cannot be enabled at the same time as host-based routing.
- QoS selection will not be honored.

7.4.12. Port-based Routing

Auto Read/Write Splitting	No
Primary Selection	Manually, by network port
Replica Selection	Manually, by network port
QoS Compatibility	None

SmartScale Compatibility	None

Port-based routing configures two independent ports that enable client applications to select whether to connect to a Primary or Replica based on the port they connect to. This method relies on the application choosing the correct port, automatic r/w splitting is not supported. Similar to host-based routing, port-based routing requires the client application to be modified to manually select the appropriate port.

Once enabled, a client can open a connection directly to a Primary or Replica by connecting to the appropriate port. For example:

```
shell> mysql -P3306
```

Will connect to the currently active Primary, while:

```
shell> mysql -P3307
```

will connect to a read-resource, ideally a Replica, but will revert to the Primary if no appropriate Replica is avaialble.

> **Note**
>
> The ports to be used for each connection type are configurable during installation.

7.4.12.1. Enabling Port-based Routing

Enabling port-based routing requires configuring the two ports that will accept queries. One port will be designated as the Primary port, one the read-only port, and queries will be automatically routed accordingly. For example:

```
shell> tpm configure alpha \
... \
--connector-readonly-listen-port=3307 \
--connector-listen-port=3306
```

Cient applications must be updated to support the two port interfaces and manually direct their queries to the appropriate Primary or Replica.

Using port routing in this way effectively marks all connections to the read-only port as behaving in a similar fashion to setting the connection QoS to *RO_RELAXED* [224].

7.4.13. Read-only Routing

It is possible to deploy a connector that has been configured to provide read-only access to the underlying databases on the standard port. This enforces read-only connectivity through this connector, regardless of any session or connector configuration options. This can be useful for a standalone connector, or a single connector within a dataservice.

This setting places the connector into RO_RELAXED mode. The connector will choose the Primary if there is no available Replica. See Section 7.4.2, “Primary/Replica Selection” for more detail on Quality of Service modes.

To enable this functionality, configure the connector using the `--connector-readonly` [439] option:

```
shell> tpm configure alpha --connector-readonly=true
```

To enable this functionality on specific hosts only, add the `--hosts` [450] option:

```
shell> tpm configure alpha --connector-readonly=true --hosts=host1,host3
```

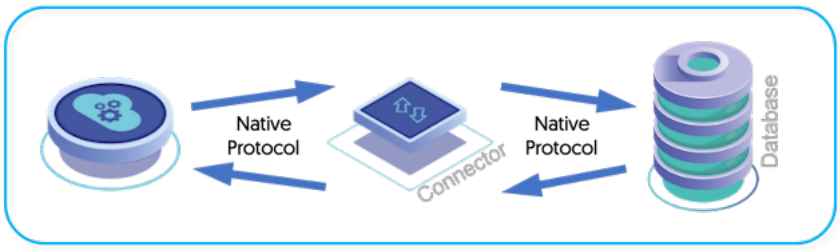
7.5. Using Bridge Mode

Bridge mode is the default connector routing method if no other routing method is explicitly stated. The bridge-mode does not use the `user.map` file which reflects other changes to take a more secure default deployment. A warning will be displayed during the validation process to tell you if bridge-mode is being enabled. It will not be enabled in the following cases:

- The `--connector-smartscale` [440] option is set to `true`.
- The `user.map` file contains `@direct` entries.
- The `user.map` file contains `@hostoption` entries.
- The `--property=selective.rwsplitting` [405] connector option is set to `true`.

Bridge mode eliminates the need to create or define users and passwords within the `user.map` file. Instead, the connector acts as a router connecting the network sockets between client application and MySQL servers.

Figure 7.7. Tungsten Connector Bridge Mode Architecture



Bridge mode provides a simpler method for connecting clients to MySQL, but with reduced facilities, as outlined in the table below:

Feature	Proxy Mode	Bridge Mode
Primary/Replica Selection	Yes	Yes
Switch/Failover	Yes	Yes
Automatic Read/Write Splitting	Yes	No
Application-based Read/Write Splitting	Yes	Yes
Seamless Reconnects	Yes	No
Data Source Selection	Current data source is checked to confirm latency and affinity	Pass-through
Session KeepAlive	Yes	No

Bridge mode connections operate as follows:

1. Client opens network connection to Connector
2. Connector allocates a network buffer for the client network connection to the database server
3. Connector opens a network connection to a database server based on the connection parameters (Primary/Replica selection)
4. Connector allocates a network buffer for the database server to the client application
5. Connector directly attaches the network sockets sockets together

Because the network sockets between the two sides are connected directly together, the following behavior applies to bridge mode connections:

- User authentication is handled directly by the database server, rather than through the `user.map` file.
- In the event of a failover or switch of the database servers, all active connections to the affected servers are closed.
- Smartscale and packet inspection to provide read/write splitting are not supported, since the Connector does not access individual packet data.

One key difference is in how Replica latency checking is handled:

- In Bridge mode, the latency is checked at connection time, then you will stick to the Replica for the connection lifetime (which can be shortened if the Replica goes offline).
- In Proxy mode, the latency is re-evaluated before each transaction, which can bring the connection to another Replica if the latency becomes too high during the life of the connection.

If you have long-lasting read-only connections that should not read from stale Replicas, then use Proxy mode.

If your connection lifetime is short (i.e make/break - one transaction then disconnect), or your application is not sensitive to reasonably outdated data for reads, then use Bridge mode and its optional read-only port.

7.5.1. Enabling Bridge Mode

To enable Bridge Mode, the `--connector-bridge-mode` [438] option to tpm must be set to `true`:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --connector-bridge-mode=true
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
connector-bridge-mode=true
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

The default value is `true`, i.e. use the connector in bridge mode.

Bridge Mode can also be used with read-only database servers and affinity if required.

In addition to enabling and disabling Bridge Mode, the size of the buffer can also be set by using the *`bridgeServerToClientBufferSize`* and *`bridgeClientToServerBufferSize`* parameters. This configures the size of the buffer used to hold packet data before the packet is forwarded.

The default size is 262144 bytes [256KB].

A buffer is opened in each direction for each connection made to the connector when operating in bridge mode.

The total memory allocated can be calculated using the formula:

```
(connections * (bridgeClientToServerBufferSize + bridgeServerToClientBufferSize)
```

For example, with the default settings, 20 simultaneous connections will require 10MB of RAM to service the buffers. With the default connector heap size the Connector should be able to handle up to 500 simultaneous connections.

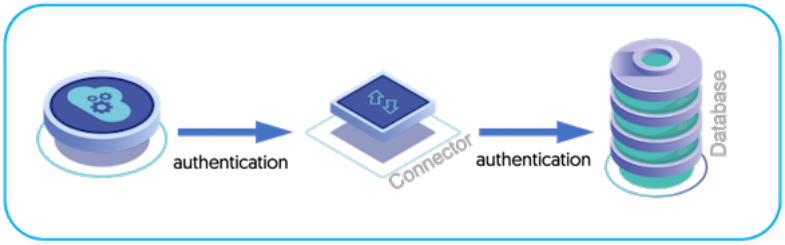
7.6. User Authentication

When configuring Tungsten Connector it is important to ensure that you have a `user.map` in place. The role of `user.map` is to define the usernames and passwords of users that will be connecting to the dataserver.

There is no authentication within the connector. Instead, the connector sends authentication information onto the dataserver. However, the MySQL network protocol exchanges a token between the client and the dataserver in order to authenticate the connection and is designed to prevent 'man in the middle' attacks.

Unfortunately, 'man in the middle' is exactly how Tungsten Connector operates, as the man in the middle to redirect queries to different dataservers as the list of active dataservers changes during the operation of a cluster. The authentication exchange cannot be reinitiated by the dataserver and client, so the Tungsten Connector performs this authentication exchange on behalf of the client using the user and password information from a special file called `user.map`.

Figure 7.8. Tungsten Connector Authentication



To get round this limitation, the connector operates as follows:

- Client opens a connection to the connector and authenticates.
- Connector connects to the datasource using the username supplied by the client, and the corresponding password stored within `user.map`.
- Database server returns the authentication token to the connector.
- Connectors sends the same authentication token back to the client.

This process gives the client application the authentication token required to enable it to communicate with the dataserver and the same token to be used by the connector.

For this system to work, a file, `user.map`, must exist on every connector installation, and it must contain the information for all users that will connect to the datasources from each client. Without this information, connectors will be unable to login on behalf of the client applications.

> **Important**
>
> All the users that require access to your MySQL servers through the Tungsten Connector *must* have an entry in the `user.map`. Without this information, the Tungsten Connector has no way of providing an onward connection to a MySQL server.

The `user.map` file primary role is to operate as the source for authentication information within the connector. However, through the use of additional flags and keywords, the file can also define the routing methods used by different users when connecting to datasources, and different dataservices.

7.6.1. `user.map` File Format

The current `user.map` file is located within the `tungsten-connector/conf` directory within an active installation. The file should be synchronized across all the servers within a dataservice. For more information on methods for keeping the file in sync, see Section 7.6.7, “Synchronizing `user.map` Data”.

The `user.map` file contains the usernames and passwords for each user that connects to the connector and the downstream MySQL server, and these entries are required for authentication. If an entry does not exist within `user.map` users will be unable to connect to MySQL through the connector.

> **Important**
>
> All the users that require access to your MySQL servers through the Tungsten Connector *must* have an entry in the `user.map`. Without this information, the Tungsten Connector has no way of providing an onward connection to a MySQL server.

The rules for the format of the file are as follows:

- Anything after a `#` (hash) symbol are interpreted as comments and ignored. For example:

```
# This line is a comment
```

- The following character cannot be used as the username, password or dataservice values:

```
space
|  # pipe
\t # tab
```

- Using the - (hyphen) character as a password indicates that there is an empty or no password ("") for the specified user.

The basic format for user entries within the user.map is:

```
username password servicename [affinity]
```

Where:

- *username* — the username to be used for authentication.

  The *username* also provides hooks into additional options; see @script, @direct, @hostoption.

- *password* — the password to be used for authentication.

  - Quotes ' and double quotes " are supported in the user.map password.
  - If there's a space in the password, the password needs to be surrounded with " or ':

    ```
    "password with space"
    ```

  - If there's one or several " or ' in the password without space, the password doesn't need to be surrounded

    ```
    my"pas'w'or"d"
    ```

  - If the password itself starts and ends with the same quote (" or '), it needs to be surrounded by quotes.

    ```
    "'mypassword'" so that the actual password is 'mypassword'.
    ```

  As a general rule, if the password is enclosed in either single or double quotes, these are not included as part of the password during authentication.

- *servicename* — the name of the dataservice or composite service to which this username/password apply.
- *affinity* — if the servicename is a composite service, the *affinity* identifies which service should be preferred for reads.

  The affinity feature routes both reads and writes when using a Composite Active/Active topology.

For example, to configure the user sales with the password secret to use MySQL servers within the alpha dataservice:

```
sales secret alpha
```

To configure a user that has no password:

```
sales - alpha
```

To configure a user within a composite service:

```
sales secret global
```

To configure a user within a composite service, preferring the east service for read-only connections:

```
sales secret global east
```

Composite Specification in 6.0.3

The deployment used in the examples below consists of a composite dataservice global, with four member dataservices (i.e. one cluster per site): east, west, north and south.

For example, to exclude site south from servicing read requests:

```
sales secret global east,west,north,-south
```

The above affinity string "east,west,north,-south" will try east, then west, then north. If none of the first three are available, a connection request would not succeed since south has been excluded by the negation ("-").

In the following example, dataservices north and south would be available as random candidates if the first two (east and west) were unavailable:

```
sales secret global east,west
```

7.6.2. user.map Direct Routing

To enable direct reads, as defined within Section 7.4.9, “Direct Routing”, the entries for the user within user.map must be prefixed using the @direct. For example:

```
@direct sales
```

Note that the standard user, password and service must be defined:

```
sales secret alpha
@direct sales
```

For limitations of direct routing, see Section 7.4.9.2, “Limitations of Direct Routing”.

7.6.3. `user.map` Host Options

The `user.map` provides a configuration point to enable the connector to support host options that enable you to define qualities of service against specific hosts, as configured according to the guidance within Section 7.4.11, “Host-based Routing”.

When configuring the host options, the hostnames must have previously been defined and be resolvable.

The QoS within `user.map` has the following format:

```
@hostoption hostname QoS
```

For example, to enable *`RW_STRICT`* [224] on one host and *`RO_RELAXED`* [224] on the other:

```
@hostoption readwrite.master qos=RW_STRICT
@hostoption readonly.master qos=RO_RELAXED
```

7.6.4. `user.map` Updates

When the `user.map` file is updated:

- The Tungsten Connector should automatically identify that the file has been changed and reload the file, updating the user map.
- To manually force the users to be updated, for example, if the `user.map` uses the `@script`, use the tungsten flush privileges command:

  ```
  mysql> tungsten flush privileges;
  +-------------------------------+
  | Message                       |
  +-------------------------------+
  | user.map reloaded successfully |
  +-------------------------------+
  1 row in set (0.00 sec)
  ```

  If you are using the `--application-readonly-port` [433] option, this command must be run through both ports. Alternatively, you can trigger a simultaneous flush by running:

  ```
  shell> touch /opt/continuent/tungsten/continuent-connector/conf/user.map
  ```

- When using `@direct` entries in `user.map`, the connector may need to be restarted using connector restart:

  ```
  shell> connector restart
  ```

  This will disconnect all connected clients, but the connector itself should be unavailable only for a short time.

- When the connector installation is updated using tpm, for example during an upgrade, the `user.map` and `dataservices.properties` are automatically copied into the new installation automatically and do not need to be manually copied or update.

  To perform an update without automatically copying the `user.map` file using the `--connector-delete-user-map` [438] option to tpm.

7.6.5. Generating `user.map` Entries from a Script

The content of the `user.map` file can be generated automatically, for example by automatically extracting information from a separate service, such as LDAP, NIS or others. To specify the script that will generate the information, the `@script` directive can be used within the `user.map`:

```
@script /opt/continuent/share/usermap
```

When using the script method:

- The information must be generated in the same format as for standard entries, i.e.:

  ```
  username password servicename
  ```

- If the script generates multiple entries with the same name, the later output will overwrite the previous entry.
- Multiple `@script` directives can be specified. Each will be processed in turn.

- If a generated list of usernames changes due to the scripts, the connector must be manually forced to reload the usermap using tungsten flush privileges on a connector connection. If you are using the `--application-readonly-port` [433] option, this command must be run through both ports. Alternatively, you can trigger a simultaneous flush by running:

```
shell> touch /opt/continuent/tungsten/continuent-connector/conf/user.map
```

- If the file is placed into `/opt/continuent/share` then the script will be retained during upgrades through tpm update.
- If a script within the `@script` fails to be executed correctly, or generates no user entries, the connector will fail to start.

The script itself can be relatively simple, the standard output of the command must contain the user entries to be included in `user.map`. Standard error is ignored.

For example:

```
#!/bin/bash

echo 'app_user password dsone'
```

This generates a simple user entry.

7.6.6. Encrypting `user.map` Data

The `user.map` file allows you to use an encryted version of the file by using the `@script` directive. Here is an example of how you can decrypt a file and return the results to `user.map`.

1. Change to a directory outside of the currently installed Tungsten

   Do this to ensure that the OpenSSL key and encrypted file are available after upgrades and other operations.

   ```
   shell> cd /opt/continuent/share
   ```

2. Create an OpenSSL key

   In this example we will use a 1024-bit RSA private key to do the encryption and decryption. There are many options for encrypting and decrypting files but this documentation will not explore those. The same process will work with other encryption techniques. You must ensure that the decryption command runs without user input.

   ```
   shell> openssl genrsa -out usermap.pem 1024
   ```

3. Create the encrypted file of `user.map` entries:

   ```
   tungsten secret nyc_sjc sjc
   tungsten_sjc secret sjc
   tungsten_nyc secret nyc
   ```

   Create an encrypted version of the file:

   ```
   shell> openssl rsautl -encrypt -inkey usermap.pem -in user.map.entries -out user.map.entries.ssl
   ```

4. Test decryption of the encrypted file:

   ```
   shell> openssl rsautl -decrypt -inkey usermap.pem -in user.map.entries.ssl
   ```

   This should return the unencrypted `user.map`:

   ```
   tungsten secret nyc_sjc
   tungsten_sjc secret sjc
   tungsten_nyc secret nyc
   ```

5. Update the installed and configured `tungsten-connector/conf/user.map` file:

   ```
   ...
   # Examples:
   # user tungstenuser has password secret and uses 'sjc_nyc' composite
   # data service, but prefers nyc site for reading:
   #   tungstenuser secret sjc_nyc nyc
   ```

   Now add a `@script` directive to point to the encrypted file and certificate:

   ```
   @script openssl rsautl -decrypt -inkey /opt/continuent/share/usermap.pem -in /opt/continuent/share/user.map.entries.ssl
   ...
   ```

6. Repeat the process on each host. The `user.map` file will be copied to the new version when you upgrade Tungsten so this process must only be completed once per host.

7.6.7. Synchronizing `user.map` Data

Tungsten Cluster does not automatically synchronize information contained within the `user.map` across all the nodes within the cluster. The connector does not identify, track, or update `user.map` content when it sees password changes.

Instead, the file must be updated by hand, through the `@script` directive, and synchronized across multiple hosts either manually or by using a script. For example:

```
#!/bin/bash

for HOST in host1 host2 host3 host4
do
  rsync /opt/continuent/tungsten/tungsten-connector/conf/user.map \
      $HOST:/opt/continuent/tungsten/tungsten-connector/conf/user.map
done
```

If `@script` directives, the corresponding scripts must also be included within this synchronization step.

> **Important**
>
> All servers within the cluster must have an identical `user.map` configuration. Failure to have a synchronized configuration may lead to clients being unable to connect to the connector and database servers.

7.6.8. `user.map` Limitations

The `user.map` configuration has the following limitations:

- Users must be defined for each dataservice; if there is a common user that can be used in any of your configured dataservices, there must be an individual line for each dataservice. For example:

  ```
  sales secret alpha
  sales secret beta
  sales secret gamma
  ```

- When using `user.map` with multiple dataservices, additional data services must exist in `dataservices.properties`. Only add the physical data services you would like to work with. Any composite data services will automatically be discovered. The connector must be restarted once the data services have been added.
- Specifying a composite dataservice that has not been defined will raise an error.
- If the `user.map` contains multiple entries for the same user, only the last entry will be used.

7.6.9. Host-based Authentication

In addition to the explicit user/host based authentication support, the connector also includes general host-based authentication that allows client connections only from specific hosts.

Host-based authentication is not enabled in the default installation. To enable it, create a file `authorized_hosts` within the `tungsten/tungsten-connector/conf/` directory of the active installation. The connector will then need to be restarted before host-based authentication is enabled.

> **Important**
>
> The `authorized_hosts` file is not automatically distributed during deployment and updates. The file must be manually copied to other hosts.
>
> If the content of the `authorized_hosts` file is changed, the connector configuration must be reloaded using the connector reconfigure [304] command for changes to take effect.

If the file exists, host-based authentication is enabled. If it is empty, all client connections are denied. The format of the file is that each line defines the host address and netmask in CIDR format. For example:

```
192.168.1.0/24
```

Enables connectivity from all hosts in the range 192.168.1.0-192.168.1.255.

7.7. Testing Connectivity Via the Connector

To test connectivity to the database server through the Tungsten Connector there are a variety of methods to choose from depending on thee selected configuration.

7.7.1. Testing Connectivity in Bridge Mode

When using Bridge mode (the default at install), all requests are routed to the Primary by default. To test query routing, run the following query when connected through the Connector:

```
Route to the Primary:
mysql> select @@hostname;
```

In Bridge mode, the only way to verify that reads are being directed to replicas is to establish a read-only port and execute queries through it to force the QoS `RO_RELAXED`.

First, ensure that your INI file has the following option, then run tpm update

```
connector-readonly-listen-port=3307
```

To test, ensure you connect to the specified read-only port:

```
Route to a Replica:
shell> mysql -h... -P3307
mysql> select @@hostname;
```

7.7.2. Testing Connectivity in Proxy Mode with No R/W Splitting Enabled

To test Connector query routing in Proxy mode, you may use the URL-based R/W splitting to test query routing:

```
Route to the Primary:
shell> mysql -h... -Dtest@qos=RW_STRICT -e "select @@hostname;"

Route to a Replica:
shell> mysql -h... -Dtest@qos=RO_RELAXED -e "select @@hostname;"
```

7.7.3. Testing Connectivity in Proxy Mode with R/W Splitting Enabled (SmartScale or @direct)

To test Connector query routing in Proxy mode when either SmartScale or @direct read/write splitting has been enabled, you may use the following:

```
Route to the Primary:
mysql> select @@hostname for update;

Route to a Replica:
mysql> select @@hostname;
```

7.8. Connector Operational States

During operation, the connector goes through a number of different states and state transition during specific events. The default mode is the `Online` [241] state, where the connector operates as configured.

During operation, all configured connectors within the dataservice remain in contact with the manager, see Section 7.9, “Connector/Manager Interface” for more information.

Supported states by the Connector are:

- **`Online`** [241] State

  The Connector operates as configured, redirecting connections to the corresponding Primary or Replica.

- **`On Hold`** [241] State

  The connector will enter this state as soon as the manager connection is lost if *`delayBeforeOnHoldIfNoManager=0`* (the default), or after the specified delay.

  In this state, new connection requests are paused (client applications trying to connect will see what appears to be a “hang”) while existing connections will continue as normal until the Offline state is reached

  This property can be set using the tpm flag `connector-delay-before-onhold`.

- **`Offline`** [241] State

  The connector enters the offline state *`delayBeforeOfflineIfNoManagerseconds`* after the connection to the manager is lost.

This property can be set using the tpm flag `connector-delay-before-offline`. The default value is 30, which means going to the offline state after 30 seconds.

When entering the offline state, the connector terminates all existing connections, and rejects all new connections requests (client applications will receive an error when trying to connect).

The state of a connector can be modified by using the router command within cctrl. This can be used to manually place the connector into online or offline states. For example, to put a connector online the full host and process ID must be used:

```
cctrl> router connector@host1[22476] online
```

Wildcards can be used to enable or disable all the hosts. For example, to place all connectors online:

```
cctrl> router * online
```

While in *`AUTOMATIC`* policy mode, connectors will automatically be placed online if they have entered the `OFFLINE` [241] state automatically as part of a failover. If the routers have been manually placed offline, routers must be manually placed back online.

While in the `ONLINE` [241] state, the connector behaves and alters it's operation according to the following states and events:

7.8.1. Connections During Automatic Failure/Failover

When an automatic failure or failover is identified, for example when the dataservice is in the *`AUTOMATIC`* policy mode, and the Primary is automatically switched to a new host, the following sequence occurs:

1. All connections to the failed datasource are terminated immediately. This ensures that running transactions or operations are terminated by the database server.
2. Connections to clients will remain open and be reconnected transparently, providing they are not within a transaction. For more information, see Section 7.8.3, “Connections During Connection Failures”.

   Only if there is a problem with the connection or an I/O error will the problem be forwarded to the clients.

As with a direct database connection, the client application should handle the reconnection to the Connector, which will be then be redirected to the corresponding Primary or Replica datasource.

7.8.2. Connections During Manual Switch

When a manual switch operation has been initiated, the Connector follows this sequence:

1. New connection attempts to the old datasource are suspended; this gives the impression of a 'hung' connection that must be managed by the client application through the normal timeout procedure.
2. Existing connections to the datasource are terminated under two conditions:
   - As the connections are naturally closed.
   - Open connections are forcibly disconnected after the timeout specified by the `waitForDisconnectTimeout` parameter. By default, this is 5 seconds. To eliminate waiting, the *`waitForDisconnect`* parameter can be set to `false`.

   Once either condition has been met, any remaining connections are closed.
3. New connections (including re-connections) are enabled, and will be routed to the appropriate Primary or Replica.

Client applications should be configured to reconnect to the connector with an interval larger than the disconnect timeout within the connector. This will ensure that the client reconnects when the connector is able to accept the new connection.

7.8.3. Connections During Connection Failures

In the event of a connection failure between a running datasource and the connector, and providing the connection is deemed idle, the connector will transparently reconnect to the failed datasource when the following conditions have been met:

- The connection is not executing any requests.
- The connection is not in the middle of a transaction.
- No temporary tables have been created during this connection.

If all three conditions are met, a new connection will be opened. Connections between the client and the connector will be unaffected.

This option is enabled by default. To disable transparent reconnections, use `--connector-autoreconnect=false=` [437] option to tpm during installation.

7.8.4. Other Errors

The Connector attempts to emulate and effectively represent any errors raised by the datasource to which the connector has routed the client connection.

- The Tungsten Connector uses the Tanuki Java Service Wrapper to manage the running process. If the Connector process fails, the service wrapper will automatically restart it. If the connector fails repeatedly, attempts to restart will be stopped. The status and reason for these failures can be tracked by examining the `connector.log` log file.

  Connected client applications will be terminated, but should be able to reconnect once the Connector has been restarted.

- Database errors, including invalid statements, operations, or security failures, will be represented identically by the Connector to any clients.

7.8.5. Connector Keepalive

Connections to MySQL servers can automatically time-out according to the `wait_timeout` variable configured within the MySQL server.

To prevent these connections being automatically closed, the connector can be configured to keep the connection alive by submitting a simple `SELECT` statement (actually `SELECT 'KEEP_ALIVE'`) periodically to ensure that the MySQL timeout is not reached and the connection closed.

Two parameters configure the keepalive functionality:

- *`connection.keepAlive.interval`*

  The interval used to check for idle connections. If set to a value of 0, the keep alive check is disabled. Any value greater than zero is the interval check period in seconds.

- *`connection.keepAlive.timeout`*

  The keep-alive statement is submitted if the time since the last activity reaches this timeout value.

The default setting for both parameters is *`autodetect`*.

When set to *`autodetect`* default, the values are automatically calculated by the connector computing suitable values based on the `wait_timeout` value configured in the MySQL server.

```
connection.keepAlive.interval = (int) Math.floor(wait_timeout * 0.10);
connection.keepAlive.timeout = (int) Math.floor(wait_timeout * 0.7);
```

These calculations cannot be modified, but the properties can be explicitly set by using the `--property` [405] to explicitly set the property through tpm, for example:

```
shell> tpm update alpha --property=connection.keepAlive.interval=30
```

Warning

Please note that Connector Keepalive is not compatible with Bridge mode.

In Bridge mode, the client session is directly connected to the MySQL server at the TCP level, literally forwarding the client's packet to the server. This means that closing connections is the responsibility of the MySQL server based on the configured wait_timeout value, not the Connector.

7.8.6. Connector Change User as Ping

When using PHP with connection pooling enabled, the the change user command is used to ping a connection within a pool to ensure that the connection is open and active before using it. The Tungsten Connector uses JDBC to connector to MySQL, which does not support the change user protocol option.

To provide an alternative to this for PHP applications communication through the connector, the connector can be configured to respond to the `COM_CHANGE_USER` command from a client application. Rather than performing the change user operation, instead the connector will respond to the client with an acknowledgement, emulating the ping operation.

This operation is disabled by default, and must be explicitly enabled. This can be achieved by setting the correct property value, `treat.com.change.user.as.ping`, to `true` during configuration with tpm:

```
shell > tpm configure alpha --property=treat.com.change.user.as.ping=true
```

7.9. Connector/Manager Interface

The connector remains in constant communication with the Tungsten Manager during operation. This enables the connector to respond to failures and errors, whether automatically identified, or manually triggered. For example, when a manual switch operation occurs, the manager communicates this information to all of the connectors. Each connector then responses according to the rules outline in Section 7.8, "Connector Operational States".

The connector remains in communication with one, and only one, manager at a time. If the manager becomes unavailable, connector tries to communicate another manager within the dataservice.

Communication from the manager to the connectors is made in parallel using multiple threads, this ensures that all connectors are made aware of a change in the topology of the cluster at the same time, rather than a round-robin or staged distribution. When a change has been requested, the manager waits for a response from the cluster before confirming that switch and operational change has taken place.

Communication between managers and the connectors is handled on ports 11999 (managed by `--router-gateway-port` [465]) and 12000 (managed by `--mgr-rmi-remote-port` [457]). The connection is used to exchange cluster status and individual datasource availability as identified by the manager so that decisions about active connections can be effectively made by the connector.

In the event that the connection between the connector and the manager is broken, the connector enters a failsafe mode called `On Hold` [241]. In this state, connections to and from the connector and datasources will continue as normal until a timeout, configured by the *`delayBeforeOfflineIfNoManager`* property, is reached. By default, this timeout is 600 seconds (10 minutes). Once the timeout has been reached, the connector reaches the `Offline` [241] state.

All of the information about the dataservice, including the other nodes, topology and individual node states and roles are entirely determined by the Connector by requesting this information from the Manager. No on-disk record or description is stored or stored, created, or read by the Connector. When the Connector is first started, it connects to a manager and requests the full cluster configuration.

If the Connector cannot communicate with a manager, the connector remains in the `Offline` [241] state until a manager can be reached.

7.10. Connector Command-Line Interface

The connector command is used for various operations that affect the Tungsten Connector, for example, starting and stopping the Tungsten Connector, getting status, updating and debugging.

When using the connector command-line tool, the following sub-commands are available:

Table 7.2. Connector Command Line Sub-Commands

Option	Description
`client-list` [303]	Return a list of the current client connections through this connector.
`cluster-status` [303]	Return the cluster status, as the connector currently understands it. This is the command-line alternative to the inline cluster status command.
`condrestart` [304]	Restart only if already running
`console` [304]	Launch in the current console (instead of a daemon)
`dump` [304]	Request a Java thread dump (if connector is running)
`graceful-stop [seconds]` [304]	Stops the connector gracefully, allowing outstanding open connections to finish and close before the connector process is stopped. All new connection requests are denied. The Connector will shut down as soon as there are no active connections. [seconds] is an integer specifying the optional time to wait before terminating the connector. Specifying no value for seconds will cause the Connector to wait indefinitely for all connections to finish. Specifying zero (0) seconds will cause the Connector to shut down immediately without waiting for existing connections to complete gracefully. As of v7.0.0, connector drain is available as an alias for connector graceful-stop.
`install` [304]	Install the service to automatically start when the system boots
`reconfigure` [304]	Reconfigure the connector by forcing the connector to reread the configuration, including the configuration files and `user.map`.
`remove` [304]	Remove the service from starting during boot
`restart` [304]	Stop connector if already running and then start
`start` [304]	Start in the background as a daemon process

Option	Description
status [305]	Query the current status
stop [305]	Stop if running (whether as a daemon or in another console) Optional timeout in seconds can be provided (From release 6.1.19 only)

For more information, please see Section 9.9, "The connector Command".

7.11. Connector Inline Command Interface

When connected to a service through Tungsten Connector, the connection has access to a number of specialized commands that can be executed

> **Important**
>
> When using Bridge Mode, these commands will not be available because you are connected directly to the database server.

Table 7.3. Inline Interface Commands

Option	Description
tungsten cluster status	Displays a detailed view of the information the connector has about the cluster
tungsten connection count	Display the current number of active connection to each datasource
tungsten connection status	Displays information about the connection status for the last statement executed
tungsten flush privileges	Reload the user.map file and update the user credentials
tungsten gc	Executes the connector garbage collector to free memory
tungsten help	Shows help description each statement
tungsten mem info	Display the memory usage information for the connector
tungsten show processlist	List all active queries on this connector instance
tungsten show variables	Display the connector configuration options currently in use

7.11.1. Connector tungsten cluster status Command

Shows the current cluster status, as far as the connector is aware. The output consists of a table showing dataservices and hosts and current status and role information:

```
mysql> tungsten cluster status;
+-----------------+-------+-------+--------+---------+----------------+----------------------+-------------------------+
| dataServiceName | name  | host  | role   | state   | appliedLatency | activeConnectionCount | connectionsCreatedCount |
+-----------------+-------+-------+--------+---------+----------------+----------------------+-------------------------+
| alpha           | host1 | host1 | slave  | SHUNNED | 60.0           | 0                    | 0                       |
| alpha           | host2 | host2 | master | ONLINE  | 0.0            | 1                    | 2                       |
| alpha           | host3 | host3 | slave  | SHUNNED | 61.0           | 0                    | 0                       |
+-----------------+-------+-------+--------+---------+----------------+----------------------+-------------------------+
3 rows in set (0.01 sec)
```

The output fields are as follows:

- *dataServiceName*

  The name of the service. In connectors configured with multiple services, including composite clusters, there will be an entry for each host/servicename combination.

- *name*

  The name of the host within the service.

- *host*

  The hostname on which the service is running.

- *role*

The current role for the host.

- *state*

  The current state for the host within the service.

- *appliedLatency*

  The applied latency of transactions; for Primaries the difference between the commit time and extraction, in a Replica, the difference between commit time in the Primary and commit time in the Replica.

- *activeConnectionCount*

  Count of the current number of active connections.

- *connectionsCreatedCount*

  Count of the number of connections created since the connector has been started.

7.11.1.1. Connector connector cluster status on the Command-line

The tungsten cluster status is also available from the command-line through the connector command. To use this command from the command line, place the cluster-status command on the command-line. For example:

```
shell> connector cluster-status
Executing Tungsten Connector Service --cluster-status ...
+--------------+--------------------+-------------+--------------+--------+--------+-----------------------------------------+----------------------+----
| Data service | Data service state | Data source | Is composite | Role   | State  | High water                              | Last shun reason     | App
+--------------+--------------------+-------------+--------------+--------+--------+-----------------------------------------+----------------------+----
| alpha        | ONLINE             | demo-c11    | false        | master | ONLINE | 11(mysql-bin.000033:0000000000000523;-1) |                      | 752
| alpha        | ONLINE             | demo-c12    | false        | slave  | ONLINE | 11(mysql-bin.000033:0000000000000523;-1) | SHUNNED-FOR-RECOVERY | 752
+--------------+--------------------+-------------+--------------+--------+--------+-----------------------------------------+----------------------+----

Done Tungsten Connector Service --cluster-status
```

The information can also be output in JSON format by adding the `-json`:

```
shell> connector cluster-status -json
Executing Tungsten Connector Service --cluster-status -json...
{
  "alpha" : {
    "demo-c11" : {
      "name" : "demo-c11",
      "dataServiceName" : "alpha",
      "host" : "demo-c11",
      "activeConnectionCount" : 0,
      "alertMessage" : "",
      "alertStatus" : "OK",
      "alertTime" : 1496310617376,
      "appliedLatency" : 7528198.0,
      "available" : true,
      "callableStatementsCreated" : 0,
      "childType" : "UNDEFINED",
      "composite" : false,
      "compositeMember" : null,
      "connectionsCreated" : 0,
      "container" : false,
      "dataServerHost" : "demo-c11",
      "dataSourceRole" : "&mas_lc;",
      "driver" : "org.drizzle.jdbc.DrizzleDriver",
      "enabled" : 0,
      "executable" : false,
      "isAvailable" : true,
      "key" : "demo-c11",
      "lastError" : "",
      "lastShunReason" : "",
      "lastUpdate" : 1511778569541,
      "&mas_lc;" : true,
      "&mas_lc;ConnectUri" : "",
      "precedence" : 99,
      "preparedStatementsCreated" : 0,
      "relativeLatency" : 7528879.0,
      "relay" : false,
      "role" : "&mas_lc;",
      "sequence" : {
        "wrapAround" : 9223372036854775807,
        "generation" : 0,
        "identity" : "b70818d0-6506-4fd1-8e23-c303ccc2bcba",
        "currentValue" : 0,
```

```
      "lastValue" : 0,
      "wrapped" : false
    },
    "&slv_lc;" : false,
    "standby" : false,
    "state" : "ONLINE",
    "statementsCreated" : 0,
    "type" : "DATASOURCE",
    "updateTimestamp" : 1511778569541,
    "url" : "jdbc:mysql:thin://demo-c11:3306/${DBNAME}?jdbcCompliantTruncation=false&zeroDateTimeBehavior=convertToNull&tinyInt1isBit=false&allowMultiQu
    "vendor" : "mysql",
    "vipAddress" : "",
    "vipInterface" : "",
    "vipIsBound" : false,
    "witness" : false
  },
  "demo-c12" : {
    "name" : "demo-c12",
    "dataServiceName" : "alpha",
    "host" : "demo-c12",
    "activeConnectionCount" : 0,
    "alertMessage" : "",
    "alertStatus" : "OK",
    "alertTime" : 1511779000635,
    "appliedLatency" : 7528198.0,
    "available" : true,
    "callableStatementsCreated" : 0,
    "childType" : "UNDEFINED",
    "composite" : false,
    "compositeMember" : null,
    "connectionsCreated" : 0,
    "container" : false,
    "dataServerHost" : "demo-c12",
    "dataSourceRole" : "&slv_lc;",
    "driver" : "org.drizzle.jdbc.DrizzleDriver",
    "enabled" : 0,
    "executable" : false,
    "isAvailable" : true,
    "key" : "demo-c12",
    "lastError" : "--",
    "lastShunReason" : "SHUNNED-FOR-RECOVERY",
    "lastUpdate" : 1511779000635,
    "&mas_lc;" : false,
    "&mas_lc;ConnectUri" : "",
    "precedence" : 99,
    "preparedStatementsCreated" : 0,
    "relativeLatency" : 7528878.0,
    "relay" : false,
    "role" : "&slv_lc;",
    "sequence" : {
      "wrapAround" : 9223372036854775807,
      "generation" : 0,
      "identity" : "a12e5122-d1c3-4d8b-98fe-d58241b86bf9",
      "currentValue" : 4,
      "lastValue" : 3,
      "wrapped" : false
    },
    "&slv_lc;" : true,
    "standby" : false,
    "state" : "ONLINE",
    "statementsCreated" : 0,
    "type" : "DATASOURCE",
    "updateTimestamp" : 1511779000634,
    "url" : "jdbc:mysql:thin://demo-c12:3306/${DBNAME}?jdbcCompliantTruncation=false&zeroDateTimeBehavior=convertToNull&tinyInt1isBit=false&allowMultiQu
    "vendor" : "mysql",
    "vipAddress" : "",
    "vipInterface" : "",
    "vipIsBound" : false,
    "witness" : false
  }
 }
}
Done Tungsten Connector Service --cluster-status -json
```


7.11.2. Connector tungsten connection count Command

Displays the current list of open connections for all hosts within the cluster.

```
mysql> tungsten connection count;
+--------------+-------------+-------------------------------------------------------------------------+
| Data service | Data source | Active Connections                                                      |
+--------------+-------------+-------------------------------------------------------------------------+
| alpha        | ct-multi1   | [internal(OPEN) DIRECT TO ct-multi1@alpha(master:ONLINE) STATUS(OK)] |
```

```
| alpha        | ct-multi2   | []                                                                          |
| alpha        | ct-multi3   | []                                                                          |
+--------------+-------------+-----------------------------------------------------------------------------+
3 rows in set (0.00 sec)
```

7.11.3. Connector tungsten connection status Command

Displays the current connection status, for all connections, including indicating whether the connection is using SSL on either the incoming (client) or outgoing (MySQL) connection:

```
mysql> tungsten connection status;
+-------------------------------------------------------------------------------------+
| Message                                                                             |
+-------------------------------------------------------------------------------------+
| ct-multi1@alpha(master:ONLINE) STATUS(OK), QOS=RW_STRICT SSL.IN=false SSL.OUT=false |
+-------------------------------------------------------------------------------------+
1 row in set (0.05 sec)
```

7.11.4. Connector tungsten flush privileges Command

Forces a reload of the `user.map` file to update the user privileges configured within the file. Only forces an update of the connector to which the client is connected.

```
mysql> tungsten flush privileges;
+--------------------------------+
| Message                        |
+--------------------------------+
| user.map reloaded successfully |
+--------------------------------+
1 row in set (0.00 sec)
```

7.11.5. Connector tungsten gc Command

Forces a Java garbage collection for the connector, recovering memory. An example of the memory used, garbage collection, and resulting memory usage below.

```
mysql> tungsten mem info;
+----------------------+-----------------------------------------------------+
| JVM Memory statistics | Value in bytes                                      |
+----------------------+-----------------------------------------------------+
| Peak Thread Count     | 18                                                  |
| Heap Memory           | init = 67108864(65536K) used = 17437496(17028K)     |
|                       | committed = 64880640(63360K) max = 259522560(253440K) |
| Non-heap Memory       | init = 24313856(23744K) used = 13970024(13642K)     |
|                       | committed = 24313856(23744K) max = 224395264(219136K) |
| Thread Count          | 16                                                  |
+----------------------+-----------------------------------------------------+
4 rows in set (0.05 sec)

mysql> tungsten gc;
+-------------------------------+
| Message                       |
+-------------------------------+
| Garbage collection successful |
+-------------------------------+
1 row in set (0.41 sec)

mysql> tungsten mem info;
+----------------------+-----------------------------------------------------+
| JVM Memory statistics | Value in bytes                                      |
+----------------------+-----------------------------------------------------+
| Peak Thread Count     | 18                                                  |
| Heap Memory           | init = 67108864(65536K) used = 4110088(4013K)       |
|                       | committed = 64946176(63424K) max = 259522560(253440K) |
| Non-heap Memory       | init = 24313856(23744K) used = 13970024(13642K)     |
|                       | committed = 24313856(23744K) max = 224395264(219136K) |
| Thread Count          | 16                                                  |
+----------------------+-----------------------------------------------------+
4 rows in set (0.00 sec)
```

7.11.6. Connector tungsten help Command

Displays the list of currently supported commands within the connector inline interface:

```
mysql> tungsten help;
+-----------------------------------------------------------------------------+
| Message                                                                     |
```

```
+-------------------------------------------------------------------------+
| tungsten connection status:                display information about the |
|                                            connection used for the last  |
|                                            request ran                   |
| tungsten connection count:                 gives the count of current    |
|                                            connections to each one of the|
|                                            cluster datasources           |
| tungsten cluster status:                   prints detailed information   |
|                                            about the cluster view this   |
|                                            connector has                 |
| tungsten show [full] processlist:          list all running queries      |
|                                            handled by this connector     |
|                                            instance                      |
| tungsten show variables [like 'string']:   list connector configuration  |
|                                            options in use. The 'string'  |
|                                            may contain '%' wildcards     |
| tungsten flush privileges:                 reload user.map and refresh   |
|                                            user credentials              |
| tungsten mem info:                         display memory information    |
|                                            about current JVM             |
| tungsten gc:                               calls garbage collector       |
| tungsten help:                             display this help message     |
+-------------------------------------------------------------------------+
9 rows in set (0.00 sec)
```

7.11.7. Connector tungsten mem info Command

```
mysql> tungsten mem info;
+----------------------+-----------------------------------------------------+
| JVM Memory statistics | Value in bytes                                      |
+----------------------+-----------------------------------------------------+
| Peak Thread Count     | 18                                                  |
| Heap Memory           | init = 67108864(65536K) used = 13469328(13153K)     |
|                       | committed = 64946176(63424K) max = 259522560(253440K) |
| Non-heap Memory       | init = 24313856(23744K) used = 14227336(13893K)     |
|                       | committed = 24313856(23744K) max = 224395264(219136K) |
| Thread Count          | 18                                                  |
+----------------------+-----------------------------------------------------+
4 rows in set (0.05 sec)
```

7.11.8. Connector tungsten show [full] processlist Command

```
mysql> tungsten show processlist;
+------------+--------+----------+--------------+---------------+---------+------+-------+------+
| DataSource | Id     | User     | Host         | db            | Command | Time | State | Info |
+------------+--------+----------+--------------+---------------+---------+------+-------+------+
| host1      | 218886 | tungsten | client1:57739 | tungsten_alpha | Sleep   |  316 |       | NULL |
| host1      | 218925 | tungsten | client2:58552 | tungsten_alpha | Sleep   |  281 |       | NULL |
| host1      | 218932 | tungsten | client1:57765 | tungsten_alpha | Sleep   |  274 |       | NULL |
+------------+--------+----------+--------------+---------------+---------+------+-------+------+
3 rows in set (0.05 sec)
```

7.11.9. Connector show slave status Command

The show slave status command generates a version of the standard MySQL command, with the output replaced with values generated by Tungsten. This can be useful for environments where the replica status need to be checked, but with the Tungsten Replicator state, rather than native replication.

```
mysql> show slave status;
*************************** 1. row ***************************
               Slave_IO_State:
                  Master_Host: host1
                  Master_User:
                  Master_Port: 0
                Connect_Retry: 0
              Master_Log_File: mysql-bin.mysql-bin.000050
          Read_Master_Log_Pos: 0
               Relay_Log_File:
                Relay_Log_Pos: 0
        Relay_Master_Log_File:
             Slave_IO_Running:
            Slave_SQL_Running:
              Replicate_Do_DB:
          Replicate_Ignore_DB:
           Replicate_Do_Table:
       Replicate_Ignore_Table:
      Replicate_Wild_Do_Table:
  Replicate_Wild_Ignore_Table:
                   Last_Errno: 0
                   Last_Error:
```

```
                Skip_Counter: 0
         Exec_Master_Log_Pos: 1269
             Relay_Log_Space: 0
             Until_Condition:
              Until_Log_File:
               Until_Log_Pos: 0
          Master_SSL_Allowed:
          Master_SSL_CA_File:
          Master_SSL_CA_Path:
             Master_SSL_Cert:
           Master_SSL_Cipher:
              Master_SSL_Key:
       Seconds_Behind_Master: 0
Master_SSL_Verify_Server_Cert:
               Last_IO_Errno: 0
               Last_IO_Error:
              Last_SQL_Errno: 0
              Last_SQL_Error:
1 row in set (0.01 sec)
```

Note

If the connector is configured in Proxy mode, then any user executing this statement will require the select privilege on the tracking schema table `trep_commit_seqno`. The following DDL can be used as an example:

```
GRANT SELECT ON tungsten_<servicename>.trep_commit_seqno TO '<user>'@'<host>';
```

7.11.10. Connector tungsten show variables Command

The connector will intercept the command `tungsten show variables;` and display its current (loaded) configuration. The `variable_Type` column indicates the file where the configuration item is stored.

Important

This command applies only to proxy mode (ie. not bridge mode).

Just as in the MySQL `show variables` command, Tungsten Connector supports filters through the `"like string"` and its wildcard ('%') sign.

```
mysql> tungsten show variables like '%timeout%';
+---------------------+---------------------------------------+----------+
| Variable_Type       | Variable_name                         | Value    |
+---------------------+---------------------------------------+----------+
| connector.properties | bridgeServerToClientForcedCloseTimeout | 50       |
| connector.properties | connection.close.idle.timeout          | 28800000 |
| connector.properties | connection.keepAlive.timeout           | 20160    |
| connector.properties | server.port.binding.timeout            | 60       |
| router.properties    | gatewayConnectTimeoutMs                | 5000     |
| router.properties    | keepAliveTimeout                       | 30000    |
| router.properties    | readCommandRetryTimeoutMs              | 10000    |
| router.properties    | waitForDisconnectTimeout               | 5        |
| router.properties    | waitIfDisabledTimeout                  | 0        |
| router.properties    | waitIfUnavailableTimeout               | 0        |
+---------------------+---------------------------------------+----------+
10 rows in set (0.01 sec)
```

7.12. Advanced Configuration

7.12.1. Working with Proxy Protocol v1

From release 6.1.13, the Connector is able to work with Proxy Protocol v1, available in newer distributions of MySQL from MariaDB and Percona.

By default, when remote clients connect to a Tungsten Cluster via the Connector, the origin IP shown in MySQL maps to the Connector host the client has connected through.

This can have many disadvantages, especially when relying on host level security restricitons within your MySQL database.

The introduction of Proxy Protocol allows the origin IP of the calling client to be passed through instead.

To enable this feature, first you need to ensure you are using a release of MySQL that supports this. At time of documenting this is limited to the following:

- Percona-5.6.25-73.0 and greater
- MariaDB 10.3 and greater

> **Note**
>
> Currently Proxy Protocol is ONLY available in the releases mentioned above. neither Community edition nor Oracle Enterprise edition yet support this.

Next ensure you enable Proxy Protocol within the `my.cnf` by adding the following property: `proxy-protocol-networks=*`

The `*` indicates allow all, however this can be a comma-separated list of (sub)networks or IP addresses instead, to allow finer granularity.

You can now enable the connector to recognise this by enabling the folloing tpm property: `--connector-enable-proxy-protocol=true`

After applying the property and issuing tpm update (or tools/tpm install if a new installation) you should see the correct origin IP's when querying show processlist and tungsten show processlist

If you enable proxy protocol within the connector, but the underlying database does not support this, you will see the following error:

```
shell> tpm connector
mysql: [Warning] Using a password on the command line interface can be insecure.
ERROR 8 (HY000): Could not authorize the user 'app_user'
Attempt to connect to the server failed.
Could not connect: Got packets out of order
Contact your Tungsten administrator.
```

7.12.2. Using Multiple Dataservices

The connector is able to work with multiple dataservices. It may be a combination of Primary/Replica or composite dataservices. The connector will communicate with managers in each dataservice and provide connectivity.

1. Configure the host as a connector for one of the dataservices. This will be the default dataservice for the connector. Any version upgrades for this cluster will also upgrade the connector. See Section 3.4, “Deploying Tungsten Connector Only” if you want the host to be fully independent.

2. Update the `dataservices.properties` file in `/opt/continuent/tungsten/cluster-home/conf`. Add a line for each new Primary/Replica cluster the connector will connect to. Keep this file updated as you add and remove servers from each cluster.

   > **Important**
   >
   > Do not list composite dataservices in this file. The connector will automatically discover those from the managers in each cluster.

3. Restart the connector. Any users connected to this connector will be disconnected at this time.

   ```
   shell > connector restart
   ```

4. Update the `user.map` to list new users for each new dataservice. See Section 7.6, “User Authentication” for more details. Specifically, the `user.map` may not include multiple users with the same name but different dataservices. Create unique users in each dataservice before updating `user.map`.

   See Section 7.6.1, “`user.map` File Format” for more details.

   When a site goes offline, connections to this site will be forced closed. Those connections will reconnect, as long as the site stays offline, they will be connected to remote site.

   You can now enable an option so that when the site comes back online, the connector will disconnect all these connections that couldn't get to their preferred site so that they will then reconnect to the expected site with the appropriate affinity.

   Note that this only applies to bridge mode. In proxy mode, relevancy of connected data source will be re-evaluated before every transaction.

   When not enabled, connections will continue to use the server originally configured until they disconnect through normal attribution. This is the default option.

   To enable forced reconnection, use the `--connector-reset-when-affinity-back=true` option to tpm.

The connector is now ready to accept users for each of the new dataservices. Keep the `dataservices.properties` and `user.map` files updated to make sure the connector works properly.

7.12.3. Connector Automatic Reconnect

Automatic reconnect enables the Connector to re-establish a connection in the event of a transient failure. Under specific circumstances, the Connector will also retry the query.

1. Connector automatic reconnect is enabled by default in Proxy and Smartscale modes. Use the tpm command option `--connector-autoreconnect=false` [437] to disable automatic reconnect.
2. This feature is not available while running in Bridge Mode. Use the tpm command option `--connector-bridge-mode=false` [438] to disable Bridge mode.
3. Automatic reconnect enables retries of statements under the following circumstances:
   - not in bridge mode
   - not inside a transaction
   - no temp table has been created
   - no lock acquired and not released
   - the request is a read

To disable:

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --connector-autoreconnect=false
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
connector-autoreconnect=false
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

Configuration group `alpha`

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--connector-autoreconnect=false` [437]

  `connector-autoreconnect=false` [437]

Enable auto-reconnect in the connector

The autoreconnect status can be monitored within the *autoReconnect* parameter output by the tungsten show variables while connected to the Connector. For example:

```
shell> tpm connector
mysql> tungsten show variables like "autoReconnect";
+----------------------+---------------+-------+
| Variable_Type        | Variable_name | Value |
+----------------------+---------------+-------+
| connector.properties | autoReconnect | false  |
+----------------------+---------------+-------+
1 row in set (0.00 sec)
```

The above output indicates that the autoreconnect feature is disabled. The tungsten show command is not available in Bridge mode.

7.12.4. Using the Connector with HA Proxy

Tungsten Connector can be used in combination with an HA Proxy installation to provide a high-availability connection to the underlying connectors that then provide an intelligent connection to the datasources within the cluster.

There are two primary ways to monitor MySQL health via HAProxy:

- mysql-check - an haproxy-native test

  The check consists of sending two MySQL packets, one Client Authentication packet, and one QUIT packet, to correctly close the MySQL session. HAProxy then parses the MySQL Handshake Initialisation packet and/or Error packet. It is a basic but useful test which does not produce errors or aborted connects on the server. This solution requires adding a user to MySQL:

  ```
  INSERT INTO mysql.user (Host,User) values ('{ip_of_haproxy}','{username}');
  ```

  > **Warning**
  >
  > This method does NOT check for database presence nor database consistency. To do this, we must use an external check script (via xinetd) which is explained in the next section.

- A check script - normally launched via xinetd, and allows for custom monitoring of the database health. This is the preferred method.

  > **Note**
  >
  > Click here to see the HA Proxy documentation for more information

7.12.4.1. Configuring HA Proxy using the native MySQL Check

A practical example for deployiong the HAProxy's native mysql-check option::

```
INSERT INTO mysql.user (Host,User) values ('%','haproxy');
FLUSH PRIVILEGES;
```

```
#---------------------------------------------------------------------
# backend
#---------------------------------------------------------------------
listen connector
 bind *:3306
 mode tcp
 option tcpka   # enables keep-alive both on client and server side
 balance roundrobin
 option mysql-check user haproxy post-41
 server conn1 db4:13306 check inter 5s rise 1 fall 1 weight 3 maxconn 5000
 server conn2 db5:13306 check inter 5s rise 1 fall 1 weight 3 maxconn 5000
```

7.12.4.2. Configuring HA Proxy with a Check Script

A suitable MySQL check script configuration can be added to a basic HA Proxy installation using the following settings:

```
#---------------------------------------------------------------------
# backend
#---------------------------------------------------------------------
listen connector
 bind *:3306
 mode tcp
 option tcpka   # enables keep-alive both on client and server side
 balance roundrobin
 default-server port 9200
```

```
server conn1 db4:13306 check inter 5s rise 1 fall 1 weight 3 maxconn 5000
server conn2 db5:13306 check inter 5s rise 1 fall 1 weight 3 maxconn 5000
```

The hostname and port numbers should be modified to match your cluster configuration.

This solution will work for *CONNECTION*-based session IDs.

For correct operation within HAProxy, a check script needs to be installed on all hosts running Tungsten Connector that will respond to A HAProxy connector check script needs to be installed on all of the hosts running connectors and a xinet listener setup.

The connector check script will listen on port 9200 for connections from HAProxy and will return the status of the connector to HAProxy in the format of HTTP return codes.

To install the check script:

1. For the check to work, a mysql user must be created within the cluster which the check script can use. The user needs the permissions to be able to run the SQL in the check script:

   ```
   mysql> grant usage on *.* to haproxy identified by 'secret';
   ```

   If you are running smartscale the user will also need replication client privilege:

   ```
   mysql> grant usage, replication client on *.* to haproxy identified by 'secret';
   ```

2. Add the new user on each connector host by adding the following line to `user.map`:

   ```
   haproxy secret cluster_name
   ```

3. Create and configure a check script on each host running Tungsten Connector. For example, create the file `/opt/continuent/share/connectorchk.sh`:

   ```
   #!/bin/sh
   #
   # This script checks if a mysql server is healthy running on localhost. It will
   # return:
   # "HTTP/1.x 200 OK\r" (if mysql is running smoothly)
   # - OR -
   # "HTTP/1.x 503 Service Unavailable\r" (else)
   #
   # The purpose of this script is make haproxy capable of monitoring mysql properly
   #

   MYSQL_HOST=`hostname`
   MYSQL_PORT="3306"           #Connector Port
   MYSQL_USERNAME="haproxy"
   MYSQL_PASSWORD="secret"
   MYSQL_OPTS="-N -q -A test"

   #If you create the following file, the proxy will return mysql down
   #routing traffic to another host
   FORCE_FAIL="/dev/shm/proxyoff"
   OUT=""
   return_ok()
   {
   echo -e "HTTP/1.1 200 OK\r\n"
   echo -e "Content-Type: Content-Type: text/plain\r\n"
   echo -e "\r\n"
   echo -e "MySQL is running.\r\n"
   echo -e "\r\n"
   exit 0
   }
   return_fail()
   {
   echo -e "HTTP/1.1 503 Service Unavailable\r\n"
   echo -e "Content-Type: Content-Type: text/plain\r\n"
   echo -e "\r\n"
   echo -e "MySQL is *down*.\r\n"
   echo -e "$OUT\r\n\r\n"
   exit 1
   }
   if [ -f "$FORCE_FAIL" ]; then
       OUT="$FORCE_FAIL found"
       return_fail;
   fi
   OUT=`mysql $MYSQL_OPTS --host=$MYSQL_HOST --port=$MYSQL_PORT --user=$MYSQL_USERNAME \
   --password=$MYSQL_PASSWORD -e "select @@hostname;" 2>&1`
   if [ $? -ne 0 ]; then
       return_fail;
   fi
   ```

```
return_ok;
```

Set the permissions for the check script:

```
shell> chown tungsten.tungsten /opt/continuent/share/connectorchk.sh
shell> chmod 700 /opt/continuent/share/connectorchk.sh
shell> chmod +x /opt/continuent/share/connectorchk.sh
```

4. Install xinetd and add the xinetd service. On RedHat/CentOS:

```
shell> yum -y install  xinetd telnet
```

On Debian/Ubuntu:

```
shell> apt-get install xinetd telnet
```

5. Add an entry for the connector check script to `/etc/services`:

```
shell> echo "connectorchk         9200/tcp" >> /etc/services
```

6. Add a configuration to xinetd by creating the file `/etc/xinetd.d/connectorchk` with the following content:

```
# default: on
# description:connectorchk
service connectorchk
{
flags           = REUSE
    socket_type     = stream
    port            = 9200
    wait            = no
    user            = tungsten
    server          = /opt/continuent/share/connectorchk.sh
    log_on_failure  += USERID
    disable         = no
#       only_from       = 0.0.0.0/0
# recommended to put the IPs that need
# to connect exclusively (security purposes)
    per_source      = UNLIMITED
}
```

7. Now restart xinetd:

```
shell> service xinetd restart
```

8. Check the service is running:

```
shell> telnet localhost 9200
```

You should get a response similar to this:

```
HTTP/1.1 200 OK

Content-Type: Content-Type: text/plain


MySQL is running.
```

7.12.5. Using Fall-Back Bridge Mode

This feature will allow the Tungsten Connector to fall back to bridge mode if a user cannot be successfully authenticated through `user.map`.

The connector is able to employ a special fall-back bridge mode which allows for a hybrid configuration of both Proxy and Bridge modes. By default, the bridge mode fallback feature is disabled.

When fallBackBridgeMode is set to either RW_STRICT or RO_RELAXED, the Connector will first check the user.map file for an entry that matches the user name passed in the connection request. If a match is found in the user.map, the Connector will act in Proxy mode so the conversation with the client will be handled locally, and a new connection will be opened from the connector to the database server based on the normal Proxy mode routing rules. If the user name is not found in user.map, then the connector will act in Bridge mode, and the connection will be forwarded directly to the specified database server, either to the Primary (RW_STRICT) or to the Replica (RO_RELAXED) for handling with no intercept, just a TCP-layer packet routing. There will be no query interpretation or analysis, and no auto-reconnect, just failover handling.

For more information, see Section 7.5, “Using Bridge Mode”, and Section 7.6, “User Authentication”.

To enable Fall-Back Bridge Mode using the DB Primary:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --property=fallBackBridgeMode=RW_STRICT \
    --connector-bridge-mode=false
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
property=fallBackBridgeMode=RW_STRICT
connector-bridge-mode=false
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

To enable Fall-Back Bridge Mode using a DB Replica (if available):

Show Staging

Show INI

```
shell> ./tools/tpm configure alpha \
    --property=fallBackBridgeMode=RO_RELAXED \
    --connector-bridge-mode=false
```

```
[alpha]
...
property=fallBackBridgeMode=RO_RELAXED
connector-bridge-mode=false
```

Warning

Updating these values require a connector restart (via tpm update) for the changes to be recognized.

Important

To be consistent, Bridge mode should be disabled when fallBackBridgeMode is enabled. The `--connector-bridge-mode` [438] option to tpm must be set to `false`. A consistency check is performed when starting the connector.

7.12.5.1. Using Fall-Back SSL To Bridge Mode

SSL connections are by design unreadable until the handshake has been exchanged. Because of this, the MySQL user name in the request is not visible to the Connector immediately, and therefore the Connector is unable to check against user.map for `fallBackBridgeMode`.

Due to this situation, another feature was created to address SSL connections while the `fallBackBridgeMode` is enabled called `fallBackSSLToBridge`. When `fallBackSSLToBridge` is set to `true` (default), then all SSL connections will use Bridge mode, while non-SSL connections will use the fallBackBridgeMode setting (i.e. RW_STRICT which routes traffic to the Primary or RO_RELAXED which routes to the Replicas). When `fallBackSSLToBridge` is set to `false`, then SSL connections will run in non-Bridge mode - if the specified user doesn't exist in user.map, an error will be raised.

> **Important**
>
> The `fallBackSSLToBridge` setting is ONLY available when `fallBackBridgeMode` is enabled, and is ignored when `fallBackBridgeMode` is set to `false`.

Since `fallBackSSLToBridge` is enabled by default when `fallBackBridgeMode` is enabled, you may turn it off as follows:

Show Staging

Show INI

```
shell> ./tools/tpm configure alpha \
    --property=fallBackSSLToBridge=false
```

```
[alpha]
...
property=fallBackSSLToBridge=false
```

> **Warning**
>
> Updating these values require a connector restart (via tpm update) for the changes to be recognized.

7.12.6. Using the Max Connections Feature

This feature will allow the connector behavior to be changed based on the connection count. The connector is able to mimic MySQL's `max_connections`. Depending on your needs, the connector can be configured to pile up or reject connections above this number. This is served by the following two tpm flags:

`--connector-max-connections` [439] - defines the maximum number of connections the connector should allow at any time.

When the `connector-max-connections` [439] is set to a non-zero numeric value, the connector denies access to the client in one of two ways: queue (default) or reject.

`--connector-drop-after-max-connections` [439] - defines how the connector should handle new connection requests - queue (default) or reject.

Enabling this option causes the connector to drop new connection requests when `connector-max-connections` [439] is reached by immediately sending a "Too Many Connections" error to the client, just like MySQL would.

> **Important**
>
> When a client connection request arrives at the connector, an object is created to track that client connection which uses a certain amount of memory.
>
> The connector then checks the value of `connector-max-connections` [439] against the current connection count.
>
> If the connection limit has been reached, the connector decides how to behave by checking the value of `connector-drop-after-max-connections` [439].
>
> If `connector-drop-after-max-connections` [439] is false (the default), the connector will queue the connection request, but send nothing back to the client at all. This connection check will repeat after a delay. Once the connection count falls below `connector-max-connections` [439] an attempt to connect to a server is made. In this mode, connections will continue to pile up in memory as new requests are queued, resulting in an Out of Memory error. For this reason, the `connector-drop-after-max-connections` [439] is available to prevent connection queueing when the maximum number of connections has been reached.
>
> If `connector-drop-after-max-connections` [439] is enabled, the connector will return a "Too Many Connections" error to the client and remove the client connection object, freeing memory.

To enable `connector-max-connections` [439]:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
```

```
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --connector-max-connections=2500
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
connector-max-connections=2500
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

To enable `connector-drop-after-max-connections` [439] you must also set a non-zero value for `connector-max-connections` [439]:

Show Staging

Show INI

```
shell> ./tools/tpm configure alpha \
    --connector-drop-after-max-connections=true \
    --connector-max-connections=2500
```

```
[alpha]
connector-drop-after-max-connections=true
connector-max-connections=2500
```

Configuration group **`alpha`**

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--connector-drop-after-max-connections=true` [439]

  `connector-drop-after-max-connections=true` [439]

  Instantly drop connections that arrive after --connector-max-connections has been reached

- `--connector-max-connections=2500` [439]

  `connector-max-connections=2500` [439]

  The maximum number of connections the connector should allow at any time

  > **Important**
  >
  > Updating these values require a connector restart (via tpm update) for the changes to be recognized.

To select a real-world value for `connector-max-connections` [439], set the value to a value slightly lower than the MySQL value of `max_connections` to prevent the server from ever hitting maximum. You may use the following formula for a more complex calculation: connector-max-connections = [MySQL Primary `max_connections` / number of connectors] * 0.95

> **Important**
>
> When `connector-drop-after-max-connections` [439] is enabled, be sure that your load balancers are configured to identify that max connections have been reached and to switch to another connector when that happens.

7.12.7. Adjusting the Client Disconnect Delay During Manual Switch

This feature controls how the connector handles existing connections when a manual switch is invoked.

When a graceful switch is invoked via cctrl, by default the Connector will wait for five (5) seconds to allow in-flight activities to complete before forcibly disconnecting all active connections from the application side, no matter what type of query was in use.

If connections still exist after the timeout interval, they are forced closed, and the application will get back an error.

> **Important**
>
> This setting ONLY applies to a manual switch. During a failover, there is no wait and all connections are force-closed immediately.

This timeout is adjusted via the tpm option `--connector-disconnect-timeout` [438].

For example, to change the delay to 10 seconds:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --connector-disconnect-timeout=10
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
connector-disconnect-timeout=10
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

Configuration group `alpha`

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--connector-disconnect-timeout=10` [438]

  `connector-disconnect-timeout=10` [438]

  Time (in seconds) to wait for active connection to disconnect before forcing them closed [default: 5]

  Warning

  If you increase this value, you delay the manual switch! ONLY change this if you accept the fact that the manual switch process will last at least as long as this setting in seconds.

  Do not set this value to zero (0) or there will be no attempt to disconnect at all. If you wish to disable the wait entirely, set `--property=waitForDisconnect=false` [405] in your configuration on the connectors and run tpm update.

  Important

  Updating these values require a connector restart (via tpm update) for the changes to be recognized.

This value is reflected in the `waitForDisconnectTimeout` setting located in `cluster-home/conf/router.properties`.

7.12.8. Adjusting the Bridge Mode Forced Client Disconnect Timeout

This feature controls how long the Connector in Bridge mode waits before forcibly disconnecting the server side of the session after a client session ends.

Default: 50ms

Note

Prior to v5.3.0, the default was 500ms.

When a client application opens a socket and connects to the connector, a second socket/connection to the server is created. The Connector in bridge mode then simply transfers data between these two sockets.

When a client application brutally closes a connection without following the proper disconnection protocol, the server will not know about that disconnect until the connector closes the Connector<>server socket. If the connector closes the Connector<>server connection too soon after a client disconnect, there is a chance that the proper disconnection messages will be missed, if sent late. If the connector does not close this connector<>server connection, it would stay open indefinitely, using memory and resources that would otherwise be reclaimed.

The default of 50ms is very conservative and will fit most environments where client applications disconnect properly. When the volume of connections opened and never closed exceeds a certain level, the timeout must be tuned (lowered) to close idle connections faster, or the available resources will get used up.

Many times this situation is caused by health checks, especially from monitoring scripts and load balancers checking port liveness. Many of these check do not gracefully close the connection, triggering the need for tuning the Connector.

If connections still exist after the timeout interval, they are forced closed, and a warning will be printed in the connector logs (C>S ended. S>C streaming did not finish within bridgeServerToClientForcedCloseTimeout=500 (ms). Will be closed anyway !).

Important

This setting ONLY applies to Bridge mode.

This timeout is adjusted via the tpm property `--property=bridgeServerToClientForcedCloseTimeout` [405] in milliseconds.

For example, to change the delay to 50 milliseconds:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41
```

```
shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --property=bridgeServerToClientForcedCloseTimeout=50
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
property=bridgeServerToClientForcedCloseTimeout=50
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

Warning

If you decrease this value, you run the risk of disconnecting valid but slow sessions.

Important

Updating these values require a connector restart (via tpm update) for the changes to be recognized.

7.12.9. Adjusting the Connnector Response to Resource Losses

This section describes how to control the Connector responses in the event of the loss of a required Datasource or all Managers.

7.12.9.1. Adjusting the Connnector Response to Datasource Loss

Summary: Whenever no Primary datasource is found, the Connector will reject connection requests.

This feature controls how long the Connector waits for the given type of DataSource to come ONLINE before forcibly disconnecting the client application.

By default, wait indefinitely for a resource to become available.

Warning

Prior to software versions 5.3.2/6.0.1, the ONHOLD state would reject new connection attempts instead of pausing them. Also, `waitIfUnavailableTimeout` was ignored, and connection attempts were never severed after timeout.

There are two (2) parameters involved in this decision-making. They are:

- `waitIfUnavailable` (default: `true`)

  If `waitIfUnavailable` is `true`, then the Connector will wait for up to the time period specified by `waitIfUnavailableTimeout` to make a connection for a given QOS. If the timeout expires, the Connector will disconnect the client application (reject connection attempts and close ongoing connections).

If `waitIfUnavailable` is `false`, the Connector will immediately disconnect the client with an error if a connection for a given QOS cannot be made immediately.

- `waitIfUnavailableTimeout` (default: 0, wait indefinitely)

  If `waitIfUnavailable` is `true`, the Connector will wait for up to `waitIfUnavailableTimeout` number of seconds before disconnecting the client. If `waitIfUnavailable` is `false`, this parameter is ignored. If this parameter is set to zero (0) seconds, the Connector will wait indefinitely (client connection requests will hang forever).

`waitIfUnavailable` is specific to data source availability and will be considered if everything else is online: connector and data service.

This will typically be used during a switch or failover while the primary changes: the client application will request a primary (RW_STRICT QoS), which at some point is not available since both new and old primaries are offline. With `waitIfUnavailable=true`, the connector will wait for the new one to come online (Upto `waitIfUnavailableTimeout` seconds), allowing seamless failover. If set to false, there will be a period of time during switch/failover where client applications will get errors trying to connect AND reconnect/retry failing requests.

For example, to immediately reject connections upon Datasource loss:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --property=waitIfUnavailable=false
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
property=waitIfUnavailable=false
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

Warning

PLEASE NOTE: this will make switch and failover much less transparent to the application since the connections will error until the new Primary is elected and back online.

Important

Updating these values require a connector restart (via tpm update) for the changes to be recognized.

These entries will NOT work if placed into `[defaults]`, each service must be handled individually.

7.12.9.2. Adjusting the Connnector Response to Manager Loss

Summary: Whenever the Connector loses sight of the managers for a given data service, it will either suspend or reject new connection requests.

`waitIfDisabled` applies to both:

1. Whole offline data service: client application tries to connect to a composite or physical data service that is offline, e.g. during a full site outage where the client application requests access to a local primary without allowing redirection to remote site.
2. connector offline or onhold: typically when the connector looses connectivity to all managers in the cluster, it will first go onhold, then offline. In both cases, waitIfDisabled defines what to do in such case: throw an error to the client application or wait until network is back and access to a manager is possible. For example, when the connector is isolated from the cluster, setting `waitIfDisabled=true` will make new connection requests "hang" until either the connector gets back network access to a manager OR `waitIfDisabledTimeout` is reached

By default, suspend requests indefinitely until Manager communications are re-established.

This feature controls how long the Connector waits during a manager loss event to either suspend or reject the client connection.

Here is the decision chain and associated settings for what happens when the connector loses sight of the managers:

1. Delay for the value of `delayBeforeOnHoldIfNoManager` seconds which is 0/no delay by default.
2. Change state to `ON-HOLD` and begin the countdown timer starting from the `delayBeforeOfflineIfNoManager` value.

   In the `ON-HOLD` state, the connector will hang all new connections and allow existing connections to continue.
3. When the `delayBeforeOfflineIfNoManager` timer expires (30 seconds by default), change state to `OFFLINE`.

   Once `OFFLINE`, the Connector with break existing connections because there is no authoritative Manager node from the Connector's perspective. Without a Manager link, any change to the cluster configuration will remain invisible to the Connector, potentially leading to writes on a Replica node.

   By default, all new connection requests will hang in the `OFFLINE` state. If `waitIfDisabled` is set to `false`, then the Connector will instead reject all new connections.

There are multiple parameters involved in this decision-making. They are:

- `delayBeforeOnHoldIfNoManager` (in seconds, default: `0`, i.e. no delay)

  When the connector loses sight of the managers, delay before going `ON-HOLD` for the value of `delayBeforeOnHoldIfNoManager` seconds, which is 0/no delay by default.
- `delayBeforeOfflineIfNoManager` (in seconds, default: 30)

  Once `ON-HOLD`, delay before going `OFFLINE` for the value of `delayBeforeOfflineIfNoManager` seconds, 30 by default.
- `waitIfDisabled` (default: `true`)

  If the Dataservice is `OFFLINE` because it is unable to communicate with any Manager, the `waitIfDisabled` parameter determines whether to suspend connection requests or to reject them. If `waitIfDisabled` is `true` (the default), then the Connector will wait indefinitely for manager communications to be re-established. If `waitIfDisabled` is set to `false`, the Connector will return an error immediately.

  To check for data service state, use the tungsten-connector/bin/connector cluster-status command. For example:

```
shell> connector cluster-status
Executing Tungsten Connector Service --cluster-status ...
+--------------+-------------------+-------------+--------------+--------+--------+-----------------------------------+-----------------+----------
| Data service | Data service state | Data source | Is composite | Role   | State  | High water                        | Last shun reason | Applied l
+--------------+-------------------+-------------+--------------+--------+--------+-----------------------------------+-----------------+----------
| europe       | OFFLINE           | c1          | false        | master | ONLINE | 0(c1-bin.000002:0000000000000510;-1) | MANUALLY-SHUNNED | 0.0
| europe       | OFFLINE           | c2          | false        | slave  | ONLINE | 0(c1-bin.000002:0000000000000510;-1) |                  | 1.0
| europe       | OFFLINE           | c3          | false        | slave  | ONLINE | 0(c1-bin.000002:0000000000000510;-1) |                  | 2.0
+--------------+-------------------+-------------+--------------+--------+--------+-----------------------------------+-----------------+----------
```

For more information, see Connector On-Hold State [241].

For example, to decrease the `ON-HOLD` time to 15 seconds:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --property=delayBeforeOfflineIfNoManager=15
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
property=delayBeforeOfflineIfNoManager=15
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

For example, to immediately reject connections upon Manager loss:

Show Staging

Show INI

```
shell> ./tools/tpm configure alpha \
    --property=waitIfDisabled=false
```

```
[alpha]
...
property=waitIfDisabled=false
```

Warning

PLEASE NOTE: this will make switch and failover much less transparent to the application since the connections will error until communications with at least one manager has been established and the Connector is back online.

Important

Updating these values require a connector restart (via tpm update) for the changes to be recognized.

These entries will NOT work if placed into `[defaults]`, each service must be updated individually.

7.12.10. Connector Logging Configuration

The connector is able to modify what is logged using different configuration options.

Informational messages like those below indicate that a client-side session did not properly close connection to the connector using a regular mysql close() call.

```
WARN [MySQLBridge] - [10.3.1.240:35686] C>S ended. S>C streaming did not finish within
                                        bridgeServerToClientForcedCloseTimeout=500 (ms). Will be closed anyway !

INFO [MySQLBridge] - [10.3.1.240:35686] Server>Client thread didn't finish cleanly - return code was: 1
```

Load balancers (especially physical ones) tend to do this when testing the connector, so these messages are expected when behind a load-balancer. Since the same error could come from buggy application code, the default is to log these circumstances.

If you know where the disconnects are coming from, you can safely disable this feature by setting the tpm option `--connector-disable-connection-warnings` [438] to `true`:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --connector-disable-connection-warnings=true
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
connector-disable-connection-warnings=true
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

> **Warning**
>
> Updating these values require a connector restart (via tpm update) for the changes to be recognized.

7.12.10.1. Connector Logging to Syslog

The Connector is able to send log information to Syslog.

You can control the full connector log by editing the `tungsten-connector/conf/wrapper.conf` file.

Depending on what you want to do, you can:

- Send full connector log to the syslog:

```
wrapper.syslog.loglevel=NONE =>
```

```
wrapper.syslog.loglevel=INFO
```

- Stop sending log to `connector.log`:

```
wrapper.logfile.loglevel=INFO =>
wrapper.logfile.loglevel=NONE
```

- Change the log file path:

```
wrapper.logfile=../../tungsten-connector/log/connector.log
```

> **Note**
>
> For logging purposes, our software uses both the Tanuki wrapper and Apache's Log4J tool.
>
> Valid log levels for the Tanuki wrapper include:
>
> - NONE for no output
> - FATAL to only show fatal error messages
> - ERROR to show all error messages
> - WARN to show all warning messages
> - STATUS to show all state changes
> - INFO shows all JVM output and informative messages
> - DEBUG shows detailed debug information
>
> Valid log levels for Apache's log4j include: TRACE, DEBUG, INFO, WARN, ERROR and FATAL
>
> Links to the full documentation for each are below:
>
> - Tanuki wrapper: https://wrapper.tanukisoftware.com/doc/english/prop-syslog-loglevel.html
> - Apache log4j: https://logging.apache.org/log4j/2.x/manual/configuration.html

7.12.11. Connector Audit Logging

Audit Logging allows for logging data transferred between client application and MySQL servers to a file, database or socket.

Configuration of audit logging is done directly in the connector's `tungsten-connector/conf/log4j.properties` configuration file by editing the parameters explained below. Changes to this configuration file do NOT need a full restart, the command connector reconfigure [304] will reload the log4j configuration and apply changes immediately.

5 categories of information can be printed:

- `ClientRequests` : client application sends a MySQL request (select, insert, update, ...) to the server. Compatible with both bridge and proxy mode, full packet text will have to be printed in order to see the actual request
- `ServerResponses` : MySQL server returns a result in response to a client request. Compatible with both bridge and proxy mode, full packet text will have to be printed in order to see the actual responses
- `AppConnections` : client application connects or disconnects to/from the Connector. Compatible with both bridge and proxy mode, will print one log entry per connection and one per disconnection
- `Commands` : proxy mode only. Will print each "mysql command" that is sent by the application to the connector. Commands include not only regular `COM_QUERY` and `COM_STMT_xxx` used for executing requests and prepared statements, but also more specific commands such as `COM_PING`, `COM_SLEEP`, or `COM_INIT_DB` and `COM_CHANGE_USER` to switch user or schema. Full list of commands is available here
- `Perf` : proxy mode only. When set to info, this logger will print the round trip time to execute individual MySQL commands (see above). A typical use of this logger is to track individual requests execution time.

Each of these categories logs may be enabled of disabled individually with:

```
logger.{category}.level=[OFF|INFO]
```

For example, all incoming client requests can be printed with the following line:

```
logger.ClientRequests.level=INFO
```

Individual log entries (individual line printed) format can be adjusted in this same `conf/log4j.properties` with the line:

```
appender.audit.layout.pattern=%d - [%X{client-ip}:%X{client-port}]<->%X{datasource} %X{user} %X{schema} %m: %X{packet-text}%n
```

Where %X entries are:

- `client-ip` : client application IP address as seen by the connector
- `client-port` : client application outgoing TCP port. Convenient to identify a given client application since a connected IP/port pair is unique at any given time
- `user` : (not available in bridge mode) user name authenticated to the connector. Since bridge mode doesn't inspect packet internals, it will not be able to display this information
- `schema` : (not available in bridge mode) schema on which the client application is connected. Will be blank if no schema has been selected. Since bridge mode doesn't inspect packet internals, it will not be able to display this information
- `datasource` : cluster data source used to execute the request, composed of `<hostname>@<dataservice>(role:STATE)`
- `packet-header` : MySQL packet header as `Packet #<packet number> size=<full packet length (inc. header)> pos=<internal pointer position>`
- `packet-text` : internal packet bytes printable as characters. This will display a readable form of the requests. Note that the header bytes are not printed here
- `packet-binary` : internal packet bytes as hexadecimal values. Will display the full packet, yet non-human-readable form. Note that the header bytes are also printed

By default, audit logging will be output in `tungsten-connector/log/connector-audit.log` file.

Log4j 2, the logging system used by Tungsten, allows for many other options and ways to log data, including Socket and Database logging. Deeper insight and exhaustive documentation will be found directly on the log4j 2 documentation page

7.12.12. Connector SSL Advertisement Configuration

When SSL is enabled, the Connector automatically advertises the ports and itself as SSL capable. With some clients, this triggers them to use SSL even if SSL has not been configured. This causes the connections to fail and not operate correctly.

You can safely disable SSL advertisement in the Connector by setting the tpm option `connector-ssl-capable` [440] to `false`:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --connector-ssl-capable=false
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, "Configuration Changes from a Staging Directory".

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
connector-ssl-capable=false
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

Configuration group `alpha`

The description of each of the options is shown below; click the icon to hide this detail:

Click the icon to show a detailed description of each argument.

- `--connector-ssl-capable=false` [440]

  `connector-ssl-capable=false` [440]

  When SSL is enabled, the Connector automatically advertises the ports and itself as SSL capable. With some clients, this triggers them to use SSL even if SSL has not been configured. This causes the connections to fail and not operate correctly.

  Warning

  Updating these values require a connector restart [via tpm update] for the changes to be recognized.

7.12.13. Connector IP Address Configuration

When the Connector starts up, it binds to all local IP addresses on the selected port using the wilcard syntax, for example: `0.0.0.0:3306`.

You can force the Connector to bind to a specific IP address by setting the tpm option `property=server.listen.address={IP_ADDRESS}` [405]

If you wished to bind to the localhost IP address only, perhaps for security reasons, here is an example:

Click the link below to switch examples between Staging and INI methods...

Show Staging

Show INI

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging USER is `tpm query staging| cut -d: -f1 | cut -d@ -f1`
The staging USER is tungsten

shell> echo The staging HOST is `tpm query staging| cut -d: -f1 | cut -d@ -f2`
The staging HOST is db1

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> ssh {STAGING_USER}@{STAGING_HOST}
shell> cd {STAGING_DIRECTORY}
```

```
shell> ./tools/tpm configure alpha \
    --property=server.listen.address=127.0.0.1
```

Run the tpm command to update the software with the Staging-based configuration:

```
shell> ./tools/tpm update
```

For information about making updates when using a Staging-method deployment, please see Section 10.3.7, “Configuration Changes from a Staging Directory”.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
...
property=server.listen.address=127.0.0.1
```

Run the tpm command to update the software with the INI-based configuration:

```
shell> tpm query staging
tungsten@db1:/opt/continuent/software/tungsten-clustering-5.4.1-41

shell> echo The staging DIRECTORY is `tpm query staging| cut -d: -f2`
The staging DIRECTORY is /opt/continuent/software/tungsten-clustering-5.4.1-41

shell> cd {STAGING_DIRECTORY}

shell> ./tools/tpm update
```

For information about making updates when using an INI file, please see Section 10.4.4, “Configuration Changes with an INI file”.

> **Warning**
>
> Updating these values require a connector restart (via tpm update) for the changes to be recognized.

7.13. Connector General Limitations

The following general limitations exist when using the Connector; these issues do not affect the connector when using bridge mode:

- When using mysqldump within MySQL 5.6 or later, the `--single-transaction` option is not supported when connectivity to the database is made through the connector.
- When using mysqldump, the `--flush-logs` option is not supported when connectivity to the database is made through the connector.

Chapter 8. Tungsten Manager

The Tungsten Manager provides the management and monitoring of the Tungsten Cluster services to ensure that datasources, connectors and other components are running, datasources are replicating to each other, and handles failover and maintenance schedules.

8.1. Tungsten Manager Introduction

The Tungsten Manager is responsible for monitoring and managing a Tungsten Cluster dataservice. The manager has a number of control and supervisory roles for the operation of the cluster, and acts both as a control and a central information source for the status and health of the dataservice as a whole.

Primarily, the Tungsten Manager handles the following tasks:

- Monitors the replication status of each datasource within the cluster.
- Communicates and updates Tungsten Connector with information about the status of each datasource. In the event of a change of status, Tungsten Connectors are notified so that queries can be redirected accordingly.
- Manages all the individual components of the system. Using the Java JMX system the manager is able to directly control the different components to change status, control the replication process, and
- Checks to determine the availability of datasources by using either the system ping protocol (default), or using the Echo TCP/IP protocol on port 7 to determine whether a host is available. The configuration of the protocol to be used can be made by adjusting the manager properties. For more information, see Section B.2.2.3, “Host Availability Checks”.
- Includes an advanced rules engine. The rule engine is used to respond to different events within the cluster and perform the necessary operations to keep the dataservice in optimal working state. During any change in status, whether user-selected or automatically triggered due to a failure, the rules are used to make decisions about whether to restart services, swap Primaries, or reconfigure connectors.

In order to be able to avoid split brain, a cluster needs an odd number of members such that if there is a network partition, there's always a chance that a majority of the members are in one of the network partitions. If there is not a majority, it's not possible to establish a quorum and the partition with the Primary, and no majority, will end up with a shunned Primary until such time a quorum is established.

To operate with an even number of database nodes, a witness node is required, preferably an active witness, since the dynamics of establishing a quorum are more likely to succeed with an active witness than with a passive witness.

8.1.1. How Does Failover Work?

Did you ever wonder just what the Tungsten Manager is thinking when it does an automatic failover or a manual switch in a cluster?

What factors are taken into account by the Tungsten Manager it picks a replica to fail over to?

This page will detail the steps the Tungsten Manager to perform a switch or failover.

This section covers both the process and some possible reasons why that process might not complete, along with best practices and ways to monitor the cluster for each situation.

8.1.1.1. Roles for Nodes and Clusters

When we say “role” in the context of a cluster datasource, we are talking about the view of a database node from the Tungsten Manager's perspective.

These roles apply to the node datasource at the local (physical) cluster level, and to the composite datasource at the composite cluster level.

Possible roles are:

- Primary
  - A database node which is writable, or
  - A composite cluster which is active (contains a writable primary)
- Relay
  - A read-only database node which pulls data from a remote cluster and shares it with downstream replicas in the same cluster
- Replica

- A read-only database node which pulls data from a local-cluster primary node, or from a local-cluster relay node for passive composite clusters
- A composite cluster which is passive (contains a relay but NO writable primary)

8.1.1.2. Moving the Primary Role to Another Node or Cluster

One of the great powers of the Tungsten Cluster is that the roles for both cluster nodes and composite cluster datasources can be moved to another node or cluster, either at will via the cctrl> switch command, or by having an automatic failover invoked by the Tungsten Manager layer.

Please note that while failovers are normally automatic and triggered by the Tungsten Manager, a failover can be also be invoked manually via the cctrl command if ever needed.

8.1.1.2.1. Switch versus Failover

There are key differences between the manual switch and automatic failover operations:

- Switch
  - Switch attempts to perform the operation as gracefully as possible, so there will be a delay as all of the steps are followed to ensure zero data loss
  - When the switch sub-command is invoked within cctrl, the Manager will cleanly close connections and ensure replication is caught up before moving the Primary role to another node
  - Switch recovers the original Primary to be a Replica
  - Please see Section 6.5.2, “Manual Primary Switch”.
- Failover
  - Failover is immediate, and could possibly result in data loss, even though we do everything we can to get all events moved to the new Primary
  - Failover leaves the original primary in a SHUNNED state
  - Connections are closed immediately
  - Use the cctrl> recover command to make the failed Primary into a Replica once it is healthy
  - Please see both Section 6.5.1, “Automatic Primary Failover” and ???

For even more details, please visit: Section 6.5, “Switching Primary Hosts”

8.1.1.2.2. Which Target Replica Node To Use?

Picking a target replica node from a pool of candidate database replicas involves several checks and decisions.

For switch commands for both physical and composite services, the user has the ability to pass in the name of the physical or composite replica that is to be the target of the switch. If no target is passed in, or if the operation is an automatic failover, then the Manager has logic to identify the 'most up to date' replica which then becomes the target of the switch or failover.

Here are the choices to pick a new primary database node from available replicas, in order:

1. Skip any replica that is either not online or that is not a standby replica.
2. Skip any replica that has its status set to ARCHIVE
3. Skip any replica that does not have an online manager.
4. Skip any replica that does not have a replicator in either online or synchronizing state.
5. Now we have a target datasource prospect...
6. By comparing the last applied sequence number of the current target datasource prospect to any other previously seen prospect, we should eventually end up with a replica that has the highest applied sequence number. We also save the prospect that has the highest stored sequence number.

7. If we find that there is a tie in the highest sequence number that has been applied or stored by any prospect with another prospect, we compare the datasource precedence and if there's a difference in this precedence, we choose the datasource with the lowest precedence number i.e. a precedence of 1 is higher than a precedence of 2. If we have a tie in precedence, select the last replica chosen and discard the replica currently being evaluated.

8. After we have evaluated all of the replicas, we will either have a single winner or we may have a case where we have one replica that has the highest applied sequence number but we have another replica that has the highest stored sequence number i.e. it has gotten the most number of THL records from the primary prior to the switch operation. In this case, and this is particularly important in cases of failover, we choose the replica that has the highest number of stored THL records.

9. Skip any replica that has a latency higher than the configured threshold. If too far behind, do not use that replica. The tpm option --property=policy.slave.promotion.latency.threshold=900 controls the check, with 900 seconds as the default value.

10. At this point return to the switch or failover command whatever target replica we have chosen so that the operation can proceed.

After looping over all available replicas, check the selected target Replica's appliedLatency to see if it is higher than the configured threshold (default: 900 seconds). If the appliedLatency is too far behind, do not use that Replica. The tpm option `--property=policy.slave.promotion.latency.threshold=900` [405] controls the check.

If no viable Replica is found (or if there is no available Replica to begin with), there will be no switch or failover at this point.

For more details on automatic failover versus manual switch, please visit: Section 8.3.1, "Manual Switch Versus Automatic Failover"

8.1.1.2.3. Switch and Failover Steps for Local Clusters

For more details on switch and failover steps for local clusters, please visit:

- Section 6.5, "Switching Primary Hosts"
- Section 8.3.2, "Switch and Failover Steps for Local Clusters"

8.1.1.2.4. Switch and Failover Steps for Composite Services

For more details on switch and failover steps for composite services, please visit:

- Section 6.7, "Composite Cluster Switching, Failover and Recovery"
- Section 8.3.3, "Switch and Failover Steps for Composite Services"

8.1.2. Best Practices for Proper Cluster Failovers

What are the best practices for ensuring the cluster always behaves as expected? Are there any reasons for a cluster NOT to fail over? If so, what are they?

Here are three common reasons that a cluster might not failover properly:

- Policy Not Automatic
  - BEST PRACTICE: Ensure the cluster policy is automatic unless you specifically need it to be otherwise
  - SOLUTION: Use the check_tungsten_policy command to verify the policy status
- Complete Network Partition
  - If the nodes are unable to communicate cluster-wide, then all nodes will go into a FailSafe-Shun mode to protect the data from a split-brain situation.
  - BEST PRACTICE: Ensure that all nodes are able to see each other via the required network ports
  - SOLUTION: Verify that all required ports are open between all nodes local and remote - see Section B.2.2.1, "Network Ports"
  - SOLUTION: Use the check_tungsten_online command to check the DataSource State on each node
- No Available Replica
  - BEST PRACTICE: Ensure there is at least one `ONLINE` node that is not in `STANDBY` or `ARCHIVE` mode

    SOLUTION: Use the check_tungsten_online command to check the DataSource State on each node
  - BEST PRACTICE: Ensure that the Manager is running on all nodes

SOLUTION: Use the check_tungsten_services command to verify that the Tungsten processes are running on each node

- BEST PRACTICE: Ensure all Replicators are either ONLINE or GOING ONLINE:SYNCHRONIZING

  SOLUTION: Use the check_tungsten_online command to verify that the Replicator (and Manager) is ONLINE on each node

- BEST PRACTICE: Ensure the replication applied latency is under the threshold, default 900 seconds

  SOLUTION: Use the check_tungsten_latency command to check the latency on each node

8.1.3. Command-Line Monitoring Tools

Below are examples of all the health-check tools listed above:

- check_tungsten_services

```
shell> check_tungsten_services -c -r
CRITICAL: Connector, Manager, Replicator are not running

shell> startall
Starting Replicator normally
Starting Tungsten Replicator Service...
Waiting for Tungsten Replicator Service.......
running: PID:14628
Starting Tungsten Manager Service...
Waiting for Tungsten Manager Service.........
running: PID:15143
Starting Tungsten Connector Service...
Waiting for Tungsten Connector Service.......
running: PID:15513

shell> check_tungsten_services -c -r
OK: All services (Connector, Manager, Replicator) are running
```

- check_tungsten_policy

```
shell> check_tungsten_policy
CRITICAL: Manager is not running

shell> manager start

shell> check_tungsten_policy
CRITICAL: Policy is MAINTENANCE

shell> cctrl
cctrl> set policy automatic
cctrl> exit

shell> check_tungsten_policy
OK: Policy is AUTOMATIC
```

- check_tungsten_latency

```
shell> check_tungsten_latency -w 100 -c 200
CRITICAL: Manager is not running

shell> manager start

shell> check_tungsten_latency -w 100 -c 200
CRITICAL: db8=65107.901s, db9 is missing latency information

shell> cctrl
cctrl> cluster heartbeat
cctrl> exit

shell> check_tungsten_latency -w 100 -c 200
WARNING: db9 is missing latency information

shell> cctrl
cctrl> set policy automatic
cctrl> exit

shell> check_tungsten_latency -w 100 -c 200
OK: All replicas are running normally (max_latency=4.511)
```

- check_tungsten_online

```
shell> check_tungsten_online
CRITICAL: Manager is not running
```

```
shell> manager start

shell> check_tungsten_online
CRITICAL: Replicator is not running

shell> replicator start

shell> check_tungsten_online
CRITICAL: db9 REPLICATION SERVICE north is not ONLINE

shell> trepctl online

shell> check_tungsten_online
CRITICAL: db9 REPLICATION SERVICE north is not ONLINE
```

Related Pages:

- ???
- Section 8.2, “Tungsten Manager Failover Tuning”
- Section 8.3, “Tungsten Manager Failover Internals”
- Section B.2.2.1, “Network Ports”

8.2. Tungsten Manager Failover Tuning

There are currently three discrete faults that can cause a failover of a Primary:

- Database server failure - failover will occur 20 seconds after the initial detection.

  `--property=policy.liveness.dbping.fail.threshold=1` [405]

  The Tungsten Manager is unable to connect to the database server and gets an i/o error. If the database cannot respond to a tcp connect request after the configured number of attempts, the database server is flagged as STOPPED which initiates the failover.

  This would mean, literally, that the process for the database server is gone and cannot respond to a tcp connect request. In this case, by default, the manager will try two more times, once every 10 seconds, after the initial i/o error is detected and after the then 30 second interval has elapsed, will flag the database server as being in the STOPPED state and this, in turn, initiates the failover.

- Host failure - failover will occur 30 seconds after the initial detection

  `--property=policy.liveness.hostPing.fail.threshold=2` [405]

  The host on which the Primary database server is running is 'gone'. The first indication that the Primary host is gone could be because the manager on that host no longer appears in the group of managers, one of which runs on each database server host. It could also be that the managers on the hosts besides the Primary do not see a 'heartbeat' message from the Primary manager. In a variety of circumstances like this, both of the managers will, over a 60 second interval of time, once every 10 seconds, attempt to establish, definitively, that the Primary host is indeed either gone or completely unreachable via the network. If this is established, the remaining managers in the group will establish a quorum and the coordinator of that group will initiate failover.

- A replicator failure, if `--property=policy.fence.masterReplicator` [405] is set to `true`, will cause a failover 70 seconds after initial detection

  `--property=policy.fence.masterReplicator.threshold=6` [405]

  Depending on how you have the manager configured, a Primary replicator failure can also start a process of initiating a failover. There's a specific manager property (`--property=policy.fence.masterReplicator=true` [405]) that tells a manager to 'fence' a Primary replicator that goes into either a failed or stopped state. The manager will then try to recover the Primary replicator to an online state and, again, after an interval of 60 seconds, if the Primary replicator does not recover, a failover will be initiated. BY DEFAULT, THIS BEHAVIOR IS TURNED OFF. Most customers prefer to keep a fully functional Primary running, even if replication fails, rather than have a failover occur.

  > **Important**
  >
  > The interval of time from the first detection of a fault until a failover occurs is configurable over 10 second intervals. The formula for determining the listed default failover intervals is based on the value of 'threshold' in the properties file (`tungsten-manager/conf/manager.properties`): interval = (threshold + 1) * 10 seconds

Additionally, there are multiple ways to influence the behavior of the cluster AFTER a failover has been invoked. Below are some of the key variables:

- Behavior when MySQL is not available but the binary logs are - wait for the Replicator to finish extracting the binary logs or not?

`--property=replicator.store.thl.stopOnDBError=false` [405]

The Manager and Replicator behave in concert when MySQL dies on the Primary node. When this happens, the replicator is unable to update the `trep_commit_seqno` table any longer, and therefore must either abort extraction or continue extracting without recording the extracted position into the database.

The default of **`false`** means that the Manager will delay failover until all remaining events have been extracted from the binary logs on the failing Primary node as a way to protect data integrity.

Failover will only continue once:

- all available events are completely read from the binary logs on the Primary node
- all events have reached the Replicas

When `--property=replicator.store.thl.stopOnDBError=true` [405], then the Replicator will stop extracting once it is unable to update the `trep_commit_seqno` table in MySQL, and the Manager will perform the failover without waiting, at the risk of possible data loss due to leaving binlog events behind. All such situations are logged.

- Replica THL apply wait time before failover - how long to wait term of seconds for a Replica to finish applying all stored THL to the database before failing over to it.

  `--property=manager.failover.thl.apply.wait.timeout=0` [405]

  During a failover, the manager will wait until the Replica that is the candidate for promotion to Primary has applied all stored THL events before promoting that node to Primary.

  The default value is 0, which means "wait indefinitely until all stored THL events are applied".

  > **Warning**
  >
  > Any value other than zero (0) invites data loss due to the fact that once the Replica is promoted to Primary, any unapplied stored events in the THL will be ignored, and therefore lost.

  Whenever a failover occurs, the Replica with most events stored in the local THL is selected so that when the events are eventually applied, the data is as close to the original Primary as possible with the least number of events missed.

  That is usually, but not always, the most up-to-date Replica, which is the one with the most events applied.

- Replica latency check - how far behind in term of seconds is each Replica? If too far behind, do not use for failover.

  `--property=policy.slave.promotion.latency.threshold=900` [405]

  The `policy.slave.promotion.latency.threshold=900` option is the "maximum Replica latency" - this means the number of seconds to which a Replica must be current with the Primary in order to qualify as a candidate for failover. The default is 15 minutes (900 seconds).

8.3. Tungsten Manager Failover Internals

The process of replica selection during either a manual switch or an automatic failover involves a number of decisions about the health of the candidate replica node(s).

For the list of discrete faults that can cause a Primary failover, please visit: Section 8.2, “Tungsten Manager Failover Tuning”.

8.3.1. Manual Switch Versus Automatic Failover

This section describes the main differences between the manual and automatic scenarios.

Manual Switch

1. The entry point for manual switch/failover is the cctrl command line tool.
2. For switch commands for both physical and composite services, the user has the ability to pass in the name of the physical or composite replica that is to be the target of the switch.

   If no target is passed in, then the Manager has logic to identify the 'most up to date' replica which then becomes the target of the switch. Here are the steps that are taken in that logic:

   a. Skip any replica that is either not online or that is NOT a standby replica.

b. Skip any replica that has its status set to ARCHIVE

c. Skip any replica that does not have an online manager.

d. Skip any replica that does not have a replicator in either online or synchronizing state.

e. Now we have a target datasource prospect.

f. By comparing the last applied sequence number of the current target datasource prospect to any other previously seen prospect, we should eventually end up with a replica that has the highest applied sequence number. We also save the prospect that has the highest stored sequence number.

g. If we find that there is a tie in the highest sequence number that has been applied or stored by any prospect with another prospect, we compare the datasource precedence and if there's a difference in this precedence, we choose the datasource with the lowest precedence number i.e. a precedence of 1 is higher than a precedence of 2. If we have a tie in precedence, select the last replica chosen and discard the replica currently being evaluated.

h. After we have evaluated all of the replicas, we will either have a single winner or we may have a case where we have one replica that has the highest applied sequence number but we have another replica that has the highest stored sequence number i.e. it has gotten the most number of THL records from the primary prior to the switch operation. In this case, and this is particularly important in cases of failover, we choose the replica that has the highest number of stored THL records.

i. At this point we return whatever target replica we have determined to the switch or failover command so that it can continue.

3. After looping over all available replicas, check the selected target replica's appliedLatency to see if it is higher than the configured threshold (default: 900 seconds). If the appliedLatency is too far behind, do not use that replica. The tpm option `--property=policy.slave.promotion.latency.threshold=900` [405] controls the check.

4. If no viable replica is found (or if there is no available replica to begin with), there will be no switch or failover at this point.

   Once the target replica has been identified and validated, the switch/failover continues and follows the steps outlined in the Switch and Failover Steps section.

Automatic Failover

> **Important**
>
> NOTE: Automatic failover only applies to local (physical) primary or relay datasources.

1. The entry point for automatic failover (there is no such thing as an automatic switch) can be found in two rules:

   - 0200a: RECOVER PRIMARY DATASOURCE BY FAILING OVER - NON-REPLICATOR FAULT
   - 0200b: RECOVER PRIMARY DATASOURCE BY FAILING OVER - REPLICATOR FAULT

2. The main difference between these two rules is that 0200b - failover because of a replicator fault - is qualified by having the existence of an expired ReplicatorFaultAlarm. Such an alarm will only exist if the customer has a non-default policy configuration that says 'I want to failover my primary if my replicator goes into a fault condition'. This is achieved by having the following properties, in `tungsten-manager/conf/manager.properties`, set to true:

   - `policy.fence.masterReplicator=true` tells the manager to set the associated primary or relay datasource to the failed state if the replicator has a fault. This will cause a failover if the cluster is in automatic mode.
   - `policy.fence.masterReplicator.threshold=6` tells the manager to do six iterations to try to recover the replicator, one iteration every 10 seconds, after which the fencing occurs.

3. The other difference, in both rules, is that the rules that call this method ensure that there's at least one potential target replica for the failover. So some of the validation that is done in the manual case, inside of the method, is actually done in the body of the rules. The reason for this is that we would prefer not to initiate a failover if it doesn't have a chance to succeed.

8.3.2. Switch and Failover Steps for Local Clusters

The set of steps described below apply to both manually-initiated commands as well as those that are initiated by the Tungsten manager rules as a part of an automated recovery scenario.

> **Important**
>
> A failure of any of the below steps will result in a rollback of the operation to the starting state.

Once either the switch or failover operation for a local cluster is triggered, the following steps are taken:

1. FAILOVER ONLY: THE CURRENT PRIMARY WILL BE MARKED AS FAILED. TUNGSTEN WILL NOT ALLOW ANY CONNECTIONS TO A FAILED PRIMARY. APPLICATIONS WILL APPEAR TO HANG.
2. FAILOVER ONLY: Put the cluster into maintenance mode. Automatic policy mode will be restored after the failover operation is complete or if the operation is rolled back.

   SWITCH ONLY: Get the current policy mode and then put the cluster into maintenance mode if it isn't already. The current policy mode will be restored after the switch operation is complete or if the operation is rolled back.
3. Verify that the manager running on target is operational.
4. Verify that the replicator on the target is in the online state.
5. SWITCH ONLY: Verify that the manager on the source is operational.
6. SWITCH ONLY: Verify that the replicator on the source is in the online state.
7. SWITCH ONLY: Set the source datasource to the offline state. This operation does the following steps, and by the time it is done, all managers and connectors have an updated copy of the primary/relay datasource which shows its state as offline.
   - Update the on-disk datasource properties files that are stored in cluster-home/conf/cluster/<cluster-name>/datasource/<datasource-name>, simultaneously, on all managers.
   - Update the same datasource on all connectors, simultaneously, by calling the router gateway within each manager. Note that this call is synchronous and will not return until ALL connectors have suspended all new requests to connect to the datasource and have closed all active connections for the datasource. For this reason, the completion of the datasource offline call can be delayed depending on how long the connectors will wait before closing active connections.
8. SWITCH ONLY: AT THIS POINT NO MORE CONNECTIONS TO THE PRIMARY ARE POSSIBLE. APPLICATIONS WILL APPEAR TO HANG IN PROXY MODE.
9. Set the target datasource to the offline state. This performs the same set of steps as for the source datasource, above.

At this point in the switch operation, we have both the source and the target datasource in the offline state, there should be no active connections to the underlying database servers for these datasources, and no new connections are being allowed to either datasource. At the connector level, if an application requests a new connection to the primary or to a replica, the call will hang until the switch operation is complete. NOTE: the only replica that is put into the offline state is the one that is the target. Any remaining replicas remain available to handle read operations although, because the primary datasource is offline, replication will start to lag.

Now we're going to do the set of steps required to make sure that the target database server has all of the transactions that have been written to the current source database server.

1. SWITCH ONLY: Perform a replicator purge operation on the source. This operation identifies any database server threads that may still be running on the source database server even if the application level connections have been closed and kills those threads. Experience shows that this can sometimes be the case and if these threads were not killed transactions would 'leak' through to the current source and could be lost.
2. SWITCH ONLY: Flush all transactions from the source to the target. This involves doing a replicator flush operation, which will return the sequence number of the flush transaction and then polling with the replicator for the sequence number returned by the flush. This call with block indefinitely, waiting for the flush sequence number.
3. Put the replicator for the target into the offline state.
4. SWITCH ONLY: Put the replicator for the source into the offline state.
5. SWITCH ONLY: Set the source datasource to the replica role.
6. Set the target datasource to the primary or relay role.
7. Set the target replicator to the primary or relay role.
8. Set the source replicator to the replica role.
9. FAILOVER ONLY: Set the source datasource to the shunned state.
10. Put the replicator for the target into the online state.
11. Put the datasource for the target into the online state.

12. AT THIS POINT, THE NEW PRIMARY OR RELAY IS AVAILABLE TO APPLICATIONS.
13. SWITCH ONLY: Put the source datasource, which is now a replica, into the online state.
14. Iterate through any remaining replicas in the cluster, if any, and reconfigure them to point at the new primary/relay.

    NOTE: This step also includes reconfiguring a relay replicator on another site if the service on which the switch or failover occurred is a primary service of a composite cluster.
15. Issue a replicator heartbeat. This writes a transaction on the primary and it will propagate to all replicas. We do not wait for this heartbeat event to propagate.

8.3.3. Switch and Failover Steps for Composite Services

Switch and Failover operations for composite services are handled by a different set of high-level methods than local (physical) dataservice.

Here are the steps taken, in the exact order taken, to execute a switch or failover operation in a composite service:

1. SWITCH ONLY: make sure that there is an online composite primary.
2. FAILOVER ONLY: identify the failed primary. NOTE: TUNGSTEN WILL NOT ALLOW ANY CONNECTIONS TO A FAILED PRIMARY. APPLICATIONS WILL APPEAR TO HANG.
3. If a target datasource is passed in, ensure that it exists and that it is not the current primary.
4. If a target is not passed in, evaluate each composite replica and, for each of those composite replicas, evaluate the relay in the physical service for the composite replica and find the relay with the highest stored sequence number.
5. Get the current policy mode and store it away. Then set the policy mode for the composite service to maintenance. This means that all physical services will also be in maintenance mode.
6. SWITCH ONLY: put the composite primary datasource into the offline state. This has the effect of also putting the physical service's primary datasource into the offline state.
7. SWITCH ONLY: AT THIS POINT NO MORE CONNECTIONS TO THE COMPOSITE/PHYSICAL PRIMARY ARE POSSIBLE. APPLICATIONS WILL APPEAR TO HANG.
8. FAILOVER ONLY: shun the composite primary datasource. If the physical service for the failed composite primary is available, this will have the effect of shunning the physical primary datasource as well.
9. Put the composite target datasource into the offline state. This has the effect of also putting the physical relay on the target site into the offline state.
10. Purge transactions on the current physical primary if it's available.
11. SWITCH ONLY: Do a flush operation, as in the physical service switch operation, and wait until the flushed transaction is present on the target relay replicator.
12. SWITCH ONLY: AT THIS POINT ALL TRANSACTIONS THAT WERE COMMITTED ON THE PRIMARY ARE AVAILABLE ON THE TARGET.
13. SWITCH ONLY: Put the replicator for the physical source offline.
14. FAILOVER ONLY: When we have a multi-site composite service, there may be a relay in the service that successfully replicated more transactions than the relay that has been chosen to be the new primary. In this case, we'll need to have the new primary catch up from that relay or else when the system goes online, the further ahead relay will fail to go online because it will have a seqno higher than the new primary. So check whether or not we have such a case and catch up from an 'intermediate' replicator if necessary.
15. FAILOVER ONLY: AT THIS POINT ALL TRANSACTIONS THAT ARE AVAILABLE, FROM THE FAILED PRIMARY, WILL NOW BE COMMITTED ON THE TARGET.
16. Put the target composite datasource offline. This has the effect of putting the target's physical relay offline as well.
17. Put the replicator for the target's physical relay offline.
18. Change the role of the target's physical relay replicator to primary.
19. SWITCH ONLY: Change the role of the source's physical primary datasource to relay.
20. Change the role of the target's physical service relay datasource to primary.

21. Put the replicator for the new physical primary online.
22. Put the datasource for the new physical primary online.
23. SWITCH ONLY: put the replicator for the previous primary datasource into the online state as a relay replicator.
24. SWITCH ONLY: put the source physical primary datasource into the offline state.
25. SWITCH ONLY: set the source physical relay datasource as a primary.
26. SWITCH ONLY: put the new physical relay datasource from the source into the online state.
27. SWITCH ONLY: set the source composite datasource role from composite primary to composite replica.
28. Put the target composite datasource offline.
29. Set the target composite datasource from a composite replica to a composite primary.
30. Put the target composite datasource online. This has the effect of also putting the new physical primary into the online state.
31. AT THIS POINT THE COMPOSITE AND PHYSICAL PRIMARY ARE ONLINE AND CONNECTION REQUESTS WILL BE ACCEPTED.
32. SWITCH ONLY: put the source composite datasource, which is now a replica, into the online state. This has the effect of setting the physical relay datasource into the online state as well.
33. Reconfigure all of the remaining composite replicas to point at the new primary. This process involves the following steps:
    a. Identify the physical relay for each replica's physical service.
    b. Put the relay replicator offline.
    c. Set the role of the replicator to relay.
    d. Put the relay replicator into the online state.
34. Take the saved policy manager mode and, if it's not maintenance, put the composite cluster into that saved mode.

8.4. Tungsten Manager Fault Detection, Fencing and Recovery

The information contained in this topic is meant to give a relatively comprehensive understanding of how the Tungsten Manager detects faults and the subsequent processing that leads to fencing the fault and possible recovery from faults. The main focus of this topic is the set of business rules, implemented in the Tungsten Manager, which, collectively, perform fault detection, fault fencing, and fault recovery.

8.4.1. Tungsten Manager Definitions

These definitions assume a familiarity with concepts like failover, switch, Primary and Replica datasource etc.

- coordinator — every cluster designates one of the Tungsten managers in the cluster as the coordinator and it is this manager that will be responsible for taking action, if action is required, to recover the cluster's database resources to the most highly available state possible.
- rules — this term specifically refers to a set of 'business rules', implemented in a format required by the 'JBoss Drools' rules engine, and which are used to perform fault detection, fencing and recovery for Tungsten Clustering.
- rule firing/triggering — refers to the action of a rule becoming active due to the coincidence of one or more conditions specified in the rule itself. For example, a rule that detects a potential missing cluster member, called a 'heartbeat gap detection' rule, can fire if there are no other active alarms and if the rule has not 'seen' a cluster member heartbeat within the last 30-45 seconds. If a rule 'fires', further processing, specified in Java, will take effect.
- fault/fault detection — any condition which, if left unresolved, could lead to a lack of availability of database resources or to data inconsistency etc. Faults are detected. An example of a fault detection is to detect that a specific database server has stopped.
- (fault) alarm — the Tungsten Manager uses raises and processes entities that we will refer to as 'alarms' as an initial part of fault detection. A set of manager rules raise alarms under specific circumstances and that alarm stays active or triggers further processing depending on other rules. An alarm, depending on its type, may not necessarily mean that a fault has been definitively detected but that something has been detected that may or may not lead to an actual fault condition. An example of this, as you will see later, is a `HeartbeatGapAlarm` which occurs when the rules on a specific manager detect that a heartbeat event has not been received from one or more of the other managers in the group.

- (fault) alarm retraction — the action taken, by the rules, to remove an alarm from from consideration for further action. For example, if the manager raises a 'Heartbeat Gap Alarm' and then, subsequently, detects that the heartbeat from the errant member has resumed, a rule will retract that alarm.
- (fault) fence/fencing — the action which leads to a first-level amelioration of a fault i.e. an action that keeps a fault from causing further harm - applications are isolated from the fault through the action of fencing. Fencing a fault results in the removal of the original fault condition but may also result in further recovery actions. An example of fencing the fault that is detected when a database server has stopped is to set the associated datasource to the FAILED state. This effectively makes the datasource unavailable to applications, immediately, thus isolating the application from the fault state.
- (fault) recover/recovery — the action which may occur after a fault is initially fenced and which leads to a condition of continued availability, data consistency etc. An example of a recovery operation is, for example, the failover that occurs after a stopped Primary database fault has been fenced.
- split-brain — a condition of a cluster such that members of the cluster group have different views of the same set of database resources and, in the most damaging incidence of split-brain, more than different cluster members designate different database resources as the `Primary` resource, resulting in applications being able, for example, to perform database updates on a database resource that should be a Replica. This condition is to be avoided at all costs since the result is data loss or data corruption.

8.4.2. Cluster Monitoring and Notification Events

The key fact that must be understood in order that the operation of the rules can be grasped is that the rules are primarily driven by notification events which are, in turn, generated by the cluster monitoring subsystem or, in some cases, by threads internal to the manager that act as monitors for specific conditions.

As a general rule, notifications are generated in the monitoring subsystem, on each host, independently of the other hosts, and sent, by each manager, to all of the managers in the group, including itself, via group communications and the notifications are then routed to the rules engine in each manager.

These notifications are sent via a messaging protocol that guarantees that the monitoring events are received by all managers in the group in exactly the same order. This ordering is a critical part of correct rules operation for if notifications are received in a different order and used to drive the rules evaluation, the rules on each manager could arrive at a different state/conclusion based on the ordering.

The cluster monitoring subsystem driven by a set of checker threads that are configured from files found in tungsten-manager/conf and are named checker*.properties. There are currently four of these checkers, with their corresponding checker configurations stored in the following tungsten-manager/conf/checker*.properties files:

- checker.heartbeat.properties - runs a thread the generates a manager heartbeat notification for the manager. If a manager goes away from the group, either by crashing, being stopped, or having a network outage, other managers won't 'see' that manager's heartbeat and will use that as a clue that there may be something amiss on that manager's host.
- checker.instrumentation.properties - TBD
- checker.mysqlserver.properties - polls the local mysql server for liveness/state. This checker attempts to establish a connection with the local MySQL server and to execute the query that is found in `tungsten-manager/conf/mysql_checker_query.sql`. The checker then evaluates the success or failure of the connect attempt and subsequent query execution and establishes the state of the MySQL server based on that evaluation. Because database server state is so critical to the operation of the cluster, particularly when it comes to availability of database resources, this particular checker uses a very fine-grained and configurable process for evaluating the state.
- checker.tungstenreplicator.properties - polls the local Tungsten replicator for liveness/state. This checker connects to the local replicator via the JMX interfaces and queries the replicator for its current state. If, in the process of connecting to the replicator, a connection cannot be established because the replicator is not running, the checker simply returns the STOPPED state.

Let's look at the contents of one of these files - checker.mysqlserver.properties:

```
# AUTO-GENERATED: 2017-03-22T10:43:25-07:00
#####################################
# CHECKER.MYSQLSERVER.PROPERTIES #
#####################################
requiresProxy=true
name=mysql_response
class=com.continuent.tungsten.monitor.checkers.JDBCMySQLDatabaseServerChecker
# delay between each monitoring run - default 3000ms
frequency=3000
# connection will be renewed after this period
reconnectAfter=30000
serverName=viveka
host=viveka
vendor=mysql
port=3306
driver=org.drizzle.jdbc.DrizzleDriver
url=jdbc:mysql:thin://viveka:3306/tungsten
```

```
username=tungsten
password=passw0rd
query=select 1
queryTimeout=5
queryFileName=mysql_checker_query.sql
```

The key thing to understand about this configuration file is that the value for the class property indicates which Java class the manager will load and that class, when alive, will then be configured with the additional properties that can be seen in this file.

Every checker will have a property frequency which indicates how often the checker thread will become active.

Then, since this checker is for MySQL server, you can see that the configuration file indicates which jdbc driver to use, which port to use to connect directly to MySQL, username, password etc. for the connection as well as the name of a file that determines what SQL the checker will run to check for the MySQL server liveness.

8.4.3. Rule Organization - Detection, Investigation, Fencing, Recovery

The main focus of manager operations are fault processing business rules, and since these rules are organized into categories based on their function. As you can infer from some of the previous definitions, there are four major categories of rules, with some ancillary 'housekeeping' categories. The four major categories are:

1. Fault Detection — raise alarms for specific or nascent faults.

   The text show below comes directly from the source code for the manager rules and comprise the major faults detected by the manager:

   - 0600: DETECT MEMBER HEARTBEAT GAP"

     This rule fires if there are not already other alarm types pending, for a specific member, and if at least 30-45 seconds has elapsed since the last time a given manager send a ClusterMemberHeartbeat event to the group of managers. The result of this rule firing will be that a MemberHeartbeatGapAlarm is raised as well as a `MembershipInvalidAlarm`. Both of these alarms trigger other rules, explained later, which do further investigations of the current cluster connectivity and membership.

   - 0601: DETECT STOPPED CLUSTER MANAGER"

     This rule fires after a `MemberHeartbeatGapAlarm` has been raised since the reason for a heartbeat gap can be that a manager has stopped. Further processing determines whether or not the manager is, indeed, stopped. This rule generates a `ManagerStoppedAlarm` if it determines that the manager in question is, in fact, stopped.

   - 0602: DETECT DATASERVER FAULT"

     This rule fires whenever monitoring detects that a given database server is not in the ONLINE state. The result of this rule firing is a `DataServerFaultAlarm` which, in turn, results in further investigation via one of the investigation rules described later.

   - 0604: DETECT UNREACHABLE REMOTE SERVICE"

     In the case of a composite cluster, the current coordinator on each site will connect to one manager on the remote site. After establishing this connection, the local manager will poll the remote manager for liveness and generate a `RemoteServiceHeartbeatNotification` that has a status of REACHABLE. If the remote manager is not reachable, the manager that is polling the remote service will generate a `RemoteServiceHeartbeatNotification` that has a resource state of UNREACHABLE in which case this rule triggers and a `RemoteDataServiceUnreachableAlarm` is raised by this rule.

   - 0606: DETECT REPLICATOR FAULT"

     As the name of this rule indicates, it will detect a replicator fault. This rule triggers if it sees a replicator notification that indicates that any of the replicators in the cluster are in a STOPPED, SUSPECT or OFFLINE state. The result of triggering of this rule is at a `ReplicatorFaultAlarm` is raised.

2. Fault Investigation - process alarms by iteratively investigating whether or not the alarm represents a true fault that requires further action.

   - 0525: INVESTIGATE MY LIVENESS"

     In this rule title the word MY refers to the manager that is currently evaluating the rule. This rule triggers when it sees a `MemberHeartbeatGapAlarm` and, as a result of triggering, the manager checks to see if it has both network connectivity as well as visibility of the other cluster members including, if necessary, visibility of a passive witness host. If, during this connectivity check, a manager determines that it is isolated from the rest of the cluster, it will restart itself in a failsafe mode meaning that if will shun all of its database resources an then attempt to join an existing cluster group as a part of a quorum. This rule is particularly important in cases where there are transient or even protracted network outages since it forms a part of the strategy used to avoid split-brain operations. If the manager, after restarting, is able to become part of a cluster quorum group, the process of joining that group will result in shunned resources becoming available again if appropriate.

- 0530: INVESTIGATE MEMBERSHIP VALIDITY"

  This rule is triggered when it sees a MembershipInvalidAlarm which was previously generated as the result of a member heartbeat gap. The previous rule, INVESTIGATE MY LIVENESS

  checks for network connectivity for the current manager. This rule checks to see if the current manager is a part of a cluster quorum group. This type of check implies a connectivity check as well but goes further to see if other managers in the group are alive and operational. This rule is another critical part of split brain avoidance since, depending on what it determines, it will take one of the following actions:

  - If the manager does not have network connectivity after checking, every 10 seconds, for a period of 60 seconds, it will restart itself in two different modes:

    a. If the manager detects that it is the last man standing

       , meaning that it is currently responsible for the Primary datasource and all of the other cluster members had previously stopped, it will restart normally, leaving the Primary datasource available, and will be prepared to be the leader of any new group of managers.

    b. If the manager is not the last man standing

       , it will restart in failsafe mode i.e. will restart with all of its resources shunned and will attempt to join an existing group.

  - If the manager has network connectivity i.e. can see all of the other hosts in the cluster, it then checks to see if it is a part of a primary partition i.e. a cluster quorum group. If, the first time it checks, it determines that it is not a part of a primary partition, it immediately disconnects all existing Tungsten connector connections from itself. This has the effect, on the Tungsten connector side, of immediately suspending all new database connection requests until such time that the manager determines that it is in a primary partition

    . This is, again, a critical part of avoiding split-brain operation since it makes it impossible for connectors to satisfy new connection requests until a valid cluster quorum can be definitively validated.

  - The manager will then keep doing this check for quorum group membership, every 10 seconds, for a period of 60 seconds. If it determines that it is not a member of a quorum group, it will use the same criteria, as mentioned previously in the network connectivity case, to determine how it shall restart i.e.:

    a. If it is the last man standing

       it will, as in the above case, restart normally, leaving the Primary datasource available.

    b. If the manager is not the last man standing

       , it will restart in failsafe mode i.e. will restart with all of its resources shunned and will attempt to join an existing group.

  - If, after all of the previous checks, the manager establishes that it is a part of a quorum group, it will, if necessary because it disconnected Tungsten connectors during quorum validation, it will become available for Tungsten connectors to connect to it again after synchronizing its view of the cluster with the current cluster coordinator, and will then continue normal operations.

- 0550: INVESTIGATE: TIME KEEPER FOR HEARBEAT GAP ALARM"
- 0550: INVESTIGATE: TIME KEEPER FOR INVALID MEMBERSHIP ALARM"
- 0550: INVESTIGATE: TIME KEEPER FOR MANAGER STOPPED ALARM"
- 0550: INVESTIGATE: TIME KEEPER FOR DATASERVER STOPPED ALARM"
- 0551: INVESTIGATE: TIME KEEPER FOR REMOTE SERVICE STOPPED ALARM"
- 0552: INVESTIGATE: TIME KEEPER FOR REPLICATOR FAULT ALARM"

3. Fault Fencing - fences validated faults, rendering them less disruptive/harmful from the standpoint of the application.
   - 0303: FENCE FAILED NODE"
   - 0304: FENCE FAULTED DATASERVER"

- 0305: FENCE UNREACHABLE REMOTE SERVICE"
- 0306: FENCE REPLICATOR FAULT - DIMINISHED DATASOURCE"
- 0306: FENCE REPLICATOR FAULT - EXPIRED ALARM"

4. Fault Recovery - attempts to render the fault completely harmless by taking some action that either corrects the fault or by providing alternative resources to manage the fault.
   - 0200a: RECOVER MASTER DATASOURCE BY FAILING OVER - NON-REPLICATOR FAULT"
   - 0200b: RECOVER MASTER DATASOURCE BY FAILING OVER - REPLICATOR FAULT"
   - 0201: RECOVER COMPOSITE DATASOURCES TO ONLINE"
   - 0201a: RECOVER FAILSAFE PHYSICAL SLAVE WITH ONLINE PRIMARY"
   - 0201: RECOVER FAILSAFE SHUNNED COMPOSITE SLAVE TO ONLINE"
   - 0202: RECOVER OFFLINE PHYSICAL DATASOURCES TO ONLINE"
   - 0203: RECOVER FAILED PHYSICAL DATASOURCES TO ONLINE"
   - 0204: RECOVER MASTER REPLICATORS TO ONLINE"
   - 0205: RECOVER SLAVE REPLICATORS TO ONLINE"
   - 0206: RECOVER FROM DIMINISHED STATE WHEN STOPPED REPLICATOR RESTARTS"
   - 0207: RECOVER MERGED MEMBERS"
   - 0208: RECOVER AND RECONCILE REMOTE DATA SERVICE STATE"
   - 0209: PREVENT MULTIPLE ONLINE MASTERS"
   - 0210: RECOVER WITNESSES TO ONLINE"
   - 0211: RECOVER REMOTE FAILSAFE SHUNNED COMPOSITE MASTER TO ONLINE"
   - 0212: RECOVER NON-READ-ONLY SLAVES TO READ-ONLY"

Chapter 9. Command-line Tools

Tungsten Cluster is supplied with a number of different command-line tools and utilities that help to install manage, control and provide additional functionality on top of the core Tungsten Cluster product.

The content in this chapter provides reference information for using and working with all of these tools. Usage and operation with these tools in particular circumstances and scenarios are provided in other chapters. For example, deployments are handled in Chapter 2, *Deployment*, although all deployments rely on the tpm command.

Commands related to the deployment

- tpm — Tungsten package manager

Commands related to managing Tungsten Cluster

- cctrl — cluster control
- cluster_backup—cluster backup automation

Commands related to the core Tungsten Replicator

- trepctl — replicator control
- multi_trepctl — multi-replicator control
- thl — examine Tungsten History Log contents

Commands related to managing Tungsten Replicator deployments

- tungsten_provision_slave — provision or reprovision a Replica from an existing Primary or Replica database
- tungsten_read_master_events — read Primary events to determine the correct log position
- tungsten_set_position — set the position of the replicator

Commands related to monitoring

- tungsten_monitor — provides a mechanism for monitoring the cluster state
- tungsten_health_check — checks the cluster for best practice configuration and operation
- tungsten_send_diag — assists with diag and file uploads to Continuent support
- tungsten_prep_upgrade — assists with upgrades from one topology to another

9.1. The cctrl Command

The cctrl command provides cluster management for your installed cluster, providing a command-line shell interface to obtain information and manage your cluster and structure.

9.1.1. cctrl Command-line Options

`cctrl [ -admin ] [ -expert ] [ -host ] [ -logical ] [ -multi ] [ -no-history ] [ -physical ] [ -port ] [ -proxy ] [ -service ] [ -timeout ]`

Where:

– `-admin` [284]

Table 9.1. cctrl Command-line Options

Option	`-admin` [284]
Description	Enter admin mode when connecting
Value Type	string

Automatically enters `admin` mode when cctrl connects to the cluster:

```
shell> cctrl -admin
Tungsten Clustering (for MySQL) 5.4
alpha: session established, encryption=false, authentication=false
[ADMIN] /alpha >
```

– -expert [285]

Table 9.2. cctrl Command-line Options

Option	-expert [285]
Description	Enter expert mode when connecting
Value Type	string

Automatically enters expert mode when cctrl connects to the cluster:

```
shell> cctrl -expert
Tungsten Clustering (for MySQL) 5.4
alpha: session established, encryption=false, authentication=false
LOGICAL:EXPERT] /alpha >
```

– -host [285]

Table 9.3. cctrl Command-line Options

Option	-host [285]
Description	Host name of the service manager to use
Value Type	string
Default	localhost

Allows you to specify the host to connect to when looking for a manager. By default, cctrl will connect to the local host:

```
shell> cctrl -host host1
Tungsten Clustering (for MySQL) 5.4
alpha: session established, encryption=false, authentication=false
[LOGICAL] /alpha >
```

– -logical [285]

Table 9.4. cctrl Command-line Options

Option	-logical [285]
Description	Enter logical mode when connecting
Value Type	string

Automatically enters logical mode when cctrl connects to the cluster. This mode is the default when connecting to a typical; using this option forces this mode:

```
shell> cctrl -expert
Tungsten Clustering (for MySQL) 5.4
alpha: session established, encryption=false, authentication=false
LOGICAL:EXPERT] /alpha >
```

– -multi [285]

Table 9.5. cctrl Command-line Options

Option	-multi [285]
Description	Allow support for connecting to multiple services
Value Type	string

Allow support for connecting to multiple services

– -no-history [285]

Table 9.6. cctrl Command-line Options

Option	-no-history [285]
Description	Disable command history
Value Type	string

Prevents cctrl from accessing or recording command history during interaction.

– -physical [285]

Table 9.7. cctrl Command-line Options

Option	-physical [285]
Description	Enter physical mode when connecting
Value Type	string

Automatically enters logical mode when cctrl connects to the cluster. This mode is the default when connecting to a typical; using this option forces this mode:

```
shell> cctrl -physical
Tungsten Clustering (for MySQL) 5.4
alpha: session established, encryption=false, authentication=false
[PHYSICAL] resource://>
```

– -port [286]

Table 9.8. cctrl Command-line Options

Option	-port [286]
Description	Specify the TCP/IP port of the service manager
Value Type	string
Default	9997

Specify the TCP/IP port of the service manager

– -proxy [286]

Table 9.9. cctrl Command-line Options

Option	-proxy [286]
Description	Operate as a proxy service
Value Type	string

Operate as a proxy service

– -service [286]

Table 9.10. cctrl Command-line Options

Option	-service [286]
Description	Connect to a specific service
Value Type	string

Enables the selection of a specific service when first connecting to the cluster. For example:

```
shell > cctrl -service east_from_west
Tungsten Clustering (for MySQL) 5.4
east: session established, encryption=false, authentication=false
east_from_west: session established, encryption=false, authentication=false
[LOGICAL] /east_from_west >
```

– -timeout [286]

Table 9.11. cctrl Command-line Options

Option	-timeout [286]
Description	Specify timeout (in seconds) to determine how long to wait before timing out when unable to connect to the manager. Default 30 seconds
Value Type	string

9.1.2. cctrl Modes

- Admin Mode
- Expert Mode

- Logical Mode
- Physical Mode

You can specify the mode to enter from the command-line, using the appropriate switch. For example, to start cctrl in `Expert` mode:

```
shell> cctrl -expert
```

The default mode is `Logical`.

You can also change the mode from within cctrl by issuing the appropriate command. For example, to switch to `Expert` mode:

```
[LOGICAL] /alpha > expert

WARNING: This is an expert-level command:
Incorrect use may cause data corruption
or make the cluster unavailable.

Do you want to continue? (y/n)> y
[LOGICAL:EXPERT] /alpha >
```

The current mode is always displayed as part of the command prompt within cctrl.

9.1.3. cctrl Commands

Table 9.12. cctrl Commands

Option	Description
admin	Change to admin mode
cd	Change to a specific site within a multisite service
cluster	Issue a command across the entire cluster
cluster validate	Validate the cluster quorum configuration
create composite	Create a composite dataservice
datasource	Issue a command on a single datasource
expert	Change to expert mode
failover	Perform a failover operation from a primary to a replica
help	Display the help information
ls	Show cluster status
members	List the managers of the dataservice
physical	Enter physical mode
ping	Test host availability
quit, exit	Exit cctrl
recover master using	Recover the Primary within a datasource using the specified Primary
replicator	Issue a command on a specific replicator
router	Issue a command on a specific router (connector)
service	Run a service script
set	Set management options
set master	Set the Primary within a datasource
show topology	Shows the currently configured cluster topology
switch	Promote a Replica to a Primary

9.1.3.1. cctrl admin Command

The admin command enables admin mode commands and displays. Admin mode is a specialized mode used to examine and repair cluster metadata. It is not recommended for normal use.

9.1.3.2. cctrl cd Command

The cd command changes the data service being administered. Subsequent commands will only affect the given data service name.

Using cd .. allows to go back to the root element. The given data service name can be either composite or physical Note that this command can only be used when cctrl is run with the '-multi' flag

9.1.3.3. cctrl cluster Command

The cluster command operates at the level of the full cluster.

9.1.3.3.1. cctrl cluster check Command

The cluster check command issues an MD5 consistency check on one or more tables in a database on the Primary data source. The consistency checks then replicate to each Replica, whereupon the Applier replicator repeats the check.

If the check fails, Replicas may go offline or print a log warning depending on how the replicators are configured. The default is to go offline. You can return a replicator to the online state after a failed check by issuing a replicator online command.

The table name can also be a wildcard (*) in which case all tables will be checked. Users may optionally specify a range of rows to check using the -limit option, which takes a starting row option followed by a number of rows to check. Rows are selected in primary key order.

The following example checks all tables in database accounting.

```
[LOGICAL] /alpha > cluster check accounting.*
```

The following command checks only the first 10 rows in a single table.

```
[LOGICAL] /alpha > cluster check accounting.invoices -limit 1,10
```

> **Warning**
>
> Consistency checks can be very lengthy operations for large tables and will lock them while they run. On the Primary this can block applications. On Replicas it blocks replication.

9.1.3.3.2. cctrl cluster flush Command

The cluster flush command sends a heartbeat event through the local cluster and returns a flush sequence number that is guaranteed to be equal to or greater than the sequence number of the flush event. Replicas that reach the flush sequence number are guaranteed to have applied the flush event.

This command is commonly used for operations like switch that need to synchronize the position of one or more Primaries or Replicas.

9.1.3.3.3. cctrl cluster heartbeat Command

The cluster heartbeat command sends a heartbeat event through the local cluster to demonstrate that all replicators are working. You should see the sequence numbers on all data sources advance by at least 1 if it is successful.

9.1.3.3.4. cctrl cluster offline Command

The cluster offline command brings all data services that are not offline into the offline state. It has no effect on services that are already offline.

9.1.3.3.5. cctrl cluster online Command

The cluster online command brings all data services that are not online into the online state. It has no effect on services that are already online.

9.1.3.3.6. cctrl cluster validate Command

The cluster validate validates the configuration of the cluster with respect to the quorum used for decision making. The number of active managers and active witnesses within the cluster is validated to ensure that there are enough active hosts to make a decision in the event of a failover or other failure event.

When executed, the validation routine checks all the available hosts, including witness hosts, and determines whether there are enough hosts, and whether their membership of the cluster is valid. In the event of deficiency, corrective action will be recommended.

By default, the command checks all hosts within the configured cluster:

```
[LOGICAL] /alpha > cluster validate
HOST host1/192.168.2.20: ALIVE
HOST host2/192.168.2.21: ALIVE
HOST host3/192.168.2.22: ALIVE
CHECKING FOR QUORUM: MUST BE AT LEAST 2 MEMBERS, OR 1 MEMBERS PLUS ALL WITNESSES
```

```
QUORUM SET MEMBERS ARE: host2, host1, host3
SIMPLE MAJORITY SIZE: 2
VALIDATED MEMBERS ARE: host2, host1, host3
REACHABLE MEMBERS ARE: host2, host1, host3
WITNESS HOSTS ARE:
REACHABLE WITNESSES ARE:
MEMBERSHIP IS VALID
GC VIEW OF CURRENT MEMBERS IS: host1, host2, host3
VALIDATED CURRENT MEMBERS ARE: host2, host1, host3
CONCLUSION: I AM IN A PRIMARY PARTITION OF 3 MEMBERS OUT OF THE REQUIRED MAJORITY OF 2
VALIDATION STATUS=VALID CLUSTER
ACTION=NONE
```

Additionally, a list of hosts to exclude from the check can be provided to verify the cluster capability when certain hosts have already failed or been shunned from the dataservice during maintenance.

To exclude hosts, add `excluding` and a comma-separated list of hosts to the command. For example:

```
[LOGICAL] /alpha > cluster validate excluding host3,host2
EXCLUDED host3 FROM VIEW
EXCLUDED host2 FROM VIEW
HOST host1/192.168.2.20: ALIVE
CHECKING FOR QUORUM: MUST BE AT LEAST 2 MEMBERS, OR 1 MEMBERS PLUS ALL WITNESSES
QUORUM SET MEMBERS ARE: host2, host1, host3
SIMPLE MAJORITY SIZE: 2
VALIDATED MEMBERS ARE: host1
REACHABLE MEMBERS ARE: host1
WITNESS HOSTS ARE:
REACHABLE WITNESSES ARE:
MEMBERSHIP IS VALID
GC VIEW OF CURRENT MEMBERS IS: host1
VALIDATED CURRENT MEMBERS ARE: host1
CONCLUSION: I AM IN A NON-PRIMARY PARTITION OF 1 MEMBERS OUT OF A REQUIRED MAJORITY SIZE OF 2
AND THERE ARE 0 REACHABLE WITNESSES OUT OF 0
VALIDATION STATUS=NON-PRIMARY PARTITION
ACTION=RESTART SAFE
```

Cluster validation can be used to provide validation only. To improve the support:

- Add active witnesses to the dataservice, see Section 3.5.2, “Adding Active Witnesses to an Existing Deployment”
- Add Replica hosts to the dataservice, see Section 3.5.1, “Adding Datasources to an Existing Deployment”

9.1.3.4. cctrl create composite Command

The create composite command creates a new composite data source or data service with the given name. Composite data services can only be create in the root directory '/' while composite data sources need to be created from a composite data service location. Composite data source names should be the same as the physical data services Composite data service name should be named after its composite data sources

The following example creates a composite data service named 'sj_nyc'

```
cctrl> create composite dataservice sj_nyc
```

The following example changes to the composite data service sj_nyc, then creates a composite data source named 'sj' in this composite data service

```
cctrl> cd sj_nyc
cctrl> create composite datasource sj
```

9.1.3.5. cctrl datasource Command

The datasource command affects a single data source.

Table 9.13. cctrldatasource Commands

Option	Description
backup	Backup a datasource
connections	Displays the current number of connections running to the given node through connectors.
drain	Prevents new connection to be made to the given data source, while ongoing connection remain untouched. If a timeout (in seconds) is given, ongoing connections will be severed only after the timeout expires.

Option	Description
fail	Fail a datasource
host	Hostname of the datasource
offline	Put a datasource into the offline state
online	Put a datasource into the online state
recover	Recover a datasource into operation state as Replica
restore	Restore a datasource from a previous backup
shun	Shun a datasource
welcome	Welcome a shunned datasource back to the cluster

9.1.3.5.1. cctrl datasource backup Command

The datasource backup command invokes a backup on the data source on the named host using the default backup agent and storage agent. Backups taken in this way can be reloaded using the datasource restore command. The following command options are supported:

- *backupAgent* — The name of a backup agent.
- *storageAgent* — The name of a storage agent.
- *timeout* — Number of seconds to wait before the backup command times out.

On success the backup URL will be written to the console.

The following example performs a backup on host saturn using the default backup agent.

```
cctrl> datasource saturn backup
```

The following example performs a backup on host mercury using the xtrabackup agent, which is named explicitly.

```
cctrl> datasource mercury backup xtrabackup
```

9.1.3.5.2. cctrl datasource fail Command

The datasource fail allows you to place a host into the failed state.

To place a node back into an online state, you must issue the datasource recover command.

If the cluster is in automatic policy mode, the cluster will attempt to recover the host automatically if the replicator and database are online.

In order to maintain the failed state, switch the cluster to maintenance and/or stop the underlying database and replicator.

The following example changes the state of the node venus, to failed:

```
cctrl> datasource venus fail
```

9.1.3.5.3. cctrl datasource offline Command

The datasource offline allows you to place a host into an offline state. It has no effect if the datasource is already in an offline state.

To place a node back into an online state, you must issue the datasource online command.

If the cluster is in *AUTOMATIC* policy mode, the cluster will return the host to online automatically.

In order to maintain the offline state, switch the cluster to *MAINTENANCE* and/or stop the underlying database and replicator.

The following example changes the state of the node mercury, to failed:

```
cctrl> datasource mercury offline
```

9.1.3.5.4. cctrl datasource online Command

The datasource online allows you to place a host into an online state. It has no effect if the datasource is already in an online state.

To place a node back into an online state, you must issue the datasource online command.

If the node is in a SHUNNED or FAIL state, this command will fail with an error. Instead, you should use the datasource recover command

The following example changes the state of the node mercury, to failed:

```
cctrl> datasource mercury online
```

9.1.3.5.5. cctrl datasource recover Command

The datasource recover reconfigures a shunned data source and returns it to the cluster as a Replica. This command can be used with failed Primary as well as Replica data sources.

For Replica data sources, the recover command attempts to restart the DBMS server followed by replication. If successful, the data source joins the cluster as an online Replica.

For Primary data sources, the recover command first reconfigures the Primary as a Replica. It then performs the same recovery process as for a failed Replica.

If datasource recover is unsuccessful, the next step is typically to restore the data source from a backup. This should enable it to rejoin the cluster as a normal Replica.

The following example recovers host mercury following a failure. The command is identical for Primary and Replica data sources.

```
cctrl> datasource mercury recover
```

9.1.3.5.6. cctrl datasource restore Command

The datasource restore command reloads a backup generated with the datasource backup command.

The following command options are supported:

- *uri* — The URI of a specific backup to restore
- *timeout* — Number of seconds to wait before the command times out.

To restore a data source you must first put the data source and its associated replicator offline.

The following example restores host saturn from the latest backup. The preceding commands place the datasource and replicator offline. The commands after the restore return the datasource to the cluster and put it online.

```
cctrl> datasource saturn shun
cctrl> datasource saturn offline
cctrl> replicator saturn offline
cctrl> datasource saturn restore
cctrl> datasource saturn welcome
cctrl> cluster online
```

The following example restores host mercury from an existing backup, which is explicitly named. The datasource and replicator must be offline.

```
cctrl> datasource mercury restore storage://file-system/store-0000000004.properties
```

9.1.3.5.7. cctrl datasource shun Command

The datasource shun command removes the data source from the cluster and makes it unavailable to applications. It will remain in the shunned state without further changes until you issue a datasource welcome or datasource recover command.

The datasource shun command is most commonly used to perform maintenance on a data source. It allows you to reboot servers and replicators without triggering automated policy mode rules.

The following example shuns the data source on host venus.

```
cctrl> datasource venus shun
```

9.1.3.5.8. cctrl datasource welcome Command

When a datasource has been shunned, the datasource can be welcomed back to the dataservice by using the welcome command. The welcome command attempts to enable the datasource in the ONLINE state using the current roles and configuration. If the datasource was operating as a Replica before it was shunned, the welcome command will enable the datasource as a Replica.

For example, the host host3 is a Replica and currently online:

```
+----------------------------------------------------------------------------+
|host3(slave:ONLINE, progress=157454, latency=1.000)                         |
|STATUS [OK] [2013/05/14 05:12:52 PM BST]                                      |
+----------------------------------------------------------------------------+
```

```
|  MANAGER(state=ONLINE)                                                  |
|  REPLICATOR(role=slave, master=host2, state=ONLINE)                   |
|  DATASERVER(state=ONLINE)                                               |
|  CONNECTIONS(created=0, active=0)                                       |
+-------------------------------------------------------------------------+
```

```
[LOGICAL:EXPERT] /alpha > datasource host3 shun
DataSource 'host3' set to SHUNNED
```

To switch the datasource back to the online state, the welcome is used:

```
[LOGICAL:EXPERT] /alpha > datasource host3 welcome
DataSource 'host3' is now OFFLINE
```

The welcome command puts the datasource into the OFFLINE state. If the dataservice policy mode is *AUTOMATIC*, the node will be placed into ONLINE mode due to automatic recovery. When in *MAINTENANCE* or *MANUAL* mode, the node must be manually set online.

The welcome command may not always work if there has been a failure or topology change between the moment it was shunned and welcomed back. Using the recover command may be a better alternative to using welcome when bringing a datasource back online. The recover commands ensures that the replicator, connector and operation of the datasource are correct within the current cluster configuration. See Section 9.1.3.14, “cctrl recover Command”.

9.1.3.6. cctrl expert Command

The expert command enables expert mode in cctrl. This suppresses prompts for commands that can cause damage to data. It is provided as a convenience for fast administration of the system.

> **Warning**
>
> This mode should be used with care, and only be used by experienced operators who fully understand the implications of the subsequent commands issued.
>
> Missuse of this feature may cause irreparable damage to a cluster

9.1.3.7. cctrl failover Command

The failover command performs a failover to promote an existing Replica to Primary after the current Primary has failed. The Primary data source must be in a failed state to use failover. If the Primary data source is not failed, you should instead use switch.

If there is no argument the failover command selects the most caught up Replica and promotes it as the Primary. You can also specify a particular host, in which case failover will ensure that the chosen Replica is fully up-to-date and promote it.

Failover ensures that the Replica has applied all transactions present in its log, then promotes the Replica to Primary. It does not attempt to retrieve transactions from the old Primary, as this is by definition already failed. After promoting the chosen Replica to Primary, failover reconfigures other Replicas to point to it and ensures all data sources are online.

To recover a failed Primary you should use the datasource recover command.

Failover to any up-to-date Replica in the cluster. If no Replica is available the operation fails:

```
cctrl> failover
```

Failover from a broken Primary to a specific node:

```
cctrl> failover to mercury
```

9.1.3.8. cctrl help Command

The help command provides help text from within the cctrl operation.

With no other arguments, help provides a list of the available commands:

```
[LOGICAL] /alpha > help

--------
Overview
--------
Description: Overview of Tungsten cctrl Commands

Commands
--------
admin                          - Enter admin mode
cd <name>                      - Change to the specified SOR cluster element
cluster <command>              - Issue a command on the entire cluster
```

```
create composite <type> <name> - Create SOR cluster components
datasource <host> <cmd>        - Issue a command on a datasource
expert                         - Enter expert mode
failover                       - Failover from failed &mas_lc; to &slv_lc;
help                           - Show help
ls [options]                   - Show generic cluster status
members                        - List all of the managers in the cluster
ping                           - Test host availability
physical                       - Enter physical mode
quit or exit                   - Leave cctrl
replicator <host> <cmd>        - Issue a command on a replicator
service                       - Run a service script
set                            - Set management options
switch                         - Promote a &slv_lc; to &mas_lc;

To get more information about particular commands type help followed by a
command.  Examples: 'help datasource' or 'help create composite'.
```

To get specific information about an individual command or operation, provide the command name to the help command. For example, to get information about the ping command, type help ping at the cctrl prompt.

9.1.3.9. cctrl ls Command

The ls command displays the current structure and status of the cluster.

`ls` [-l] [host] [[resources] | [services] | [sessions]]

The ls command operates in a number of different modes, according to the options provided on the command-line, as follows:

- No options

  Generates a list of the current routers, datasources, and the their current status and services.

- -l

  Outputs extended information about the current status and configuration. The -l option can be used in both the standard (no option) and host specific output formats to provide more detailed information.

- host

  You can also specify an individual component within the cluster on which to obtain information. For example, to get the information only for a single host, issue

  ```
  cctrl> ls host1
  ```

- resources

  The resources option generates a list of the configured resources and their current status.

- services

  The services option generates a list of the configured services known to the manager.

- sessions

  The sessions outputs statistics for the cluster. Statistics will only be presented when *SMARTSCALE* is enabled for the connectors

Without any further options, the output of ls looks similar to the following:

```
[LOGICAL] /alpha > ls

COORDINATOR[host1:AUTOMATIC:ONLINE]

ROUTERS:
+----------------------------------------------------------------------------+
|connector@host1[1179](ONLINE, created=0, active=0)                          |
|connector@host2[1532](ONLINE, created=0, active=0)                          |
|connector@host3[17665](ONLINE, created=0, active=0)                         |
+----------------------------------------------------------------------------+

DATASOURCES:
+----------------------------------------------------------------------------+
|host1(master:ONLINE, progress=60, THL latency=0.498)                        |
|STATUS [OK] [2013/03/22 02:25:00 PM GMT]                                    |
+----------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                     |
|  REPLICATOR(role=master, state=ONLINE)                                     |
```

```
|  DATASERVER(state=ONLINE)                                                    |
|  CONNECTIONS(created=0, active=0)                                            |
+------------------------------------------------------------------------------+

+------------------------------------------------------------------------------+
|host2(slave:ONLINE, progress=31, latency=0.000)                               |
|STATUS [OK] [2013/03/22 02:25:00 PM GMT]                                      |
+------------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                       |
|  REPLICATOR(role=slave, master=host1, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                    |
|  CONNECTIONS(created=0, active=0)                                            |
+------------------------------------------------------------------------------+

+------------------------------------------------------------------------------+
|host3(slave:ONLINE, progress=35, latency=9.455)                               |
|STATUS [OK] [2013/03/21 06:47:53 PM GMT]                                      |
+------------------------------------------------------------------------------+
|  MANAGER(state=ONLINE)                                                       |
|  REPLICATOR(role=slave, master=host1, state=ONLINE)                          |
|  DATASERVER(state=ONLINE)                                                    |
|  CONNECTIONS(created=0, active=0)                                            |
+------------------------------------------------------------------------------+
```

The purpose of the `Alert STATUS` field is to provide standard, datasource-state-specific values for ease of parsing and backwards-compatibility with older versions of the cctrl command.

The `STATUS` field is effectively the same information as the `DataSource State` that appears on the first line after the colon [:], just presented slightly differently.

Here are the possible values for `STATUS`, showing the `DataSource State` first, and the matching `Alert STATUS` second:

Datasource State	Alert STATUS
ONLINE	OK
OFFLINE	WARN [for non-composite datasources]
OFFLINE	DIMINISHED [for composite passive replica]
OFFLINE	CRITICAL [for composite active primary]
FAILED	CRITICAL
SHUNNED	SHUNNED

Any other `DataSource State` sets the `STATUS` to `UNKNOWN`.

9.1.3.10. cctrl members Command

The members command outputs a list of the currently identified managers within the dataservice.

For example:

```
[LOGICAL] /alpha > members
alpha/host1(ONLINE)/192.168.1.60:7800
alpha/host2(ONLINE)/192.168.1.61:7800
alpha/host3(ONLINE)/192.168.1.62:7800
```

The command outputs each identified manager service within the current dataservice.

The format of the output information is:

```
DATASERVICE/HOST(STATUS)/IPADDR:PORT
```

Where:

- `DATASERVICE`

  The name of the dataservice.

- `HOST`

  The name of the host on which the manager resides.

- `STATUS`

  The current status of the manager.

- IPADDR

  The IP address of the manager.

- PORT

  The primary TCP/IP port used for contacting the manager service.

The members service can be used as an indicator of the overall status of the dataservice. The information shown for each manager should within a single dataservice should be identical. If different information is shown, or an incomplete number of managers compared to the number of configured managers is provided, then it may indicate a communication or partition problem within the dataservice.

9.1.3.11. cctrl physical Command

The members command enables physical mode commands and displays. This is a specialized mode used to examine interfaces of resources managed by the cluster. It is not recommended for normal administrative use.

9.1.3.12. cctrl ping Command

The ping command checks to see whether a host is alive. If the host name is omitted, it tests all hosts in the cluster including witness hosts.

Ping uses the host ping timeout and methods specified in the manager.properties file. By default output is parsimonious.

The following shows an example of the output:

```
[LOGICAL] /nyc > ping
NETWORK CONNECTIVITY: PING TIMEOUT=2
NETWORK CONNECTIVITY: CHECKING MY OWN ('db2') CONNECTIVITY
NETWORK CONNECTIVITY: CHECKING CLUSTER MEMBER 'db1'
NETWORK CONNECTIVITY: CHECKING CLUSTER MEMBER 'db3'
```

9.1.3.13. cctrl quit Command

Exits cctrl and returns the user to the shell. For example:

9.1.3.14. cctrl recover Command

The recover will attempt to recover and bring online all nodes and services that are not in an ONLINE state.

Any previous failed Primary nodes will be reconfigured as Replicas, and all associated replicator services will be reconciled to connect to the correct Primary

If recovery is unsuccessful, the next step is typically to restore any failed data source from a backup.

9.1.3.15. cctrl recover master using Command

9.1.3.16. cctrl recover relay using Command

9.1.3.17. cctrl recover using Command

9.1.3.18. cctrl replicator Command

9.1.3.19. cctrl rm Command

9.1.3.20. cctrl router Command

9.1.3.21. cctrl service Command

The service command executes a command on the operating system according to standard Linux/Unix service script conventions. The service command may apply to a single host or may be executed on all hosts using the * operator. This latter form is also known as a broadcast command. You can enter service commands from any manager.

Commonly defined services include the following. User-defined services may also be invoked using the service command provided they are listed in the service configuration files for the cluster.

- connector: Tungsten Connector service
- mysql: MySQL service
- replicator: Tungsten Replicator service

The standard service commands are:

- restart: Stop and then start the service
- start: Start the service if it is not already running
- status: Show the current process status
- stop: Stop the service if it is running
- tail: Show the end of the process log (useful for diagnostics)

To start all mysqld processes in the cluster. This should be done in. *maintenance* mode to avoid triggering a failover.

```
cctrl> service */mysql restart
```

Stop the replicator process on host mercury.

```
cctrl> service mercury/replicator tail
```

Show the end of the log belonging to the connector process on host jupiter.

```
cctrl> service jupiter/connector tail
```

Warning

[Re-]starting Primary DBMS servers can cause failover when operating in *automatic* policy mode. Always set policy mode to *maintenance* before restarting a Primary DBMS server.

9.1.3.22. cctrl set Command

The set command sets a management option. The following options are available.

- set policy - Set policy for cluster automation
- set output - Set logging level in cctrl
- set force [true|false]

Warning

Setting force should NOT be used unless advised by Support. Using this feature without care, can break the cluster and possibly cause data corruption.

9.1.3.23. cctrl show topology Command

The show topology command shows the topology for the currently selected cluster, or cluster composite.

For example, below is sample output for an Composite Active/Passive cluster:

```
[LOGICAL] /east > show topology
clustered_master_slave
```

For example, below is sample output for an Composite Active/Active cluster:

```
[LOGICAL] /usa > show topology
clustered_multi_master
```

When selecting a cluster within the composite:

```
[LOGICAL] /usa > use east
[LOGICAL] /east >  show topology
```

```
clustered_primary
```

The following values are output according to the cluster selected:

- Active service returns `clustered-primary`
- Passive service returns `clustered-sub-service`
- Composite Active/Passive returns `composite-master-slave`
- Composite Active/Active returns `composite-multi-master`

9.1.3.24. cctrl set master Command

9.1.3.25. cctrl switch Command

The switch command performs a planned failover to promote an existing Replica to Primary and reconfigure the current Primary as a Replica.

The most common reason for a switch operation is to perform maintenance on the Primary.

If there is no argument the switch command selects the most caught up Replica and promotes it as the Primary. You can also specify a particular host, in which case switch will ensure that the chosen Replica is fully up-to-date and promote it.

Switch is a complex operation.

- First, we ensure that all transactions to the Primary through SQL router or connector processes complete before initiating the switch.
- It submits a flush transaction through the replicator to ensure that the chosen Replica is fully caught up with the Primary.
- It then reconfigures the Primary and Replica to reverse their roles.
- Finally, it puts the Primary and Replica back online.

In the event that switch does not complete, We attempt to revert to the old Primary. If a switch fails, you should check the cluster using 'ls' to ensure that things rolled back correctly.

Examples:

Switch to any up-to-date Replica in the cluster. If no Replica is available the operation fails.

```
cctrl> switch
```

Switch the Primary to host mercury.

```
cctrl> switch to mercury
```

The switch command can also be used to switch between the Active and Passive clusters in a Tungsten Cluster+ Active/Passive™ Topology.

In this scenario, the switch will promote the RELAY node in the remote cluster to be the Primary, and revert the Primary in the local cluster to be the Relay

To initiate the switch in a composite cluster, issue the command from the composite cluster, for example if you have cluster service east and west in a composite cluster called global, and east is the current Active site:

```
cctrl> use global
cctrl> switch
```

9.2. The check_tungsten_latency Command

The check_tungsten_latency command reports warning or critical status information depending on whether the latency across the nodes in the cluster is above a specific level.

Table 9.14. check_tungsten_latency Options

Option	Description
`-c`	Report a critical status if the latency is above this level
`--perslave-perfdata`	Show the latency performance information on a per-Replica basis

Option	Description
`--perfdata`	Show the latency performance information
`-w`	Report a warning status if the latency is above this level

The command outputs information in the following format:

```
LEVEL: DETAIL
```

Where DETAIL includes detailed information about the status report, and LEVEL is:

- CRITICAL — latency on at least one node is above the specified threshold level for a critical report. The host reporting the high latency will be included in the DETAIL portion:

  For example:

  ```
  CRITICAL: host2=0.506s
  ```

- WARNING — latency on at least one node is above the specified threshold level for a warning report. The host reporting the high latency will be included in the DETAIL portion:

  For example:

  ```
  WARNING: host2=0.506s
  ```

- OK — status is OK; the highest reported latency will be included in the output.

  For example:

  ```
  OK: All slaves are running normally (max_latency=0.506)
  ```

The `-w` and `-c` options must be specified on the command line, and the critical figure must be higher than the warning figure. For example:

```
shell> check_tungsten_latency -w 0.1 -c 0.5
CRITICAL: host2=0.506s
```

Performance information can be included in the output to monitor the status. The format for the output is included in the DETAIL block and separates the maximum latency information for each node with a semicolon, and the detail block with a pipe symbol. For example:

```
shell> check_tungsten_latency -w 1 -c 1 --perfdata
OK: All slaves are running normally (max_latency=0.506) |  max_latency=0.506;1;1;;
```

Performance information for all the Replicas in the cluster can be output by using the `--perslave-perfdata` option which must be used in conjunction with the `--perfdata` option:

```
shell> check_tungsten_latency -w 0.2 -c 0.5 --perfdata --perslave-perfdata
CRITICAL: host2=0.506s | host1=0.0;0.2;0.5;; host2=0.506;0.2;0.5;;
```

9.3. The check_tungsten_online Command

The check_tungsten_online command checks whether all the services for a given service and host are online and running.

Within a Tungsten Cluster service, the replicator, manager and connector services are checked. All must be online for an OK response.

Table 9.15. check_tungsten_online Options

Option	Description
`-h`	Display the help text
`-s`	Specify the service you would like to check [default: all available services]

By default, the script will check all manager and replication services for the localhost

> **Note**
>
> Prior to v6.1.16, the default behavior was to check all nodes within a cluster

To also check the manager services on the other cluster nodes, use -a

You can also check the cluster-wide composite status using -c

Warning

Using -a or -c on multiple nodes will alert on all monitored nodes for the same offline service

The command outputs information in the following format:

```
LEVEL: DETAIL
```

Where DETAIL includes detailed information about the status report, and LEVEL is:

- CRITICAL — status is critical and requires immediate attention. This indicates that more than one service is not running.

  For example:

  ```
  CRITICAL: Replicator is not running
  ```

- WARNING — status requires attention. This indicates that one service within the system is not online.
- OK — status is OK.

  For example:

  ```
  OK: All services are online
  ```

This output is easily parseable by various monitoring tools, including Nagios NRPE, and can be used to monitor the status of your services quickly without resorting to using the full trepctl output.

For example:

```
shell> check_tungsten_online
OK: All services are online
```

If you have multiple services installed, use the `-s` to specify the service:

```
shell> check_tungsten_online -s alpha
OK: All services are online
```

9.4. The check_tungsten_policy Command

The check_tungsten_policy command checks whether the policy is in *AUTOMATIC* mode or not.

Table 9.16. check_tungsten_policy Options

Option	Description
-h	Display the help text

This command only needs to be run on one node within the service; the command returns the policy mode for all nodes.

The command outputs information in the following format:

```
LEVEL: DETAIL
```

Where DETAIL includes detailed information about the status report, and LEVEL is:

- CRITICAL — status is critical and requires immediate attention. This indicates that the policy is not *AUTOMATIC*.

  For example:

  ```
  CRITICAL: Policy is MAINTENANCE
  ```

- WARNING — status requires attention. This indicates that one service within the system is not online.
- OK — status is OK.

  For example:

  ```
  OK: Policy is AUTOMATIC
  ```

This output is easily parseable by various monitoring tools, including Nagios NRPE, and can be used to monitor the status of your services quickly without resorting to using the full trepctl output.

For example:

```
shell> check_tungsten_policy
OK: Policy is AUTOMATIC
```

9.5. The check_tungsten_progress Command

The check_tungsten_progress command determines whether the replicator is actually making progress by executing a heartbeat operation and monitoring for this operation to complete within an optional time period (default is 1 second).

Table 9.17. check_tungsten_progress Options

Option	Description
-t	Give a time period during which progress should be identified

The command outputs information in the following format:

```
LEVEL: DETAIL
```

Where DETAIL includes detailed information about the status report, and LEVEL is:

- CRITICAL — replicator is not making progress and either has not completed the heartbeat operation, or has failed. If failed, the reason will be shown in the DETAIL:

  For example:

  ```
  CRITICAL: Replicator is not ONLINE
  ```

- OK — replicator is making progress.

  For example:

  ```
  OK: Replicator is making progress
  ```

This output is easily parseable by various monitoring tools, including Nagios NRPE, and can be used to monitor the status of your services quickly without resorting to using the full trepctl output.

The time delay can be added on busy systems to ensure that the replicator is progressing, especially if you see errors like this:

```
CRITICAL: Replicator is not ONLINE
```

For example, to wait 5 seconds to ensure the replicator is progressing:

```
shell> check_tungsten_progress  -t 5
OK: Replicator is making progress
```

9.6. The check_tungsten_services Command

The check_tungsten_services command provides a simple check to confirm whether configured services are currently running. The command must be executed with a command-line option specifying which services should be checked and confirmed.

Table 9.18. check_tungsten_services Options

Option	Description
-c	Check the Connector service status.
-h	Display the help text.
-r	Check the replication services status.

The command outputs information in the following format:

```
LEVEL: DETAIL
```

Where DETAIL includes detailed information about the status report, and LEVEL is:

- CRITICAL — status is critical and requires immediate attention.

  For example:

  ```
  CRITICAL: Replicator is not running
  ```

- OK — status is OK.

For example:

```
OK: All services (Replicator) are online
```

This output is easily parseable by various monitoring tools, including Nagios NRPE, and can be used to monitor the status of your services quickly without restoring to using the full trepctl output.

> **Note**
>
> The check_tungsten_services only confirms that the services and processes are running; their state is not confirmed. To check state with a similar interface, use the check_tungsten_online command.

To check the services:

- To check the replicator services:

```
shell> check_tungsten_services -r
OK: All services (Replicator) are online
```

- To check the replicator and manager services are executing:

```
shell> check_tungsten_services -r
OK: All services (Replicator, Manager) are running
```

- To check the connector services:

```
shell> check_tungsten_services -c
OK: All services (Replicator) are online
```

9.7. The clean_release_directory Command

The clean_release_directory is located in the `tools` directory removes older releases of the installed product from the installation directory. Over time, as tpm update the configuration or new releases of the product, new directories with the full release information are created, but old ones are not removed in case you need to go back to a previous release.

The clean_release_directory command removes all but the five most recent installs and the current release. For example, with the following directory:

```
shell> ls -l /opt/continuent/releases
drwxrwxr-x 17 mc mc 4096 Jul  7 15:36 ./
drwxr-xr-x  9 mc mc 4096 Jul  7 15:36 ../
drwxrwxr-x  2 mc mc 4096 Jul  7 15:36 install/
drwxr-xr-x  5 mc mc 4096 Jul  7 14:35 tungsten-replicator-5.2.0-218_pid16197/
drwxr-xr-x  5 mc mc 4096 Jul  7 15:36 tungsten-replicator-5.2.0-219_pid10303/
drwxr-xr-x  5 mc mc 4096 Jul  7 15:35 tungsten-replicator-5.2.0-219_pid1393/
drwxr-xr-x  5 mc mc 4096 Jul  7 15:34 tungsten-replicator-5.2.0-219_pid23112/
drwxr-xr-x  5 mc mc 4096 Jul  7 15:35 tungsten-replicator-5.2.0-219_pid24935/
drwxr-xr-x  5 mc mc 4096 Jul  7 15:35 tungsten-replicator-5.2.0-219_pid26720/
drwxr-xr-x  5 mc mc 4096 Jul  7 15:35 tungsten-replicator-5.2.0-219_pid28491/
drwxr-xr-x  5 mc mc 4096 Jul  7 15:35 tungsten-replicator-5.2.0-219_pid30270/
drwxr-xr-x  5 mc mc 4096 Jul  7 15:35 tungsten-replicator-5.2.0-219_pid32041/
drwxr-xr-x  5 mc mc 4096 Jul  7 15:35 tungsten-replicator-5.2.0-219_pid3212/
drwxr-xr-x  5 mc mc 4096 Jul  7 15:35 tungsten-replicator-5.2.0-219_pid4983/
drwxr-xr-x  5 mc mc 4096 Jul  7 15:35 tungsten-replicator-5.2.0-219_pid6754/
drwxr-xr-x  5 mc mc 4096 Jul  7 15:36 tungsten-replicator-5.2.0-219_pid8530/
drwxrwxr-x  5 mc mc 4096 Jul  6 11:09 tungsten-replicator-5.2.0_pid2869/
```

> **Warning**
>
> The clean_release_directory command removes old releases. Although this does not affect THL, stored data, or your configuration, it may remove working, but old, configurations, releases and versions of Tungsten Cluster.

Running clean_release_directory:

```
shell> ./tools/clean_release_directory
Deleting release directories in /opt/continuent; keeping the last five and current installation
Cleaning old releases from /opt/continuent
Deleting /opt/continuent/releases/tungsten-replicator-5.2.0-219_pid32041
Deleting /opt/continuent/releases/tungsten-replicator-5.2.0-219_pid30270
Deleting /opt/continuent/releases/tungsten-replicator-5.2.0-219_pid28491
Deleting /opt/continuent/releases/tungsten-replicator-5.2.0-219_pid26720
Deleting /opt/continuent/releases/tungsten-replicator-5.2.0-219_pid24935
Deleting /opt/continuent/releases/tungsten-replicator-5.2.0-219_pid23112
Deleting /opt/continuent/releases/tungsten-replicator-5.2.0-218_pid16197
Deleting /opt/continuent/releases/tungsten-replicator-5.2.0_pid2869
```

The resulting releases directory now contains a simpler list:

```
shell> /opt/continuent/releases/
total 36
drwxrwxr-x 9 mc mc 4096 Jul  7 15:52 ./
drwxr-xr-x 9 mc mc 4096 Jul  7 15:36 ../
drwxrwxr-x 2 mc mc 4096 Jul  7 15:36 install/
drwxr-xr-x 5 mc mc 4096 Jul  7 15:36 tungsten-replicator-5.2.0-219_pid10303/
drwxr-xr-x 5 mc mc 4096 Jul  7 15:35 tungsten-replicator-5.2.0-219_pid1393/
drwxr-xr-x 5 mc mc 4096 Jul  7 15:35 tungsten-replicator-5.2.0-219_pid3212/
drwxr-xr-x 5 mc mc 4096 Jul  7 15:35 tungsten-replicator-5.2.0-219_pid4983/
drwxr-xr-x 5 mc mc 4096 Jul  7 15:35 tungsten-replicator-5.2.0-219_pid6754/
drwxr-xr-x 5 mc mc 4096 Jul  7 15:36 tungsten-replicator-5.2.0-219_pid8530/
```

9.8. The cluster_backup Command

The cluster_backup command provides a simple mechanism to execute a Tungsten Replicator backup inside of the cluster. It is designed to be called manually or as part of cron. The command should be added to cron on every server. When started, the command will check if the server is the current coordinator for the cluster. If not, the command will exit without an error. This design ensures that the command will only run on one server in the cluster.

The command supports command-line options that allow you to alter how and where the backup is executed.

`cluster_backup [ --agent ] [ --datasource ] [ --directory ] [ --help, -h ] [ --info, -i ] [ --json ] [ --net-ssh-option ] [ --notice, -n ] [ --offline-backup String ] [ --quiet, -q ] [ --require-slave-backup String ] [ --require-automatic-mode String ] [ --validate ] [ --verbose, -v ]`

Where:

Table 9.19. cluster_backup Command-line Options

Option	Description
`--agent`	The replicator backup agent to use when running the backup, as configured in cctrl
`--datasource`	Execute the backup against the specified datasource
`--directory`	Use this installed Tungsten directory as the base for all operations
`--help, -h`	Display this message
`--info, -i`	
`--json`	Provide return code and logging messages as a JSON object after the script finishes
`--net-ssh-option`	Set the Net::SSH option for remote system calls
`--notice, -n`	
`--offline-backup String`	Put the datasource OFFLINE prior to taking the backup.
`--quiet, -q`	
`--require-slave-backup String`	Require that the backup is taken of a Replica datasource. If this is enabled and there are no Replicas available, no backup will be taken.
`--require-automatic-mode String`	The script will fail if the cluster is not in the AUTOMATIC policy mode
`--validate`	Only run the script validation
`--verbose, -v`	

After the command confirms the current server is the coordinator, it will attempt to find a datasource to backup. Unless `--require-slave-backup` has been disabled, only Replicas that are `ONLINE` will be eligible. If no datasource can be found, the command will exit with an error. The backup will then be started on the datasource.

The cluster_backup command will wait until the cctrl command has returned before exiting. The cctrl command can return prior to the backup is completed if it takes too long or if there is another error. The tungsten_nagios_backups check or similar should be used to make sure that you always have a recent backup available in the cluster.

The cluster_backup command may also be configured for use in Composite clusters. In this use case, one backup per cluster will be created.

See Section 6.9.2, “Automating Backups” for more information.

For example:

```
shell> crontab -l
```

```
00 00 * * * /opt/continuent/tungsten/cluster-home/bin/cluster_backup >>/opt/continuent/service_logs/cluster_backup.log 2>&1
```

All output will be sent to `/opt/continuent/service_logs/cluster_backup.log`.

9.9. The connector Command

The connector is the wrapper script that handles the execution of the connector service.

Table 9.20. connector Commands

Option	Description
`client-list` [303]	Return a list of the current client connections through this connector.
`cluster-status` [303]	Return the cluster status, as the connector currently understands it. This is the command-line alternative to the inline cluster status command.
`condrestart` [304]	Restart only if already running
`console` [304]	Launch in the current console (instead of a daemon)
`dump` [304]	Request a Java thread dump (if connector is running)
`graceful-stop [seconds]` [304]	Stops the connector gracefully, allowing outstanding open connections to finish and close before the connector process is stopped. All new connection requests are denied. The Connector will shut down as soon as there are no active connections. [seconds] is an integer specifying the optional time to wait before terminating the connector. Specifying no value for seconds will cause the Connector to wait indefinitely for all connections to finish. Specifying zero (0) seconds will cause the Connector to shut down immediately without waiting for existing connections to complete gracefully. As of v7.0.0, connector drain is available as an alias for connector graceful-stop.
`install` [304]	Install the service to automatically start when the system boots
`reconfigure` [304]	Reconfigure the connector by forcing the connector to reread the configuration, including the configuration files and `user.map`.
`remove` [304]	Remove the service from starting during boot
`restart` [304]	Stop connector if already running and then start
`start` [304]	Start in the background as a daemon process
`status` [305]	Query the current status
`stop` [305]	Stop if running (whether as a daemon or in another console) Optional timeout in seconds can be provided (From release 6.1.19 only)

These commands and options are described below:

– `client-list` [303]

Lists all ongoing connections with origin, local and remote (mysql data source) IPs/ports

```
shell> connector client-list
 Executing Tungsten Connector Service --client-list ...
 +---------------------+--------------------+---------------------+-----------------------+
 | Client | Connector Inbound | Connector Outbound | Data Source |
 +---------------------+--------------------+---------------------+-----------------------+
 | /192.168.20.11:53890 | /192.168.20.11:9999 | /192.168.20.11:51612 | c1/192.168.20.11:13306 |
 | /192.168.20.1:56492 | /192.168.20.11:9999 | /192.168.20.11:58556 | c1/192.168.20.11:13306 |
 +---------------------+--------------------+---------------------+-----------------------+

 Done Tungsten Connector Service --client-list
```

– `cluster-status` [303]

Returns the cluster status, in the same form as the inline tungsten cluster status command. In addition, the same information can be generated encapsulated in JSON format by adding the `-json` option. See Section 7.11.1.1, “Connector connector cluster status on the Command-line”, for more information.

```
shell> connector cluster-status
Executing Tungsten Connector Service --cluster-status ...
+--------------+-------------------+-------------+--------------+--------+--------+-----------------------------------------+-----------------+-----------------+--------
| Data service | Data service state | Data source | Is composite | Role | State | High water | Last shun reason | Applied latency | Relative latency | Act
```

```
+-------------+-------------------+-------------+-------------+--------+--------+-----------------------------------------+-----------------+--------
| europe | ONLINE | c1 | false | master | ONLINE | 0(c1-bin.000002:0000000000001219;113912) | | 1.0 | 114.0 | 1 | 4 |
| europe | ONLINE | c2 | false | slave | ONLINE | 0(c1-bin.000002:0000000000001219;113912) | | 1.0 | 113.0 | 0 | 0 |
| europe | ONLINE | c3 | false | slave | ONLINE | 0(c1-bin.000002:0000000000001219;113912) | | 1.0 | 113.0 | 0 | 1 |
+-------------+-------------------+-------------+-------------+--------+--------+-----------------------------------------+-----------------+--------

Done Tungsten Connector Service --cluster-status
```

– `condrestart` [304]

Restart the connector, only if it is already running. This can be useful to use when changing configuration or performing database management within automated scripts, as the connector will be only be restart if it was previously running.

For example, if the connector is running, connector condrestart [304] operates as connector restart:

```
shell> connector condrestart
Stopping Tungsten Connector Service...
Waiting for Tungsten Connector Service to exit...
Stopped Tungsten Connector Service.
Starting Tungsten Connector Service...
Waiting for Tungsten Connector Service......
running: PID:26646
```

However, if not already running, the operation does nothing:

```
shell> connector condrestart
Stopping Tungsten Connector Service...
Tungsten Connector Service was not running.
```

– `console` [304]

Launch in the current console (instead of a daemon)

– `dump` [304]

Request a Java thread dump (if connector is running)

– `graceful-stop [seconds]` [304]

Stops the connector gracefully, allowing outstanding open connections to finish and close before the connector process is stopped. All new connection requests are denied. The Connector will shut down as soon as there are no active connections. [seconds] is an integer specifying the optional time to wait before terminating the connector. Specifying no value for seconds will cause the Connector to wait indefinitely for all connections to finish. Specifying zero (0) seconds will cause the Connector to shut down immediately without waiting for existing connections to complete gracefully. As of v7.0.0, connector drain is available as an alias for connector graceful-stop.

– `install` [304]

Installs the startup scripts for running the connector at boot. For an alternative method of deploying these start-up scripts, see deployall.

– `reconfigure` [304]

Reloads the configuration without touching existing connections. New configuration only applies to new connections. Note that this command won't work for the following settings: connection.keepAlive.interval, connection.keepAlive.timeout, server.listen.address, server.port, server.port.binding.timeout, server.port.binding.retry.delay (when reaching server.max_connections only)

– `remove` [304]

Removes the startup scripts for running the connector at boot. For an alternative method of removing these start-up scripts, see undeployall.

– `restart` [304]

Stops the connector, if it is already running, and then restarts it:

```
shell> connector restart
Stopping Tungsten Connector Service...
Stopped Tungsten Connector Service.
Starting Tungsten Connector Service...
Waiting for Tungsten Connector Service......
running: PID:26248
```

– `start` [304]

To start the connector service if it is not already running:

```
shell> connector start
 Starting Tungsten Connector Service...
```

– status [305]

Checks the execution status of the connector:

```
shell> connector status
Tungsten Connector Service is running: PID:27015, Wrapper:STARTED, Java:STARTED
```

If the connector is not running:

```
shell> connector status
Tungsten Connector Service is not running.
```

This only provides the execution state of the connector, not the actual state of replication. To get detailed information on the status of replication use trepctl status.

– stop [305]

Stops the connector if it is already running, terminating all connections immediately:

```
shell> connector stop
Stopping Tungsten Connector Service...
Waiting for Tungsten Connector Service to exit...
Stopped Tungsten Connector Service.
```

Optional timeout can be provided, for example:

```
shell> connector stop 30
Stopping Tungsten Connector Service...
Waiting for Tungsten Connector Service to exit...
Stopped Tungsten Connector Service.
```

This would cause the connector to wait 30 seconds to allow connections to terminate cleanly, after the timeout, any remaining connections will be terminated.

9.10. The ddlscan Command

The ddlscan command scans the existing schema for a database or table and then generates a schema or file in a target database environment. For example, ddlscan is used in MySQL to Oracle heterogeneous deployments to translate the schema definitions within MySQL to the Oracle format. For more information on heterogeneous deployments, see Understanding Heterogeneous Deployments.

For example, to generate Oracle DDL from an existing MySQL database:

```
shell> ddlscan -user tungsten -url 'jdbc:mysql:thin://tr-source:13306/test' -pass password \
    -template ddl-mysql-oracle.vm -db test

SQL generated on Thu Sep 11 15:39:06 BST 2019 by ./ddlscan utility of Tungsten

url = jdbc:mysql:thin://tr-source:13306/test
user = tungsten
dbName = test
*/

DROP TABLE test.sales;
CREATE TABLE test.sales
(
  id NUMBER(10, 0) NOT NULL,
  salesman CHAR,
  planet CHAR,
  value FLOAT,
  PRIMARY KEY (id)
);
```

The format of the command is:

ddlscan [-conf path] [-db db] [-opt opt val] [-out file] [-pass secret] [-path path] [-rename file] [-service name] [-tableFile file] [-tables regex] [-template file] [-url jdbcUrl] [-user user]

The available options are as follows:

Table 9.21. ddlscan Command-line Options

Option	Description
-conf path [306]	Path to a static-{svc}.properties file to read JDBC connection address and credentials
-db db [306]	Database to use (will substitute ${DBNAME} in the URL, if needed)

Option	Description
-opt opt val [307]	Option(s) to pass to template, try: -opt help me
-out file [307]	Render to file (print to stdout if not specified)
-pass secret [306]	JDBC password
-path path [307]	Add additional search path for loading Velocity templates
-rename file [307]	Definitions file for renaming schemas, tables and columns
-service name [306]	Name of a replication service instead of path to config
-tableFile file [306]	New-line separated definitions file of tables to find
-tables regex [306]	Comma-separated list of tables to find
-template file [306]	Specify template file to render
-url jdbcUrl [306]	JDBC connection string (use single quotes to escape)
-user user [306]	JDBC username

ddlscan supports three different methods for execution:

- Using an explicit JDBC URL, username and password:

```
shell> ddlscan -user tungsten -url 'jdbc:mysql:thin://tr-hadoop1:13306/test' -user user \
    -pass password ...
```

  This is useful when a deployment has not already been installed.

- By specifying an explicit configuration file:

```
shell> ddlscan -conf /opt/continuent/tungsten/tungsten-replicator/conf/static-alpha.properties ...
```

- When an existing deployment has been installed, by specifying one of the active services:

```
shell> ddlscan -service alpha ...
```

In addition, the following two options must be specified on the command-line:

- The template to be used (using the -template [306] option) for the DDL translation must be specified on the command-line. A list of the support templates and their operation are available in Table 9.22, "ddlscan Supported Templates".

- The -db [306] parameter, which defines the database or schema that should be scanned. All tables are translated unless an explicit list, regex, or table file has been specified.

For example, to translate MySQL DDL to Oracle for all tables within the schema test using the connection to MySQL defined in the service alpha:

```
shell> ddlscan -service alpha -template ddl-mysql-oracle.vm -db test
```

ddlscan provides a series of additional command-line options, and a full list of the available templates.

9.10.1. Optional Arguments

The following arguments are optional:

- -tables [306]

  A comma-separate list of the tables to be extracted.

```
shell> ddlscan -service alpha -template ddl-mysql-oracle.vm -db test -tables typetwo,typethree
```

- -tableFile [306]

  A file containing a list of the files to be extracted. The file should be formatted as Comma Separated Values (CSV), only the first column is extracted. For example, the file:

```
typetwo,Table of type two customer forms
typethree,Table of type three customer forms
```

  Could be used with ddlscan:

```
shell> ddlscan -service alpha -template ddl-mysql-oracle.vm -db test -tableFile tablelist.txt
```

- -rename [307]

  A list of table renames which will be taken into account when generating target DDL. The format of the table matches the format of the rename filter.

- -path [307]

  The path to additional Velocity templates to be searched when specifying the template name.

- -opt [307]

  An additional option (and variable) which are supplied to be used within the template file. Different template files may support additional options for specifying alternative information, such as schema names, file locations and other values.

```
shell> ddlscan -service alpha -template ddl-mysql-oracle.vm -db test -opt schemaPrefix mysql_
```

- -out [307]

  Sends the generated DDL output to a file, in place of sending it to standard output.

- -help [307]

  Generates the help text of arguments.

9.10.2. Supported Templates and Usage

Table 9.22. ddlscan Supported Templates

file	Description
ddl-check-pkeys.vm	Reports which tables are without primary key definitions
ddl-mysql-hive-0.10.vm	Generates DDL from a MySQL host suitable for the base tables in a Hadoop/Hive Environment
ddl-mysql-hive-0.10-staging.vm	Generates DDL from a MySQL host suitable for the staging tables in a Hadoop/Hive Environment
ddl-mysql-hive-metadata.vm	Generates metadata as JSON to be used within a Hadoop/Hive Environment
ddl-mysql-oracle.vm	Generates Oracle schema from a MySQL schema
ddl-mysql-oracle-cdc.vm	Generates Oracle tables with CDC capture information from a MySQL schema
ddl-mysql-redshift.vm	Generates DDL from a MySQL host suitable for the base tables in Amazon Redshift.
ddl-mysql-redshift-staging.vm	Generates DDL from a MySQL host suitable for the staging tables in Amazon Redshift.
ddl-mysql-vertica.vm	Generates DDL suitable for the base tables in HP Vertica
ddl-mysql-vertica-staging.vm	Generates DDL suitable for the staging tables in HP Vertica
ddl-oracle-mysql.vm	Generates DDL for MySQL tables from an Oracle schema
ddl-oracle-mysql-pk-only.vm	Generates Primary Key DDL statements from an Oracle database for MySQL

9.10.2.1. ddl-check-pkeys.vm

The ddl-check-pkeys.vm template can be used to check whether specific tables within a schema do not have a primary key:

```
shell> ddlscan -template ddl-check-pkeys.vm \
 -user tungsten -pass password -db sales \
 -url jdbc:mysql://localhost:13306/sales
/*
SQL generated on Thu Sep 04 10:23:52 BST 2014 by ./ddlscan utility of Tungsten

url = jdbc:mysql://localhost:13306/sales
user = tungsten
dbName = sales
*/

/* ERROR: sales.dummy1 has no primary key! *//*
```

```
SQL generated on Thu Sep 04 10:23:52 BST 2014 by ./ddlscan utility of Tungsten

url = jdbc:mysql://localhost:13306/sales
user = tungsten
dbName = sales
*/

/* ERROR: sales.dummy2 has no primary key! *//*
SQL generated on Thu Sep 04 10:23:52 BST 2014 by ./ddlscan utility of Tungsten

url = jdbc:mysql://localhost:13306/sales
user = tungsten
dbName = sales
*/
```

For certain environments, particularly heterogeneous replication, the lack of primary keys can lead to inefficient replication, or even fail to replicate data at all.

9.10.2.2. ddl-mysql-hive-0.10.vm

Generates DDL suitable for a carbon-copy form of the table from the MySQL host:

```
shell> ddlscan -user tungsten -url 'jdbc:mysql://tr-hadoop1:13306/test' -pass password \
 -template ddl-mysql-hive-0.10.vm -db test
--
-- SQL generated on Thu Sep 11 12:57:11 BST 2014 by Tungsten ddlscan utility
--
-- url = jdbc:mysql://tr-hadoop1:13306/test
-- user = tungsten
-- dbName = test
--


DROP TABLE IF EXISTS test.sales;

CREATE TABLE test.sales
(
 id INT,
 salesman STRING,
 planet STRING,
 value DOUBLE )
;
```

Wherever possible, the closest Hive equivalent datatype is used for each source datatype, as follows:

MySQL Datatype	Hive Datatype
DATETIME	STRING
TIMESTAMP	TIMESTAMP
DATE	STRING
YEAR	INT
TIME	STRING
TINYINT	TINYINT
TINYINT UNSIGNED	SMALLINT
SMALLINT	SMALLINT
SMALLINT UNSIGNED	INT
MEDIUMINT	INT
INT	INT
INT UNSIGNED	BIGINT
BIGINT	BIGINT
BIGINT UNSIGNED	STRING
DECIMAL	STRING
VARCHAR	STRING
CHAR	STRING
BINARY	BINARY
VARBINARY	BINARY

MySQL Datatype	Hive Datatype
TEXT	STRING
BLOB	BINARY
FLOAT	DOUBLE
DOUBLE	DOUBLE
ENUM	STRING
SET	STRING
BIT	STRING

The template supports the following optional parameters to change behavior:

- `-opt schemaPrefix`

  A prefix to be placed in front of all schemas. For example, if called with *`schemaPrefix`* set to `mysql_`:

  ```
  shell> ddlscan ... -opt schemaPrefix mysql_
  ```

  The schema name will be prefixed, translating the schema name from `sales` into `mysql_sales`.

- `-opt tablePrefix`

  A prefix to be placed in front of all schemas. For example, if called with *`tablePrefix`* set to `mysql_`:

  ```
  shell> ddlscan ... -opt tablePrefix mysql_
  ```

  The table name will be prefixed, translating the tablename from `sales` into `mysql_sales`.

9.10.2.3. ddl-mysql-hive-0.10-staging.vm

Staging tables within Hive define the original table columns with additional columns to track the operation type, sequence number, time-stamp and unique key for each row. For example, the table `sales` in MySQL:

```
mysql> describe sales;
+----------+----------+------+-----+---------+----------------+
| Field | Type | Null | Key | Default | Extra |
+----------+----------+------+-----+---------+----------------+
| id | int(11) | NO | PRI | NULL | auto_increment |
| salesman | char(20) | YES | | NULL | |
| planet | char(20) | YES | | NULL | |
| value | float | YES | | NULL | |
+----------+----------+------+-----+---------+----------------+
4 rows in set (0.00 sec)
```

Generates the following Hive-compatible DDL when using this template:

```
shell> ddlscan -user tungsten -url 'jdbc:mysql://tr-hadoop1:13306/test' -pass password \
 -template ddl-mysql-hive-0.10-staging.vm -db test
--
-- SQL generated on Thu Sep 11 12:31:45 BST 2014 by Tungsten ddlscan utility
--
-- url = jdbc:mysql://tr-hadoop1:13306/test
-- user = tungsten
-- dbName = test
--


DROP TABLE IF EXISTS test.stage_xxx_sales;

CREATE EXTERNAL TABLE test.stage_xxx_sales
(
 tungsten_opcode STRING ,
 tungsten_seqno INT ,
 tungsten_row_id INT ,
 tungsten_commit_timestamp TIMESTAMP ,
 id INT,
 salesman STRING,
 planet STRING,
 value DOUBLE )
ROW FORMAT DELIMITED FIELDS TERMINATED BY '\001' ESCAPED BY '\\'
LINES TERMINATED BY '\n'
STORED AS TEXTFILE LOCATION '/user/tungsten/staging/test/sales' ;
```

Wherever possible, the closest Hive equivalent datatype is used for each source datatype, see `ddl-mysql-hive-0.10.vm` for more information.

9.10.2.4. ddl-mysql-hive-metadata.vm

The Hadoop tools require information about the schema in JSON format so that the table names and primary key information can be used when materializing data from the staging tables into the base tables. This template generates that information in JSON format:

```
shell> ddlscan -user tungsten -url 'jdbc:mysql://tr-hadoop1:13306/test' -pass password \
 -template ddl-mysql-hive-metadata.vm -db test


{
 "tables": [
 {
 "schema": "test",
 "name": "sales",
 "keys": ["id"],
 "columns": [
 {"name": "id", "type": "INT"},
 {"name": "salesman", "type": "STRING"},
 {"name": "planet", "type": "STRING"},
 {"name": "value", "type": "DOUBLE"}
 ]
 }
 ]
}
```

9.10.2.5. ddl-mysql-oracle.vm

When translating MySQL tables to Oracle compatible schema, the following datatypes are migrated to their closest Oracle equivalent:

MySQL Datatype	Oracle Datatype
INT	NUMBER(10, 0)
BIGINT	NUMBER(19, 0)
TINYINT	NUMBER(3, 0)
SMALLINT	NUMBER(5, 0)
MEDIUMINT	NUMBER(7, 0)
DECIMAL(x,y)	NUMBER(x, y)
FLOAT	FLOAT
CHAR(n)	CHAR(n)
VARCHAR(n)	VARCHAR2(n) (n < 2000), CLOB n > 2000)
DATE	DATE
DATETIME	DATE
TIMESTAMP	DATE
TEXT	CLOB
BLOB	BLOB
ENUM(...)	VARCHAR(255)
ENUM(...)	VARCHAR(4000)
BIT(1)	NUMBER(1)

The following additional transformations happen automatically:

- Table names are translated to uppercase.
- Column names are translated to uppercase.
- If a column name is a reserved word in Oracle, then the column name has an underscore character appended (for example, `TABLE` becomes `TABLE_`).

In addition to the above translations, errors will be raised for the following conditions:

- If the table name starts with a number.
- If the table name exceeds 30 characters in length.
- If the table name is a reserved word in Oracle.

Warnings will be raised for the following conditions:

- If the column or column name started with a number.
- If the column name exceeds 30 characters in length, the column name will be truncated.
- If the column name is a reserved word in Oracle.

9.10.2.6. ddl-mysql-oracle-cdc.vm

The ddl-mysql-oracle-cdc.vm template generates identical tables in Oracle, from their MySQL equivalent, but with additional columns for CDC capture. For example:

```
shell> ddlscan -user tungsten -url 'jdbc:mysql://tr-hadoop1:13306/test' -pass password \
 -template ddl-mysql-oracle-cdc.vm -db test
/*
SQL generated on Thu Sep 11 13:17:05 BST 2014 by ./ddlscan utility of Tungsten

url = jdbc:mysql://tr-hadoop1:13306/test
user = tungsten
dbName = test
*/

DROP TABLE test.sales;
CREATE TABLE test.sales
(
 id NUMBER(10, 0) NOT NULL,
 salesman CHAR,
 planet CHAR,
 value FLOAT,
 CDC_OP_TYPE VARCHAR(1), /* CDC column */
 CDC_TIMESTAMP TIMESTAMP, /* CDC column */
 CDC_SEQUENCE_NUMBER NUMBER PRIMARY KEY /* CDC column */
);
```

For information on the datatypes translated, see ddl-mysql-oracle.vm.

9.10.2.7. ddl-mysql-redshift.vm

The ddl-mysql-redshift.vm template generates DDL for Amazon Redshift tables from MySQL schemas. For example:

```
CREATE TABLE test.all_mysql_types
(
 my_id INT,
 my_bit BOOLEAN /* BIT(1) */,
 my_tinyint SMALLINT /* TINYINT(4) */,
 my_boolean SMALLINT /* TINYINT(1) */,
 my_smallint SMALLINT,
 my_mediumint INT /* MEDIUMINT(9) */,
 my_int INT,
 my_bigint BIGINT,
 my_decimal_10_5 DECIMAL(10,5),
 my_float FLOAT,
 my_double DOUBLE PRECISION /* DOUBLE */,
 my_date DATE,
 my_datetime DATETIME,
 my_timestamp TIMESTAMP,
 my_time VARCHAR(17) /* WARN: no pure TIME type in Redshift */,
 my_year YEAR(4) /* ERROR: unrecognized (type=0, length=0) */,
 my_char_10 CHAR(10),
 my_varchar_10 VARCHAR(40) /* VARCHAR(10) */,
 my_tinytext VARCHAR(65535) /* WARN: MySQL TINYTEXT translated to max VARCHAR */,
 my_text VARCHAR(65535) /* WARN: MySQL TEXT translated to max VARCHAR */,
 my_mediumtext VARCHAR(65535) /* WARN: MySQL MEDIUMTEXT translated to max VARCHAR */,
 my_longtext VARCHAR(65535) /* WARN: MySQL LONGTEXT translated to max VARCHAR */,
 my_enum_abc VARCHAR(1) /* ENUM('A','B','C') */,
 my_set_def VARCHAR(65535) /* SET('D','E','F') */,
 PRIMARY KEY (my_id)
);
```

Columns are translated as follows:

Oracle Datatype	Redshift Datatype
BIGINT	BIGINT
BINARY	BINARY, CHAR in 5.2.1 and later
BIT(1)	BOOLEAN

Oracle Datatype	Redshift Datatype
BIT	CHAR
BLOB	VARBINARY VARCHAR in 5.2.1 and later
CHAR	CHAR
DATE	DATE
DATETIME	DATETIME
DECIMAL	DECIMAL
DOUBLE	DOUBLE PRECISION
ENUM	VARCHAR
FLOAT	FLOAT
INT	INT
LONGBLOB	VARBINARY CHAR in 5.2.1 and later
LONGTEXT	VARCHAR
MEDIUMBLOB	VARBINARY CHAR in 5.2.1 and later
MEDIUMINT	INT
MEDIUMTEXT	VARCHAR
SET	VARCHAR
SMALLINT	SMALLINT
TEXT	VARCHAR
TIME	VARCHAR
TIMESTAMP	TIMESTAMP
TINYBLOB	VARBINARY CHAR in 5.2.1 and later
TINYINT	SMALLINT
TINYTEXT	VARCHAR
VARBINARY	VARBINARY CHAR in 5.2.1 and later
VARCHAR	VARCHAR

In addition to these explicit changes, the following other considerations are taken into account:

- When translating the DDL for CHAR and VARCHAR columns, the actual column size is increased by a factor of four. This is because Redshift tables always stored data using 32-bit UTF characters and column sizes are in bytes, not characters. Therefore a CHAR(20) column is created as CHAR(80) within Redshift.
- TEXT columns are converted to a Redshift VARCHAR of 65535 in length (the maximum allowed).
- BLOB columns are converted to a Redshift VARBINARY of 65000 in length (the maximum allowed).
- BIT columns with a size of 1 are converted to Redshift BOOLEAN columns, larger sizes are converted to CHAR columns of 64 bytes in length.
- TIME columns are converted to a Redshift VARCHAR of 17 bytes in length since no explicit TIME type exists.

9.10.2.8. ddl-mysql-redshift-staging.vm

The ddl-mysql-redshift-staging.vm template generates DDL for Amazon Redshift tables from MySQL schemas. For example:

```
CREATE TABLE test.stage_xxx_all_mysql_types
(
 tungsten_opcode CHAR(2),
 tungsten_seqno INT,
 tungsten_row_id INT,
 tungsten_commit_timestamp TIMESTAMP,
 my_id INT,
 my_bit BOOLEAN /* BIT(1) */,
 my_tinyint SMALLINT /* TINYINT(4) */,
 my_boolean SMALLINT /* TINYINT(1) */,
 my_smallint SMALLINT,
 my_mediumint INT /* MEDIUMINT(9) */,
 my_int INT,
 my_bigint BIGINT,
```

```
 my_decimal_10_5 DECIMAL(10,5),
 my_float FLOAT,
 my_double DOUBLE PRECISION /* DOUBLE */,
 my_date DATE,
 my_datetime DATETIME,
 my_timestamp TIMESTAMP,
 my_time VARCHAR(17) /* WARN: no pure TIME type in Redshift */,
 my_year YEAR(4) /* ERROR: unrecognized (type=0, length=0) */,
 my_char_10 CHAR(10),
 my_varchar_10 VARCHAR(40) /* VARCHAR(10) */,
 my_tinytext VARCHAR(65535) /* WARN: MySQL TINYTEXT translated to max VARCHAR */,
 my_text VARCHAR(65535) /* WARN: MySQL TEXT translated to max VARCHAR */,
 my_mediumtext VARCHAR(65535) /* WARN: MySQL MEDIUMTEXT translated to max VARCHAR */,
 my_longtext VARCHAR(65535) /* WARN: MySQL LONGTEXT translated to max VARCHAR */,
 my_enum_abc VARCHAR(1) /* ENUM('A','B','C') */,
 my_set_def VARCHAR(65535) /* SET('D','E','F') */,
 PRIMARY KEY (tungsten_opcode, tungsten_seqno, tungsten_row_id)
);
```

The actual translation of datatypes is identical to that found in `ddl-mysql-redshift.vm`.

9.10.2.9. `ddl-mysql-vertica.vm`

The `ddl-mysql-vertica.vm` template generates DDL for generating tables within an HP Vertica database from an existing MySQL database schema. For example:

```
shell> ddlscan -user tungsten -url 'jdbc:mysql://tr-hadoop1:13306/test' -pass password \
 -template ddl-mysql-vertica.vm -db test
/*
SQL generated on Thu Sep 11 14:20:14 BST 2014 by ./ddlscan utility of Tungsten

url = jdbc:mysql://tr-hadoop1:13306/test
user = tungsten
dbName = test
*/
CREATE SCHEMA test;

DROP TABLE test.sales;

CREATE TABLE test.sales
(
 id INT ,
 salesman CHAR(20) ,
 planet CHAR(20) ,
 value FLOAT ) ORDER BY id;
```

Because Vertica does not explicitly support primary keys, a default projection for the key order is created based on the primary key of the source table.

The templates translates different datatypes as follows:

MySQL Datatype	Vertica Datatype
DATETIME	DATETIME
TIMESTAMP	TIMESTAMP
DATE	DATE
TIME	TIME
TINYINT	TINYINT
SMALLINT	SMALLINT
MEDIUMINT	INT
INT	INT
BIGINT	INT
VARCHAR	VARCHAR
CHAR	CHAR
BINARY	BINARY
VARBINARY	VARBINARY
TEXT, TINYTEXT, MEDIUMTEXT, LONGTEXT	VARCHAR(65000)
BLOB, TINYBLOB, MEDIUMBLOB, LONGBLOB	VARBINARY(65000)
FLOAT	FLOAT

MySQL Datatype	Vertica Datatype
DOUBLE	DOUBLE PRECISION
ENUM	VARCHAR
SET	VARCHAR(4000)
BIT(1)	BOOLEAN
BIT	CHAR(64)

In addition, the following considerations should be taken into account:

- DECIMAL MySQL type is not supported.
- TEXT types in MySQL are converted to a VARCHAR in Vertica of the maximum supported size.
- BLOB types in MySQL are converted to a VARBINARY in Vertica of the maximum supported size.
- SET types in MySQL are converted to a VARCHAR in Vertica of 4000 characters, designed to work in tandem with the settostring filter.
- ENUM types in MySQL are converted to a VARCHAR in Vertica of the size of the longest ENUM value, designed to work in tandem with the enum-tostring filter.

9.10.2.10. ddl-mysql-vertica-staging.vm

The ddl-mysql-vertica-staging.vm template generates DDL for HP Vertica staging tables. These include the full table definition, in addition to three columns used to define the staging data, including the operation code, sequence number and unique row ID. For example:

```
shell> ddlscan -user tungsten -url 'jdbc:mysql://tr-hadoop1:13306/test' -pass password \
 -template ddl-mysql-vertica-staging.vm -db test
/*
SQL generated on Thu Sep 11 14:22:06 BST 2014 by ./ddlscan utility of Tungsten

url = jdbc:mysql://tr-hadoop1:13306/test
user = tungsten
dbName = test
*/
CREATE SCHEMA test;

DROP TABLE test.stage_xxx_sales;

CREATE TABLE test.stage_xxx_sales
(
 tungsten_opcode CHAR(1) ,
 tungsten_seqno INT ,
 tungsten_row_id INT ,
 id INT ,
 salesman CHAR(20) ,
 planet CHAR(20) ,
 value FLOAT ) ORDER BY tungsten_seqno, tungsten_row_id;
```

9.10.2.11. ddl-oracle-mysql.vm

The ddl-oracle-mysql.vm template generates the DDL required to create a schema within MySQL based on the existing Oracle schema. For example:

```
shell> ddlscan -service sales -template ddl-oracle-mysql.vm -db sales
/*
SQL generated on Thu Sep 11 04:29:08 PDT 2014 by ./ddlscan utility of Tungsten

url = jdbc:oracle:thin:@//tr-fromoracle1:1521/ORCL
user = SALES_PUB
dbName = sales
*/
/* ERROR: no tables found! Is database and tables option specified correctly? */

[tungsten@tr-fromoracle1 ~]$ ddlscan -service sales -template ddl-oracle-mysql.vm -db SALES
/*
SQL generated on Thu Sep 11 04:29:16 PDT 2014 by ./ddlscan utility of Tungsten

url = jdbc:oracle:thin:@//tr-fromoracle1:1521/ORCL
user = SALES_PUB
dbName = SALES
*/

DROP TABLE IF EXISTS sales.sample;
CREATE TABLE sales.sample
```

```
(
 id DECIMAL(38) /* NUMBER(38, ?) */ NOT NULL,
 msg CHAR(80),
 PRIMARY KEY (id)
) ENG
```

Columns are translated as follows:

Oracle Datatype	MySQL Datatype
DATE	DATETIME
NUMBER(0)	NUMERIC
NUMBER(n) where n < 19	INT
NUMBER(n) where n > 19	BIGINT
NUMBER(n) where n < 3	TINYINT
NUMBER(n) where n < 5	SMALLINT
NUMBER(n) where n < 7	MEDIUMINT
NUMBER(n) where n < 10	INT
NUMBER(n) where n < 19	BIGINT
NUMBER	DECIMAL
FLOAT	FLOAT
VARCHAR	VARCHAR
LONG	LONGTEXT
BFILE	VARCHAR(1024)
CHAR	CHAR
CLOB	LONGTEXT
BLOB	LONGBLOB
LONG RAW	LONGBLOB
TIMESTAMP	TIMESTAMP
RAW	VARBINARY

The following additional transformations happen automatically:

- If a column name is a reserved word in MySQL, then the column name has an underscore character appended (for example, `TABLE` becomes `TABLE_`).

An error is raised in the following conditions:

- If the size of a `FLOAT` is larger than 53 points of precision.

9.10.2.12. ddl-oracle-mysql-pk-only.vm

The `ddl-oracle-mysql-pk-only.vm` template generates alter table statements to add the primary key, as determined from the Oracle primary key or index information. For example:

```
shell> ddlscan -service hadoop -template ddl-oracle-mysql-pk-only.vm -db HADOOP
/*
SQL generated on Thu Sep 11 06:17:28 PDT 2014 by ./ddlscan utility of Tungsten

url = jdbc:oracle:thin:@//tr-fromoracle1:1521/ORCL
user = HADOOP_PUB
dbName = HADOOP
*/

ALTER TABLE hadoop.sample ADD PRIMARY KEY (ID);
```

Note that it does not generate table DDL, only statements to alter existing tables with primary key information.

9.11. The deployall Command

The deployall tool installs the required startup scripts into the correct location so that all required services can be automatically started and stopped during the startup and shutdown of your server.

To use, the tool should be executed with superuser privileges, either directly using sudo, or by logging in as the superuser and running the command directly.

```
shell> sudo deployall
```

The startup scripts are added to the correct run levels to enable operation during standard startup and shutdown levels.

> **Important**
>
> This note affects all versions up to and including v7.0.2. The workaround mentioned below will be included as a fix in the next patch release.
>
> When a service is controlled by systemd, the relevant OS limits (such as open file limits) are not controlled in the normal way (via settings in the limits.conf file) and therefore for clusters with heavy workloads there is a risk that you may experience open file limits being exceeded which will affect the clusters operation.
>
> To resolve this, you must ensure you increase the limits for each service. Follow the steps below to do this:
>
> - Edit the service files in /etc/systemd/system. There will be one file for each service, for example `treplicator.service`
> - Under the `[service]` stanza, add the following:
>
>   ```
>   LimitNOFILE=65535
>   ```
>
> - When you have changed all the files, reload the systemctl by issuing the following:
>
>   ```
>   systemctl daemon-reload
>   ```
>
> - Retstart each of the services, e.g:
>
>   ```
>   systemctl restart treplicator
>   ```
>
> Note that the restart will cause a momentary outage to each component therefore only do this when you are sure it is safe to do so, and ensure you cluster is in `MAINTENANCE` mode.

See Section 4.3, “Configuring Startup on Boot”.

To remove the scripts from the system, use undeployall.

9.12. The dsctl Command

The dsctl command provides a simplified interface into controlling the datasource within a replication scenario to set the current replication position. Because dsctl uses the built-in datasource connectivity of the replicator, differences in the storage and configuration of the current replicator metadata and position can be controlled without resorting to updating the corresponding database directly.

The command is driven by a number of command-specific instructions to get or set the datasource position.

Table 9.23. dsctl Commands

Option	Description
get	Return the available position information
help	Print the help display
reset	Clear the datasource position information
set	Set the position

These must be used in conjunction with one of the following options to select the required datasources or service:

Table 9.24. dsctl Command-line Options

Option	Description
`-conf`	Path to the static services properties file
`-ds`	Name of the datasource
`-service`	Name of the replication service to get information from

If more than one service or datasource has been configured, one of these options much be used to select the service. Otherwise, by default dsctl will use the corresponding configured service.

9.12.1. dsctl get Command

Table 9.25. dsctl Command-line Options

Option	Description
-ascmd	Generates the command required to set the datasource to the current position

Returns the current datasource status and position, returning the information as a JSON string. The example below has been formatted for clarity:

```
shell> dsctl
[
   {
      "last_frag" : true,
      "applied_latency" : 1,
      "extract_timestamp" : "2015-01-21 21:46:57.0",
      "eventid" : "mysql-bin.000014:0000000000005645;-1",
      "source_id" : "tr-11",
      "epoch_number" : 22,
      "update_timestamp" : "2015-01-21 21:46:58.0",
      "task_id" : 0,
      "shard_id" : "tungsten_alpha",
      "seqno" : 22,
      "fragno" : 0
   }
]
```

When the -ascmd option is used, the information is output in form of a command:

```
shell> dsctl get -ascmd
dsctl set -seqno 17 -epoch 11 -event-id "mysql-bin.000082:0000000014031577;-1" -source-id "ubuntu"
```

If the -reset is used, then the generated command also includes the option. For example:

```
shell> dsctl get -ascmd -reset
dsctl set -seqno 17 -epoch 11 -event-id "mysql-bin.000082:0000000014031577;-1" -source-id "ubuntu" -reset
```

9.12.2. dsctl set Command

Table 9.26. dsctl Command-line Options

Option	Description
-epoch	Epoch Number
-event-id	Source Event ID
-reset	Resets the datasources before performing set operation
-seqno	Sequence number
-source-id	Source ID

Sets the current replicator position. When using this option, the -seqno, -epoch, -event-id, and -source-id options must be specified to set the corresponding values in the replicator.

For example:

```
shell> dsctl set -seqno 22 -epoch 22 -event-id "mysql-bin.000014:0000000000005645;-1" -source-id tr-11
Service "alpha" datasource "global" position was set to: seqno=22 epoch_number=22 »
    eventid=mysql-bin.000014:0000000000005645;-1 source_id=tr-11
```

When used with the -reset, the datasource is reset before the set operation:

```
shell> dsctl set -seqno 17 -epoch 11 -event-id "mysql-bin.000082:0000000014031577;-1" -source-id "ubuntu" -reset
Service "alpha" datasource "global" catalog information cleared
Service "alpha" datasource "global" position was set to: seqno=17 epoch_number=11 »
    eventid=mysql-bin.000082:0000000014031577;-1 source_id=ubuntu
```

Adding the -reset option to the dsctl get -ascmd command also adds the option to the generated command:

```
shell> dsctl get -ascmd -reset
dsctl set -seqno 17 -epoch 11 -event-id "mysql-bin.000082:0000000014031577;-1" -source-id "ubuntu" -reset
```

9.12.3. dsctl reset Command

Clears the current replicator status and position information:

```
shell> dsctl reset
Service "alpha" datasource "global" catalog information cleared
```

9.12.4. dsctl help Command

Displays the current help text:

```
shell> dsctl help
Datasource Utility
Syntax: dsctl [conf|service] [-ds name] [operation]
Configuration (required if there's more than one service):
  -conf path       - Path to a static-<svc>.properties file
     OR
  -service name    - Name of a replication service to get datasource configuration from
Options:
 [-ds name]        - Name of the datasource (default: global)
Operations:
  get              - Return all available position information
     [-ascmd]      - Return all available position information as command
  set -seqno ###   - Set position (all four parameters required)
      -epoch ###
      -event-id AAAAAAAAA.######:#######
      -source-id AAA.AAA.AAA
     [-reset]      - Optionally reset the information first
  reset            - Clear datasource position information
  help             - Print this help display
```

9.13. `env.sh` Script

After installation, the `env.sh` can be used to setup the local environment, such as appending to the local $PATH.

If --profile-script is set during installation, then the local profile script will also be updated to ensure the `env.sh` file is loaded at login of the OS user.

```
shell> cat .bash_profile
...
# Begin Tungsten Environment for /opt/continuent
# Include the Tungsten variables
# Anything in this section may be changed during the next operation
if [ -f "/opt/continuent/share/env.sh" ]; then
    . "/opt/continuent/share/env.sh"
fi
# End Tungsten Environment for /opt/continuent
```

If not set, then the script can manually be sourced

```
shell> source /opt/continuent/share/env.sh
```

If --executable-prefix is set, then the `env.sh` script will also configure aliases for all of the common executable binaries

For example, if --executable-prefix has been set to "mm", then aliases for executable binaries will be prefixed with this value, as shown in the small example below:

```
shell> alias
...
alias mm_thl='/opt/continuent/tungsten/tungsten-replicator/bin/thl'
alias mm_tpm='/opt/continuent/tungsten/tools/tpm'
alias mm_trepctl='/opt/continuent/tungsten/tungsten-replicator/bin/trepctl'
...
```

9.14. The load-reduce-check Tool

The load-reduce-check tool provides a single command to perform the final steps to convert data loaded through the Hadoop applier into a final, Hive-compatible table providing a carbon copy of the data within Hive as extracted from the source database.

See Deploying the Hadoop Applier for more details on configuring the Hadoop Applier.

The four steps, each of which can be enabled or disabled individually are:

1. Section 9.14.1, “Generating Staging DDL”

Accesses the source database, reads the schema definition, and generates the necessary DDL for the staging tables within Hive. Tables are by default prefixed with `stage_xxx_`, and created in a Hive schema matching the source schema.

2. Section 9.14.2, "Generating Live DDL"

   Accesses the source database, reads the schema definition, and generates the necessary DDL for the tables within Hive. Tables are created with an identical table and schema name to the source schema.

3. Section 9.14.3, "Materializing a View"

   Execute a view materialization, where the data in any existing table, and the staging table are merged into the final table data. This step is identical to the process executed when running the materialize tool.

4. Section 9.14.6, "Compare Loaded Data"

   Compares the data within the source and materialized tables and reports any differences.

The load-reduce-check tool

9.14.1. Generating Staging DDL

9.14.2. Generating Live DDL

9.14.3. Materializing a View

9.14.4. Generating Sqoop Load Commands

9.14.5. Generating Metadata

9.14.6. Compare Loaded Data

9.15. The manager Command

The manager is the wrapper script that handles the execution of the manager service.

Table 9.27. manager Commands

Option	Description
`condrestart` [319]	Restart only if already running
`console` [320]	Launch in the current console (instead of a daemon)
`dump` [320]	Request a Java thread dump (if manager is running)
`install` [320]	Install the service to automatically start when the system boots
`remove` [320]	Remove the service from starting during boot
`restart` [320]	Stop manager if already running and then start
`start` [320]	Start in the background as a daemon process
`status` [320]	Query the current status
`stop` [320]	Stop if running (whether as a daemon or in another console)

These commands and options are described below:

– `condrestart` [319]

Restart the manager, only if it is already running. This can be useful to use when changing configuration or performing database management within automated scripts, as the manager will be only be restart if it was previously running.

For example, if the manager is running, manager condrestart operates as manager restart:

```
shell> manager condrestart
Stopping Tungsten Manager Service...
Waiting for Tungsten Manager Service to exit...
Stopped Tungsten Manager Service.
Starting Tungsten Manager Service...
Waiting for Tungsten Manager Service......
running: PID:26646
```

However, if not already running, the operation does nothing:

```
shell> manager condrestart
Stopping Tungsten Manager Service...
Tungsten Manager Service was not running.
```

– `console` [320]

Launch in the current console (instead of a daemon)

– `dump` [320]

Request a Java thread dump (if manager is running)

– `install` [320]

Installs the startup scripts for running the manager at boot. For an alternative method of deploying these start-up scripts, see deployall.

– `remove` [320]

Removes the startup scripts for running the manager at boot. For an alternative method of removing these start-up scripts, see undeployall.

– `restart` [320]

> **Warning**
>
> Restarting a running manager temporarily stops and restarts replication.

Stops the manager, if it is already running, and then restarts it:

```
shell> manager restart
Stopping Tungsten Manager Service...
Stopped Tungsten Manager Service.
Starting Tungsten Manager Service...
Waiting for Tungsten Manager Service......
running: PID:26248
```

– `start` [320]

To start the manager service if it is not already running:

```
shell> manager start
 Starting Tungsten Manager Service...
```

– `status` [320]

Checks the execution status of the manager:

```
shell> manager status
Tungsten Manager Service is running: PID:27015, Wrapper:STARTED, Java:STARTED
```

If the manager is not running:

```
shell> manager status
Tungsten Manager Service is not running.
```

This only provides the execution state of the manager, not the actual state of replication. To get detailed information on the status of replication use trepctl status.

– `stop` [320]

Stops the manager if it is already running:

```
shell> manager stop
Stopping Tungsten Manager Service...
Waiting for Tungsten Manager Service to exit...
Stopped Tungsten Manager Service.
```

If the cluster was configured with `auto-enable=false` [433] then you will need to put each node online individually.

9.16. The materialize Command

9.17. The multi_trepctl Command

The multi_trepctl command provides unified status and operation support across your Tungsten Cluster installation across multiple hosts without the need to run the trepctl command across multiple hosts and/or services individually.

`multi_trepctl` [`--by-service`] [`--fields appliedLastSeqNo` | `appliedLatency` | `host` | `role` | `serviceName` | `state`] [`--host`, `--hosts self`]
list [`--output json` | `list` | `name` | `tab` | `yaml`] [`--path`, `--paths`] [`--role`, `--roles`]
run [`--service`, `--services self`] [`--skip-headers`] [`--sort-by`]

The default operation, with no further command-line commands or arguments displays the status of all the hosts and services identified as related to the current host. In a typical single-service deployment, the command outputs the status of all services by determining the relationship between hosts connected to the default service:

```
shell> multi_trepctl
| host   | serviceName | role   | state  | appliedLastSeqno | appliedLatency |
| tr-ms1 | alpha       | master | ONLINE |               54 |          0.867 |
| tr-ms2 | alpha       | slave  | ONLINE |               54 |          1.945 |
| tr-ms3 | alpha       | slave  | ONLINE |               54 |         42.051 |
```

On a server with multiple services, information is output for each service and host:

```
shell> multi_trepctl
| host  | servicename | role   | state         | appliedlastseqno | appliedLatency |
| east1 | east        | master | ONLINE        |               53 |          0.000 |
| east1 | west        | slave  | OFFLINE:ERROR |               -1 |         -1.000 |
| west1 | west        | master | ONLINE        |           294328 |          0.319 |
| west1 | east        | slave  | ONLINE        |               53 |        119.834 |
| west2 | west        | master | ONLINE        |           231595 |          0.316 |
| west2 | east        | slave  | ONLINE        |               53 |        181.128 |
| west3 | east        | slave  | ONLINE        |               53 |        204.790 |
| west3 | west        | slave  | ONLINE        |           231595 |         22.895 |
```

9.17.1. multi_trepctl Options

The multi_trepctl tool provides a number of options that control the information and detail output when the command is executed.

Table 9.28. multi_trepctl Command-line Options

Option	Description
`--by-service` [321]	Sort the output by the service name
`--fields` [322]	Fields to be output during during summary
`--host` [322], `--hosts` [322]	Host or hosts on which to limit output
`--output` [322]	Specify the output format
`--paths` [322], `--path` [322]	Directory or directories to check when looking for tools
`--role` [323], `--roles` [323]	Role or roles on which to limit output
`--service` [323], `--services` [323]	Service or services on which to limit output
`--skip-headers` [323]	Skip the headers
`--sort-by` [323]	Sort by a specified field

Where:

- `--by-service` [321]

  Order the output according to the service name and role within the service:

```
shell> multi_trepctl --by-service
| host  | servicename | role   | state         | appliedlastseqno | appliedLatency |
| east1 | east        | master | ONLINE        |               64 |         59.380 |
| west1 | east        | slave  | ONLINE        |               64 |         60.889 |
| west2 | east        | slave  | ONLINE        |               64 |         60.970 |
| west3 | east        | slave  | ONLINE        |               64 |         61.097 |
| west1 | west        | master | ONLINE        |           294328 |          0.319 |
| west2 | west        | master | ONLINE        |           231595 |          0.316 |
```

```
| east1 | west        | slave  | OFFLINE:ERROR |              -1 |         -1.000 |
| west3 | west        | slave  | ONLINE        |          231595 |         22.895 |
```

- `--fields` [322]

  Limited the output to the specified list of fields from the output of fields output by trepctl. For example, to limit the output to the host, role, and *appliedLatency*:

```
shell> multi_trepctl --fields=host,role,appliedlatency
| host   | role   | appliedlatency |
| tr-ms1 | master |          0.524 |
| tr-ms2 | slave  |          0.000 |
| tr-ms3 | slave  |         -1.000 |
```

- `--host` [322], `--hosts` [322]

  Limit the output to the host, or a comma-separated list of hosts specified. For example:

```
shell> multi_trepctl --hosts=tr-ms1,tr-ms3
| host   | servicename | role   | state         | appliedlastseqno | appliedlatency |
| tr-ms1 | alpha       | master | ONLINE        |             2322 |          0.524 |
| tr-ms3 | alpha       | slave  | OFFLINE:ERROR |               -1 |         -1.000 |
```

- `--output` [322]

  Specify the output format.

  Table 9.29. multi_trepctl `--output` Option

Option	`--output` [322]	
Description	Specify the output format	
Value Type	string	
Default	info	
Valid Values	json	JSON format
	list	List format
	name	Name (simplified text) format
	tab	Tab-delimited format
	yaml	YAML format

  For example, to output the current status in JSON format:

```
shell> multi_trepctl --output json
[
  {
    "appliedlastseqno": 2322,
    "appliedlatency": 0.524,
    "host": "tr-ms1",
    "role": "master",
    "servicename": "alpha",
    "state": "ONLINE"
  },
  {
    "appliedlastseqno": 2322,
    "appliedlatency": 0.0,
    "host": "tr-ms2",
    "role": "slave",
    "servicename": "alpha",
    "state": "ONLINE"
  },
  {
    "appliedlastseqno": -1,
    "appliedlatency": -1.0,
    "host": "tr-ms3",
    "role": "slave",
    "servicename": "alpha",
    "state": "OFFLINE:ERROR"
  }
]
```

- `--path` [322], `--paths` [322]

  Limit the search for trepctl to the specified path or comma-separated list of paths. On a deployment with multiple services, the output will be limited by the services installed within the specified directories:

```
shell> multi_trepctl --path /opt/replicator
| host | servicename | role  | state  | appliedlastseqno | appliedlatency |
| db1  | west        | slave | ONLINE |                3 |          0.450 |
| db2  | west        | slave | ONLINE |                3 |          0.481 |
| db3  | west        | slave | ONLINE |                3 |          0.484 |
| db4  | east        | slave | ONLINE |                4 |          0.460 |
| db5  | east        | slave | ONLINE |                4 |          0.451 |
| db6  | east        | slave | ONLINE |                4 |          0.496 |
```

This is also useful when control of cross-site replicators is desired in MSMM topologies prior to v6.0.0.

For example, take all cross-site replicators offline:

```
shell> multi_trepctl --path /opt/replicator offline
```

To bring all cross-site replicators online:

```
shell> multi_trepctl --path /opt/replicator online
```

- `--role` [323], `--roles` [323]

  Limit the output to show only the specified role or comma-separated list of roles:

```
shell> multi_trepctl --roles=slave
| host   | servicename | role  | state         | appliedlastseqno | appliedlatency |
| tr-ms2 | alpha       | slave | ONLINE        |             2322 |          0.000 |
| tr-ms3 | alpha       | slave | OFFLINE:ERROR |               -1 |         -1.000 |
```

- `--service` [323], `--services` [323]

  Limit the output to the specified service or comma-separated list of services:

```
shell>  multi_trepctl --service=east
| host  | servicename | role   | state         | appliedlastseqno | appliedlatency |
| east1 | east        | master | ONLINE        |               53 |          0.000 |
| west1 | east        | slave  | ONLINE        |               53 |        119.834 |
| west2 | east        | slave  | ONLINE        |               53 |        181.128 |
| west3 | east        | slave  | ONLINE        |               53 |        204.790 |
```

- `--skip-headers` [323]

  Prevents the generation of the headers when generating the list output format:

```
shell> multi_trepctl --skip-headers
| tr-ms1 | alpha | master | ONLINE        | 2322 | 0.524 |
| tr-ms2 | alpha | slave  | ONLINE        | 2322 | 0.000 |
| tr-ms3 | alpha | slave  | OFFLINE:ERROR |   -1 | -1.000 |
```

- `--sort-by` [323]

  Sort by the specified fieldname. For example, to sort the output by the latency:

```
shell> multi_trepctl --sort-by appliedlatency
| host   | servicename | role   | state         | appliedlastseqno | appliedlatency |
| tr-ms3 | alpha       | slave  | OFFLINE:ERROR |               -1 |         -1.000 |
| tr-ms2 | alpha       | slave  | ONLINE        |             2322 |          0.000 |
| tr-ms1 | alpha       | master | ONLINE        |             2322 |          0.524 |
```

9.17.2. multi_trepctl Commands

The default operational mode is for multi_trepctl list to output the status. A specific mode can be also be specified on the command-line.

Table 9.30. multi_trepctl Commands

Option	Description
list	List the information about each service
run	Run the specified trepctl command on all hosts/services

In addition to the two primary commands, multi_trepctl can execute commands that would normally be applied to trepctl, running them on each selected host, service or directory according to the options. The output format and expectation is controlled through the list and run commands.

For example:

```
shell> multi_trepctl status
```

Outputs the long form of the status information (as per trepctl status) for each identified host.

9.17.2.1. multi_trepctl backups Command

Lists the available backups across all replicators.

```
shell> multi_trepctl backups
| host  | servicename | backup_date         | prefix           | agent     |
| host1 | alpha       | 2014-08-15 09:40:37 | store-0000000002 | mysqldump |
| host1 | alpha       | 2014-08-15 09:36:57 | store-0000000001 | mysqldump |
| host2 | alpha       | 2014-08-12 07:02:29 | store-0000000001 | mysqldump |
```

9.17.2.2. multi_trepctl heartbeat Command

Runs the trepctl heartbeat command on all hosts that are identified as masters.

```
shell> multi_trepctl heartbeat
host: host1
servicename: alpha
role: master
state: ONLINE
appliedlastseqno: 8
appliedlatency: 2.619
output:
```

9.17.2.3. multi_trepctl masterof Command

Lists which hosts are Primaries of others within the configured services.

```
shell> multi_trepctl masterof
| servicename | host  | uri              |
| alpha       | host1 | thl://host1:2112/ |
```

9.17.2.4. multi_trepctl list Command

The multi_trepctl list mode is the default mode for multi_trepctl and outputs the current status across all hosts and services as a table:

```
shell> multi_trepctl
| host  | servicename | role   | state                     | appliedlastseqno | appliedlatency |
| host1 | firstrep    | master | OFFLINE:ERROR             |               -1 |         -1.000 |
| host2 | firstrep    | slave  | GOING-ONLINE:SYNCHRONIZING |             5271 |       4656.264 |
| host3 | firstrep    | slave  | OFFLINE:ERROR             |               -1 |         -1.000 |
| host4 | firstrep    | slave  | OFFLINE:ERROR             |               -1 |         -1.000 |
```

Or selected hosts and services if options are specified. For example, to get the status only for `host1` and `host2`:

```
shell> multi_trepctl --hosts=host1,host2
| host  | servicename | role   | state  | appliedlastseqno | appliedlatency |
| host1 | firstrep    | master | ONLINE |             5277 |          0.476 |
| host2 | firstrep    | slave  | ONLINE |             5277 |          0.000 |
```

The multi_trepctl command implies that the status or information is being output from each of the commands executed on the remote hosts and services.

9.17.2.5. multi_trepctl run Command

The multi_trepctl run command can be used where the output of the corresponding trepctl command cannot be formatted into a convenient list. For example, to execute a backup on every host within a deployment:

```
shell> multi_trepctl run backup
```

The same filters and host or service selection can also be made:

```
shell> multi_trepctl run backup --hosts=host1,host2,host3
host: host1
servicename: firstrep
output: |
  Backup completed successfully; URI=storage://file-system/store-0000000005.properties
---
host: host2
servicename: firstrep
output: |
  Backup completed successfully; URI=storage://file-system/store-0000000001.properties
---
```

```
host: host3
servicename: firstrep
output: |
  Backup completed successfully; URI=storage://file-system/store-0000000001.properties
...
```

Return from the command will only take place when remote commands on each host have completed and returned.

9.18. The query Command

Table 9.31. query Common Options

Option	Description
-conf PATH	Configuration file that contains values for connection properties (url, user and password)
-file PATH	File containing the SQL commands to run. If missing, read SQL commands from STDIN
-password	Prompt for password
-url JDBCURL	JDBC url of the database to connect to
-user USER	User used to connect to the database

The query command line tool can be used to issue SQL statements against a database.

The queries can either be entered via STDIN, or read in from a text file

The following example shows a SELECT statement issued via STDIN

```
shell> query -url "jdbc:mysql:thin://db2:13306/" -user tungsten -password
Enter password: ********
select * from tungsten_nyc.trep_commit_seqno;

[
 {
  "statement":"select * from tungsten_nyc.trep_commit_seqno;","rc":0,"results":
 [
  [
   {
    "task_id":0,
    "seqno":1,
    "fragno":0,
    "last_frag":"1",
    "source_id":"db1",
     "epoch_number":1,
    "eventid":"mysql-bin.000002:0000000000000879;-1",
    "applied_latency":0,
    "update_timestamp":"2019-06-28 10:44:20.0",
    "shard_id":"tungsten_nyc",
    "extract_timestamp":"2019-06-28 10:44:19.0"
   }
  ]
 ],
  "error":null
 }
]
```

9.19. The replicator Command

The replicator is the wrapper script that handles the execution of the replicator service.

Table 9.32. replicator Commands

Option	Description
condrestart [326]	Restart only if already running
console [326]	Launch in the current console (instead of a daemon)
dump [326]	Request a Java thread dump (if replicator is running)
install [326]	Install the service to automatically start when the system boots
remove [326]	Remove the service from starting during boot
restart [326]	Stop replicator if already running and then start

Option	Description
start [327]	Start in the background as a daemon process
status [327]	Query the current status
stop [327]	Stop if running (whether as a daemon or in another console)

These commands and options are described below:

– condrestart [326]

Table 9.33. replicator Commands Options for condrestart [326]

Option	Description
offline	Start in OFFLINE state

Restart the replicator, only if it is already running. This can be useful to use when changing configuration or performing database management within automated scripts, as the replicator will be only be restart if it was previously running.

For example, if the replicator is running, replicator condrestart operates as replicator restart:

```
shell> replicator condrestart
Stopping Tungsten Replicator Service...
Waiting for Tungsten Replicator Service to exit...
Stopped Tungsten Replicator Service.
Starting Tungsten Replicator Service...
Waiting for Tungsten Replicator Service......
running: PID:26646
```

However, if not already running, the operation does nothing:

```
shell> replicator condrestart
Stopping Tungsten Replicator Service...
Tungsten Replicator Service was not running.
```

– console [326]

Table 9.34. replicator Commands Options for console [326]

Option	Description
offline	Start in OFFLINE state

Launch in the current console (instead of a daemon)

– dump [326]

Request a Java thread dump (if replicator is running)

– install [326]

Installs the startup scripts for running the replicator at boot. For an alternative method of deploying these start-up scripts, see deployall.

– remove [326]

Removes the startup scripts for running the replicator at boot. For an alternative method of removing these start-up scripts, see undeployall.

– restart [326]

Table 9.35. replicator Commands Options for restart [326]

Option	Description
offline	Stop and restart in OFFLINE state

Warning

Restarting a running replicator temporarily stops and restarts replication.

Stops the replicator, if it is already running, and then restarts it:

```
shell> replicator restart
```

```
Stopping Tungsten Replicator Service...
Stopped Tungsten Replicator Service.
Starting Tungsten Replicator Service...
Waiting for Tungsten Replicator Service......
running: PID:26248
```

– start [327]

Table 9.36. replicator Commands Options for start [327]

Option	Description
offline	Start in OFFLINE state

To start the replicator service if it is not already running:

```
shell> replicator start
 Starting Tungsten Replicator Service...
```

– status [327]

Checks the execution status of the replicator:

```
shell> replicator status
Tungsten Replicator Service is running: PID:27015, Wrapper:STARTED, Java:STARTED
```

If the replicator is not running:

```
shell> replicator status
Tungsten Replicator Service is not running.
```

This only provides the execution state of the replicator, not the actual state of replication. To get detailed information on the status of replication use trepctl status.

– stop [327]

Stops the replicator if it is already running:

```
shell> replicator stop
Stopping Tungsten Replicator Service...
Waiting for Tungsten Replicator Service to exit...
Stopped Tungsten Replicator Service.
```

If the cluster was configured with auto-enable=false [433] then you will need to put each node online individually.

9.20. The startall Command

The startall will start all configured services within the configured directory:

```
shell> startall
Starting Tungsten Replicator Service...
Waiting for Tungsten Replicator Service......
running: PID:2578
Starting Tungsten Manager Service...
Waiting for Tungsten Manager Service.........
running: PID:2722
Starting Tungsten Connector Service...
Waiting for Tungsten Connector Service.....
running: PID:2917
```

If a service is already running, then a notification of the current state will be provided:

```
Starting Tungsten Replicator Service...
Tungsten Replicator Service is already running.
```

Note that if any service is not running, and a suitable PID is found, the file will be deleted and the services started, for example:

```
Removed stale pid file:
 /opt/continuent/releases/tungsten-clustering-5.4.1-41_pid25898/tungsten-connector/bin/../var/tconnector.pid
```

9.21. The stopall Command

The stopall command stops all running services if they are already running:

```
shell> stopall
```

```
Stopping Tungsten Connector Service...
Waiting for Tungsten Connector Service to exit...
Stopped Tungsten Connector Service.
Stopping Tungsten Manager Service...
Stopped Tungsten Manager Service.
Stopping Tungsten Replicator Service...
Waiting for Tungsten Replicator Service to exit...
Stopped Tungsten Replicator Service.
```

9.22. The thl Command

The thl command provides an interface to the THL data, including the ability to view the list of available files, details of the enclosed event information, and the ability to purge THL files to reclaim space on disk beyond the configured log retention policy.

The command supports two command-line options that are applicable to all operations, as shown in Table 9.37, "thl Options".

Table 9.37. thl Options

Option	Description
`-conf path`	Path to the configuration file containing the required replicator service configuration
`-service servicename`	Name of the service to be used when looking for THL information

For example, to execute a command on a specific service:

```
shell> thl index -service firstrep
```

Individual operations are selected by use of a specific command to the thl command. Supported commands are:

- index — obtain a list of available THL files.
- info — obtain summary information about the available THL data.
- list — list one or more THL events.
- purge — purge THL data.
- help — get the command help text.

Further information on each of these operations is provided in the following sections.

9.22.1. thl Position Commands

The thl command supports a number of position and selection command-line options that can be used to select an individual THL event, or a range of events, to be displayed.

- `-seqno #` [328]

  Valid for: thl list

  Output the THL sequence for the specific sequence number. When reviewing or searching for a specific sequence number, for example when the application of a sequence on a Replica has failed, the replication data for that sequence number can be individually viewed. For example:

  From version 5.3.3, the output also includes the filename of the THL file on disk where the THL event is located:

```
shell> thl list -seqno 15
SEQ# = 15 / FRAG# = 0 (last frag)
- FILE = thl.data.0000000001
- TIME = 2013-05-02 11:37:00.0
- EPOCH# = 7
- EVENTID = mysql-bin.000004:0000000000003345;0
- SOURCEID = host1
- METADATA = [mysql_server_id=1687011;unsafe_for_block_commit;dbms_type=mysql;»
    service=firstrep;shard=cheffy]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
- OPTIONS = [##charset = UTF-8, autocommit = 1, sql_auto_is_null = 0, foreign_key_checks = 0, »
    unique_checks = 0, sql_mode = 'NO_AUTO_VALUE_ON_ZERO', character_set_client = 33, »
    collation_connection = 33, collation_server = 8]
- SCHEMA = cheffy
- SQL(0) = CREATE TABLE `access_log` (
  `id` int(10) unsigned NOT NULL AUTO_INCREMENT,
  `userid` int(10) unsigned DEFAULT NULL,
  `datetime` int(10) unsigned NOT NULL DEFAULT '0',
```

```
...
```

If the sequence number selected contains multiple fragments, each fragment will be output. Depending on the content of the sequence number information, the information can be output containing only the header/metadata information or only the table data (row or SQL) that was contained within the fragment. See `-headers` and `-sql` for more information.

> **Note**
>
> Unsigned integers are displayed and stored in the THL as their negative equivalents, and translated to the correct unsigned type when the data is applied to the target database.

- `-low #` [329] and/or `-high #` [329]

  `-from #` [329] and/or `-to #` [329]

  Valid for: thl list, thl purge

  Specify the start (`-from` [329]) or end (`-to` [329]) of the range of sequence numbers to be output. If only `-from` [329] is specified, then all sequence numbers from that number to the end of the THL are output. If `-to` [329] is specified, all sequence numbers from the start of the available log file to the specified sequence number are output. If both numbers are specified, output all the sequence numbers within the specified range.

  For example:

  ```
  shell> thl list -from 320
  ```

  Or:

  ```
  shell> thl list -low 320
  ```

  Will output all the sequence number fragments from number 320.

  ```
  shell> thl list -to 540
  ```

  Or:

  ```
  shell> thl list -high 540
  ```

  Will output all the sequence number fragments up to and including 540.

  ```
  shell> thl list -from 320 -to 540
  ```

  Or:

  ```
  shell> thl list -low 320 -high 540
  ```

  Will output all the sequence number fragments from number 320 up to, and including, sequence number 540.

- `-first` [329]

  Valid for: thl list, thl purge

  The `-first` [329] selects only the first stored THL event. For example:

  ```
  shell> thl list -first
  SEQ# = 0 / FRAG# = 0 (last frag)
  - TIME = 2017-06-28 13:12:38.0
  - EPOCH# = 0
  ...
  ```

- `-first #` [329]

  Valid for: thl list, thl purge

  The `-first #` [329] selects the specified number of events, starting from the first event. For example:

  ```
  shell> thl list -first 5
  ```

  Would display the first five events from the stored THL.

- `-last` [329]

  Valid for: thl list, thl purge

  The `-last` [329] selects only the last stored THL event. For example:

```
shell> thl list -last
SEQ# = 1601 / FRAG# = 0 (last frag)
- TIME = 2017-06-29 06:02:23.0
- EPOCH# = 1601
...
```

The use of this option can be particularly useful in the event of synchronisation or THL corruption due to a lack of diskspace. Using the thl purge command, the last THL event can be easily removed without having to work out the ranges and index information:

```
shell> thl purge -last
```

- `-last #` [330]

  Valid for: thl list, thl purge

  The `-last #` [330] selects the specified number of events, starting from the last-# event. For example:

  ```
  shell> thl list -last 5
  ```

  When the THL index contains events from 1558-1601, would display events 1597 through to 1601.

9.22.2. thl list Command

The list command to the thl command outputs a list of the sequence number information from the THL. By default, the entire THL as stored on disk is output. Command-line options enable you to select individual sequence numbers, sequence number ranges, or all the sequence information from a single file.

`thl` list
[-seqno #]
[-low #] | [-from #] | [-high #] | [-to #]
[-last] [-last #] [-first] [-first #]
[-file filename] [-no-checksum] [-sql] [-sizes] [-sizesdetail] [-sizessummary] [-charset] [-headers] [-json] [-specs-] [-charset]

- `-event eventid` [330]

  Output THL found that matches the provided eventid. If no exact match found, a message will display details of an approximate match if found. See example below:

  An exact match is found:

  ```
  shell> thl list -event mysql-bin.000017:0000000074628349
  - METADATA = [mysql_server_id=1000;mysql_thread_id=62;unsafe_for_block_commit;dbms_type=mysql;tz_aware=true;service=alpha;shard=employees]
  - TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
  - OPTIONS = [##charset = ISO8859_1, autocommit = 1, sql_auto_is_null = 0, foreign_key_checks = 1, unique_checks = 1, sql_mode = 'NO_ENGINE_SUBSTITUTION,
  - SCHEMA = employees
  - SQL(0) = DROP TABLE `salaries` /* generated by server */
  ```

  No match found:

  ```
  Event not found : Approximative match found between seqno 915 (mysql-bin.000017:0000000074628153;62) and seqno 916 (mysql-bin.000017:0000000074628349;62
  ```

- `-file filename` [330]

  Outputs all of the sequence number fragment information from the specified THL file. If the filename has been determined from the thl index command, or by examining the output of other fragments, the file-based output can be used to identify statements or row data within the THL.

- `-charset charset` [330]

  Specify the character set to be used to decode the character-based row data embedded within the THL event. Without this option, data is output as a hex value.

- `-hex` [330]

  For SQL that may be in different character sets, the information can be optionally output in hex format to determine the contents and context of the statement, even though the statement itself may be unreadable on the command-line.

- `-no-checksum` [330]

  Ignores checksums within the THL. In the event of a checksum failure, use of this option will enable checksums to be ignored when the THL is being read.

- `-sql`

Prints only the SQL for the selected sequence range. Use of this option can be useful if you want to extract the SQL and execute it directly by storing or piping the output.

- `-headers`

  Generates only the header information for the selected sequence numbers from the THL. For THL that contains a lot of SQL, obtaining the headers can be used to get basic content and context information without having to manually filter out the SQL in each fragment.

  The information is output as a tab-delimited list:

```
2047 1412 0 false 2020-05-03 20:58:14.0 mysql-bin.000005:0000000579721045;0 host3
2047 1412 1 true 2020-05-03 20:58:14.0 mysql-bin.000005:0000000579721116;0 host3
2048 1412 0 false 2020-05-03 20:58:14.0 mysql-bin.000005:0000000580759206;0 host3
2048 1412 1 true 2020-05-03 20:58:14.0 mysql-bin.000005:0000000580759277;0 host3
2049 1412 0 false 2020-05-03 20:58:16.0 mysql-bin.000005:0000000581791468;0 host3
2049 1412 1 true 2020-05-03 20:58:16.0 mysql-bin.000005:0000000581791539;0 host3
2050 1412 0 false 2020-05-03 20:58:18.0 mysql-bin.000005:0000000582812644;0 host3
```

  The format of the fields output is:

```
Sequence No | Epoch | Fragment | Last | Fragment | Date/Time | EventID | SourceID | Comments
```

  For more information on the fields displayed, see Section E.1.1, “THL Format”.

- `-json`

  Only valid with the `-headers` option, the header information is output for the selected sequence numbers from the THL in JSON format. The field contents are identical, with each fragment of each THL sequence being contained in a JSON object, with the output consisting of an array of the these sequence objects. For example:

```
[
   {
      "lastFrag" : false,
      "epoch" : 7,
      "seqno" : 320,
      "time" : "2020-05-02 11:41:19.0",
      "frag" : 0,
      "comments" : "",
      "sourceId" : "host1",
      "eventId" : "mysql-bin.000004:0000000244490614;0"
   },
   {
      "lastFrag" : true,
      "epoch" : 7,
      "seqno" : 320,
      "time" : "2020-05-02 11:41:19.0",
      "frag" : 1,
      "comments" : "",
      "sourceId" : "host1",
      "eventId" : "mysql-bin.000004:0000000244490685;0"
   }
]
```

  For more information on the fields displayed, see THL SEQNO [587].

- `-sizes`

  Shows the size information for a given THL event, describing either the size of the SQL, or the number of rows within the given event. For example:

```
shell> thl list -sizes
SEQ# Frag# Tstamp
...
12 0 2020-06-28 13:21:11.0  Event total: 1 chunks 73 bytes in SQL statements 0 rows
13 0 2020-06-28 13:21:10.0  Event total: 1645 chunks 0 bytes in SQL statements 1645 rows
14 0 2020-06-28 13:21:11.0  Event total: 1 chunks 36 bytes in SQL statements 0 rows
15 0 2020-06-28 13:21:11.0  Event total: 1 chunks 61 bytes in SQL statements 0 rows
16 0 2020-06-28 13:21:11.0  Event total: 1 chunks 73 bytes in SQL statements 0 rows
17 0 2020-06-28 13:21:12.0  Event total: 1 chunks 36 bytes in SQL statements 0 rows
18 0 2020-06-28 13:21:12.0  Event total: 1 chunks 61 bytes in SQL statements 0 rows
19 0 2020-06-28 13:21:10.0  Event total: 1784 chunks 0 bytes in SQL statements 1784 rows
20 0 2020-06-28 13:21:12.0  Event total: 1 chunks 73 bytes in SQL statements 0 rows
21 0 2020-06-28 13:21:11.0  Event total: 1576 chunks 0 bytes in SQL statements 1576 rows
22 0 2020-06-28 13:21:12.0  Event total: 1 chunks 36 bytes in SQL statements 0 rows
23 0 2020-06-28 13:21:12.0  Event total: 1 chunks 61 bytes in SQL statements 0 rows
...
```

  Summary information is also output identicating an overall count of the changes. For example:

```
Total ROW chunks: 69487 with 18257671 updated rows (100%)
Total STATEMENT chunks: 0 with 0 bytes (0%)
628 events processed
```

This information can be useful when viewing or monitoring the replication progress as it can help to indicate and identify the size of a specific transaction, particularly if the transaction is large. This can be particularly useful in combination with the `-first` [329] and/or `-last` [329].

For more detailed information on individual fragments within a sequence (and for large transactions there will be multiple fragments), use the thl list -sizesdetail command.

- `-sizesdetail`

  Shows detailed size information for a given THL event, describing either the size of the SQL, or the number of rows within the given event per fragment within each event, and with a summary for each event total. For very large THL event sizes this provide more detailed information about the size and makeup of the event. For example:

```
shell> thl list -sizes -last
SEQ# Frag# Tstamp   Chunks  SQL Data    Row Data
1604 0 2020-06-29 11:04:53.0 123 chunks SQL 0 bytes (0 avg bytes per chunk) Rows 45633 (371 avg rows per chunk)
1604 1 2020-06-29 11:04:53.0 123 chunks SQL 0 bytes (0 avg bytes per chunk) Rows 45633 (371 avg rows per chunk)
1604 2 2020-06-29 11:04:53.0 123 chunks SQL 0 bytes (0 avg bytes per chunk) Rows 45633 (371 avg rows per chunk)
1604 3 2020-06-29 11:04:53.0 123 chunks SQL 0 bytes (0 avg bytes per chunk) Rows 45633 (371 avg rows per chunk)
1604 4 2020-06-29 11:04:53.0 123 chunks SQL 0 bytes (0 avg bytes per chunk) Rows 45633 (371 avg rows per chunk)
1604 5 2020-06-29 11:04:53.0 123 chunks SQL 0 bytes (0 avg bytes per chunk) Rows 45633 (371 avg rows per chunk)
1604 6 2020-06-29 11:04:53.0 123 chunks SQL 0 bytes (0 avg bytes per chunk) Rows 45633 (371 avg rows per chunk)
1604 7 2020-06-29 11:04:53.0 123 chunks SQL 0 bytes (0 avg bytes per chunk) Rows 45633 (371 avg rows per chunk)
1604 8 2020-06-29 11:04:53.0 123 chunks SQL 0 bytes (0 avg bytes per chunk) Rows 45633 (371 avg rows per chunk)
1604 9 2020-06-29 11:04:53.0 123 chunks SQL 0 bytes (0 avg bytes per chunk) Rows 45633 (371 avg rows per chunk)
1604 10 2020-06-29 11:04:53.0 123 chunks SQL 0 bytes (0 avg bytes per chunk) Rows 45633 (371 avg rows per chunk)
1604 11 2020-06-29 11:04:53.0 7 chunks SQL 0 bytes (0 avg bytes per chunk) Rows 2535 (362 avg rows per chunk)
   Event total: 1360 chunks 0 bytes in SQL statements 504498 rows
```

  Summary information is also output identicating an overall count of the changes. For example:

```
Total ROW chunks: 69487 with 18257671 updated rows (100%)
Total STATEMENT chunks: 0 with 0 bytes (0%)
628 events processed
```

  This information can be useful when viewing or monitoring the replication progress as it can help to indicate and identify the size of a specific transaction, particularly if the transaction is large. This can be particularly useful in combination with the `-first` [329] and/or `-last` [329].

- `-sizessummary`

  Outputs only the size summary information for the requested THL:

```
shell> thl list -sizessummary
Total ROW chunks: 69487 with 18257671 updated rows (100%)
Total STATEMENT chunks: 0 with 0 bytes (0%)
628 events processed
```

- `-specs`

  Shows the column specifications, such as identified type, length, and additional settings, when viewing events within row-based replication. This can be helpful when examining THL data in heterogeneous replication deployments.

  For example:

```
shell> thl list -low 5282 -specs
SEQ# = 5282 / FRAG# = 0 (last frag)
- TIME = 2020-01-30 05:46:26.0
- EPOCH# = 5278
- EVENTID = mysql-bin.000017:0000000000001117;0
- SOURCEID = host1
- METADATA = [mysql_server_id=1687011;dbms_type=mysql;is_metadata=true;»
   service=firstrep;shard=tungsten_firstrep;heartbeat=MASTER_ONLINE]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
- SQL(0) =
 - ACTION = UPDATE
 - SCHEMA = tungsten_firstrep
 - TABLE = heartbeat
 - ROW# = 0
  - COL(index=1 name= type=4 [INTEGER] length=8 unsigned=false blob=false desc=null) = 1
  - COL(index=2 name= type=4 [INTEGER] length=8 unsigned=false blob=false desc=null) = 1416
  - COL(index=3 name= type=12 [VARCHAR] length=0 unsigned=false blob=false desc=null) = [B@65b60280
  - COL(index=4 name= type=93 [TIMESTAMP] length=0 unsigned=false blob=false desc=null) = 2020-01-30 05:46:26.0
  - COL(index=5 name= type=93 [TIMESTAMP] length=0 unsigned=false blob=false desc=null) = 2020-05-03 12:05:47.0
```

```
  - COL(index=6 name= type=4 [INTEGER] length=8 unsigned=false blob=false desc=null) = 1015
  - COL(index=7 name= type=4 [INTEGER] length=8 unsigned=false blob=false desc=null) = 0
  - COL(index=8 name= type=12 [VARCHAR] length=0 unsigned=false blob=false desc=null) = [B@105e55ab
  - KEY(index=1 name= type=4 [INTEGER] length=8 unsigned=false blob=false desc=null) = 1
```

When identifying the different data types, the following effects should be noted:

- `CHAR` and `VARCHAR` are identified as type 12, `VARCHAR`
- `SET` is identified as an `INTEGER`
- When the value is either `NULL` or `0` (Zero), date and time fields are shown as type 0, `NULL`
- `ENUM` is identified as an `OTHER`
- `BLOB` and `TEXT` are identified as type 2004, `BLOB`

- `-timezone`

  Specify the timezone to use when display date or time values. When not specified, times are displayed using UTC.

9.22.3. thl index Command

The index command to thl provides a list of all the available THL files and the sequence number range stored within each file:

```
shell> thl index
LogIndexEntry thl.data.0000000001(0:113)
LogIndexEntry thl.data.0000000002(114:278)
LogIndexEntry thl.data.0000000003(279:375)
LogIndexEntry thl.data.0000000004(376:472)
LogIndexEntry thl.data.0000000005(473:569)
LogIndexEntry thl.data.0000000006(570:941)
LogIndexEntry thl.data.0000000007(942:1494)
LogIndexEntry thl.data.0000000008(1495:1658)
LogIndexEntry thl.data.0000000009(1659:1755)
LogIndexEntry thl.data.0000000010(1756:1852)
LogIndexEntry thl.data.0000000011(1853:1949)
LogIndexEntry thl.data.0000000012(1950:2046)
LogIndexEntry thl.data.0000000013(2047:2563)
```

The optional argument `-no-checksum` [330] ignores the checksum information on events in the event that the checksum is corrupt.

9.22.4. thl purge Command

The purge command to the thl command deletes sequence number information from the THL files.

`thl` purge
[-low #] | [-high #]
[-y] [-no-checksum]

The purge command deletes the THL data according to the following rules:

- **Warning**

  Purging all data requires that the THL information either be recreated from the source table, or reloaded from the Primary replicator.

  Without any specification, a purge command will delete all of the stored THL information.

- When only `-high` is specified, delete all the THL data up to and including the specified sequence number.
- When only `-low` is specified, delete all the THL data from and including the specified sequence number.
- With a range specification, using one or both of the `-low` and `-high` options, the range of sequences will be purged. The rules are the same as for the list command, enabling purge from the start to a sequence, from a sequence to the end, or all the sequences within a given range. The ranges must be on the boundary of one or more log files. It is not possible to delete THL data from the middle of a given file.

For example, consider the following list of THL files provided by thl index:

```
shell> thl index
LogIndexEntry thl.data.0000000377(5802:5821)
LogIndexEntry thl.data.0000000378(5822:5841)
LogIndexEntry thl.data.0000000379(5842:5861)
LogIndexEntry thl.data.0000000380(5862:5881)
LogIndexEntry thl.data.0000000381(5882:5901)
```

```
LogIndexEntry thl.data.0000000382(5902:5921)
LogIndexEntry thl.data.0000000383(5922:5941)
LogIndexEntry thl.data.0000000384(5942:5961)
LogIndexEntry thl.data.0000000385(5962:5981)
LogIndexEntry thl.data.0000000386(5982:6001)
LogIndexEntry thl.data.0000000387(6002:6021)
LogIndexEntry thl.data.0000000388(6022:6041)
LogIndexEntry thl.data.0000000389(6042:6061)
LogIndexEntry thl.data.0000000390(6062:6081)
LogIndexEntry thl.data.0000000391(6082:6101)
LogIndexEntry thl.data.0000000392(6102:6121)
LogIndexEntry thl.data.0000000393(6122:6141)
LogIndexEntry thl.data.0000000394(6142:6161)
LogIndexEntry thl.data.0000000395(6162:6181)
LogIndexEntry thl.data.0000000396(6182:6201)
LogIndexEntry thl.data.0000000397(6202:6221)
LogIndexEntry thl.data.0000000398(6222:6241)
LogIndexEntry thl.data.0000000399(6242:6261)
LogIndexEntry thl.data.0000000400(6262:6266)
```

The above shows a range of THL sequences from 5802 to 6266.

To delete all of the THL from the start of the list, sequence no 5802, to 6021 (inclusive), use the `-high` to specify the highest number to be removed (6021):

```
shell> thl purge -high 6021
WARNING: The purge command will break replication if you delete all
events or delete events that have not reached all slaves.
Are you sure you wish to delete these events [y/N]?
y
Deleting events where SEQ# <=6021
2020-02-10 16:31:36,235 [ - main] INFO  thl.THLManagerCtrl Transactions deleted
```

Running a thl index, sequence numbers from 6022 to 6266 are still available:

```
shell> thl index
LogIndexEntry thl.data.0000000388(6022:6041)
LogIndexEntry thl.data.0000000389(6042:6061)
LogIndexEntry thl.data.0000000390(6062:6081)
LogIndexEntry thl.data.0000000391(6082:6101)
LogIndexEntry thl.data.0000000392(6102:6121)
LogIndexEntry thl.data.0000000393(6122:6141)
LogIndexEntry thl.data.0000000394(6142:6161)
LogIndexEntry thl.data.0000000395(6162:6181)
LogIndexEntry thl.data.0000000396(6182:6201)
LogIndexEntry thl.data.0000000397(6202:6221)
LogIndexEntry thl.data.0000000398(6222:6241)
LogIndexEntry thl.data.0000000399(6242:6261)
LogIndexEntry thl.data.0000000400(6262:6266)
```

To delete the last two THL files, specify the sequence number at the start of the file, 6242 to the `-low` to specify the sequence number:

```
shell> thl purge -low 6242 -y
WARNING: The purge command will break replication if you delete all
events or delete events that have not reached all slaves.
Deleting events where SEQ# >= 6242
2020-02-10 16:40:42,463 [ - main] INFO  thl.THLManagerCtrl Transactions deleted
```

A thl index shows the sequence as removed:

```
shell> thl index
LogIndexEntry thl.data.0000000388(6022:6041)
LogIndexEntry thl.data.0000000389(6042:6061)
LogIndexEntry thl.data.0000000390(6062:6081)
LogIndexEntry thl.data.0000000391(6082:6101)
LogIndexEntry thl.data.0000000392(6102:6121)
LogIndexEntry thl.data.0000000393(6122:6141)
LogIndexEntry thl.data.0000000394(6142:6161)
LogIndexEntry thl.data.0000000395(6162:6181)
LogIndexEntry thl.data.0000000396(6182:6201)
LogIndexEntry thl.data.0000000397(6202:6221)
LogIndexEntry thl.data.0000000398(6222:6241)
```

The confirmation message can be bypassed by using the `-y` option, which implies that the operation should proceed without further confirmation.

The optional argument `-no-checksum` [330] ignores the checksum information on events in the event that the checksum is corrupt.

When purging, the THL files must be writeable; the replicator must either be offline or stopped when the purge operation is completed.

A purge operation may fail for the following reasons:

- Fatal error: The disk log is not writable and cannot be purged.

  The replicator is currently running and not in the OFFLINE state. Use trepctl offline to release the write lock n the THL files.

- Fatal error: Deletion range invalid; must include one or both log end points: low seqno=0 high seqno=1000

  An invalid sequence number or range was provided. The purge operation will refuse to purge events that do not exist in the THL files and do not match a valid file boundary, i.e. the low figure must match the start of one file and the high the end of a file. Use thl index to determine the valid ranges.

9.22.5. thl info Command

The info command to thl command provides the current information about the THL, including the identified log directory, sequence number range, and the number of individual events with the available span. The lowest and highest THL file and sizes are also given. For example:

```
shell> thl info
log directory = /opt/continuent/thl/alpha/
log files = 41
logs size = 193.53 MB
min seq# = 0
max seq# = 228
events = 228
oldest file = thl.data.0000000001 (95.48 MB, 2019-12-18 11:53:00)
newest file = thl.data.0000000041 (0.98 MB, 2019-12-18 12:34:32)
```

The optional argument `-no-checksum` [330] ignores the checksum information on events in the event that the checksum is corrupt.

9.22.6. thl help Command

The help command to the thl command outputs the current help message text.

9.23. The trepctl Command

The trepctl command provides the main status and management interface to Tungsten Replicator. The trepctl command is responsible for:

- Putting the replicator online or offline
- Performing backup and restore operations
- Skipping events in the THL in the event of an issue
- Getting status and active configuration information

The operation and control of the command is defined through a series of command-line options which specify general options, replicator wide commands, and service specific commands that provide status and control over specific services.

The trepctl command by default operates on the current host and configured service. For installations where there are multiple services and hosts in the deployment. Explicit selection of services and hosts is handled through the use of command-line options, for more information see Section 9.23.1, “trepctl Options”.

```
trepctl
backup [ -backup agent ] [ -limit s ] [ -storage agent ]
capabilities
check
clear
clients [ -json ]
flush [ -limit s ]
heartbeat [ -name ] [ -host name ]
kill [ -y ]
load
offline [ -all-services ]
offline-deferred [ -at-event event ] [ -at-heartbeat [heartbeat] ] [ -at-seqno seqno ] [ -at-time YYYY-MM-DD_hh:mm:ss ] [ -immediate ]
online [ -all-services ] [ -base-seqno x ] [ -force ] [ -from-event event ] [ -no-checksum ] [ -skip-seqno seqdef ] [ -until-event event ] [ -until-heartbeat [name]
] [ -until-seqno seqno ] [ -until-time YYYY-MM-DD_hh:mm:ss ]
pause [ -stage stage-to-pause ] [ -time value-in-seconds ]
perf [ -r ] [ -port number ]
properties [ -filter name ] [ -values ]
purge [ -limit s ] [ -y ]
qs [ -r ]
reset [ -all ] [ -db ] [ -relay ] [ -thl ] [ -y ]
```

resume [-stage stage-to-resume] [-retry N] [-service name]
services [-full] [-json]
setdynamic [-property] [-value]
setrole [-role master | slave | relay | thl-applier | thl-client | thl-server] [-uri]
shard [-delete shard] [-insert shard] [-list] [-update shard]
status [-json] [-name channel-assignments | services | shards | stages | stores | tasks | watches] [-r]
unload [-y] [-verbose]
version
wait [-applied seqno] [-limit s] [-state st]

For individual operations, trepctl uses a sub-command structure on the command-line that specifies which operation is to be performed. There are two classifications of commands, global commands, which operate across all replicator services, and service-specific commands that perform operations on a specific service and/or host. For information on the global commands available, see Section 9.23.2, "trepctl Global Commands". Information on individual commands can be found in Section 9.23.3, "trepctl Service Commands".

9.23.1. trepctl Options

Table 9.38. trepctl Command-line Options

Option	Description
-host name	Host name of the replicator
-port number	Port number of the replicator
-retry N	Number of times to retry the connection
-service name	Name of the replicator service
-verbose	Enable verbose messages for operations

Global command-line options enable you to select specific hosts and services. If available, trepctl will read the active configuration to determining the host, service, and port information. If this is unavailable or inaccessible, the following rules are used to determine which host or service to operate upon:

- If no host is specified, then trepctl defaults to the host on which the command is being executed.
- If no service is specified:
  - If only one service has been configured, then trepctl defaults to showing information for the configured service.
  - If multiple services are configured, then trepctl returns an error, and requests a specific service be selected.

To use the global options:

- -host

  Specify the host for the operation. The replicator service must be running on the remote host for this operation to work.

- -port

  Specify the base TCP/IP port used for administration. The default is port 10000; port 10001 is also used. When using different ports, port and port+1 is used, i.e. if port 4996 is specified, then port 4997 will be used as well. When multiple replicators are installed on the same host, different numbers may be used.

- -service

  The servicename to be used for the requested status or control operation. When multiple services have been configured, the servicename must be specified.

```
shell> trepctl status
Processing status command...
Operation failed: You must specify a service name with the -service flag
```

- -verbose

  Turns on verbose reporting of the individual operations. This includes connectivity to the replicator service and individual operation steps. This can be useful when diagnosing an issue and identifying the location of a particular problem, such as timeouts when access a remote replicator.

- -retry

  Retry the request operation the specified number of times. The default is 10.

9.23.2. trepctl Global Commands

The trepctl command supports a number of commands that are global, or which work across the replicator regardless of the configuration or selection of individual services.

Table 9.39. trepctl Replicator Wide Commands

Option	Description
kill	Shutdown the replication services immediately
services	List the configured replicator services
version	Show the replicator version number and build

These commands can be executed on the current or a specified host. Because these commands operate for replicators irrespective of the service configuration, selecting or specifying a service is note required.

9.23.2.1. trepctl kill Command

The trepctl kill command terminates the replicator without performing any cleanup of the replicator service, THL or sequence number information stored in the database. Using this option may cause problems when the replicator service is restarted.

`trepctl` kill [`-y`]

When executed, trepctl will ask for confirmation:

```
shell> trepctl kill
Do you really want to kill the replicator process? [yes/NO]
```

The default is no. To kill the service, ignoring the interactive check, use the `-y` option:

```
shell> trepctl kill -y
Sending kill command to replicator
Replicator appears to be stopped
```

9.23.2.2. trepctl services Command

The trepctl services command outputs a list of the current replicator services configured in the system and their key parameters such as latest sequence numbers, latency, and state.

`trepctl` services [`-full`] [`-json`]

For example:

```
shell> trepctl services
Processing services command...
NAME              VALUE
----              -----
appliedLastSeqno: 2541
appliedLatency  : 0.48
role            : master
serviceName     : alpha
serviceType     : local
started         : true
state           : ONLINE
Finished services command...
```

For more information on the fields displayed, see Section E.2, “Generated Field Reference”.

For a replicator with multiple services, the information is output for each configured service:

```
shell> trepctl services
Processing services command...
NAME              VALUE
----              -----
appliedLastSeqno: 44
appliedLatency  : 0.692
role            : master
serviceName     : alpha
serviceType     : local
started         : true
state           : ONLINE
NAME              VALUE
----              -----
appliedLastSeqno: 40
appliedLatency  : 0.57
```

```
role            : slave
serviceName     : beta
serviceType     : remote
started         : true
state           : ONLINE
NAME              VALUE
----              -----
appliedLastSeqno: 41
appliedLatency  : 0.06
role            : slave
serviceName     : gamma
serviceType     : remote
started         : true
state           : ONLINE
Finished services command...
```

The information can be reported in JSON format by using the `-json` option to the command:

```
shell> trepctl services -json
[
  {
    "serviceType" : "local",
    "appliedLatency" : "0.48",
    "serviceName" : "alpha",
    "appliedLastSeqno" : "2541",
    "started" : "true",
    "role" : "master",
    "state" : "ONLINE"
  }
]
```

The information is output as an array of objects, one object for each service identified.

If the `-full` option is added, the JSON output includes full details of the service, similar to that output by the trepctl status command, but for each configured service:

```
shell> trepctl services -json -full
[
  {
    "masterConnectUri" : "",
    "rmiPort" : "10000",
    "clusterName" : "default",
    "currentTimeMillis" : "1370256230198",
    "state" : "ONLINE",
    "maximumStoredSeqNo" : "2541",
    "minimumStoredSeqNo" : "0",
    "pendingErrorCode" : "NONE",
    "masterListenUri" : "thl://host1:2112/",
    "pendingErrorSeqno" : "-1",
    "pipelineSource" : "jdbc:mysql:thin://host1:3306/",
    "serviceName" : "alpha",
    "pendingErrorEventId" : "NONE",
    "appliedLatency" : "0.48",
    "transitioningTo" : "",
    "relativeLatency" : "245804.198",
    "role" : "master",
    "siteName" : "default",
    "pendingError" : "NONE",
    "uptimeSeconds" : "246023.627",
    "latestEpochNumber" : "2537",
    "extensions" : "",
    "dataServerHost" : "host1",
    "resourcePrecedence" : "99",
    "pendingExceptionMessage" : "NONE",
    "simpleServiceName" : "alpha",
    "sourceId" : "host1",
    "offlineRequests" : "NONE",
    "channels" : "1",
    "version" : "Tungsten Replicator 5.4.1 build 41",
    "seqnoType" : "java.lang.Long",
    "serviceType" : "local",
    "currentEventId" : "mysql-bin.000007:0000000000001033",
    "appliedLastEventId" : "mysql-bin.000007:0000000000001033;0",
    "timeInStateSeconds" : "245803.753",
    "appliedLastSeqno" : "2541",
    "started" : "true"
  }
]
```

Auto-refresh support added in 6.0.1. Starting with Tungsten Cluster 6.0.1, trepctl services supports the `-r` option to support auto-refresh.

For more information on the fields displayed, see Section E.2, “Generated Field Reference”.

9.23.2.3. trepctl version Command

The trepctl version command outputs the version number of the specified replicator service.

`trepctl` version

```
shell> trepctl version
Tungsten Replicator 5.4.1 build 41
```

The system can also be used to obtain remote version:

```
shell> trepctl -host host2 version
Tungsten Replicator 5.4.1 build 41
```

Version numbers consist of two parts, the main version number which denotes the product release, and the build number. Updates and fixes to a version may use updated build numbers as part of the same product release.

9.23.3. trepctl Service Commands

The trepctl service commands operate per-service, that is, when there are multiple services in a configuration, the service name on which the command operates must be explicitly stated. For example, when a backup is executed, the backup executes on an explicit, specified service.

The individuality of different services is critical when dealing with the replicator commands. Services can be placed into online or offline states independently of each other, since each service will be replicating information between different hosts and environments.

Table 9.40. trepctl Service Commands

Option	Description
backup	Backup database
capabilities	List the configured replicator capabilities
check	Generate consistency check
clear	Clear one or all dynamic variables
clients	List clients connected to this replicator
flush	Synchronize transaction history log to database
heartbeat	Insert a heartbeat event with optional name
load	Load the replication service
offline	Set replicator to OFFLINE state
offline-deferred	Set replicator OFFLINE at a future point in the replication stream
online	Set Replicator to ONLINE with start and stop points
pause	Pause the replicator. Specify the stage using the -stage option and optional time using -time
perf	Print detailed performance information
properties	Display a list of all internal properties
purge	Purge non-Tungsten logins on database
qs	Print a simplified quick replicator status
reset	Deletes the replicator service
resume	Resume a paused replicator. Specify the stage using the -stage option.
setdynamic	Set dynamic properties
setrole	Set replicator role
shard	List, add, update, and delete shards
status	Print replicator status information
unload	Unload the replication service
wait	Wait for the replicator to reach a specific state, time or applied sequence number

The following sections detail each command individually, with specific options, operations and information.

9.23.3.1. trepctl backup Command

The trepctl backup command performs a backup of the corresponding database for the selected service.

`trepctl` backup [`-backup agent`] [`-limit s`] [`-storage agent`]

Where:

Table 9.41. trepctl backup Command Options

Option	Description
`-backup agent` [340]	Select the backup agent
`-limit s` [340]	The period to wait before returning after the backup request
`-storage agent` [340]	Select the storage agent

Without specifying any options, the backup uses the default configured backup and storage system, and will wait indefinitely until the backup process has been completed:

```
shell> trepctl backup
Backup completed successfully; URI=storage://file-system/store-0000000002.properties
```

The return information gives the URI of the backup properties file. This information can be used when performing a restore operation as the source of the backup. See Section 9.23.3.17, "trepctl restore Command". Different backup solutions may require that the replicator be placed into the `OFFLINE` state before the backup is performed.

A log of the backup operation will be stored in the replicator log directory, in a file corresponding to the backup tool used (e.g. `mysqldump.log`).

If multiple backup agents have been configured, the backup agent can be selected on the command-line:

```
shell> trepctl backup -backup mysqldump
```

If multiple storage agents have been configured, the storage agent can be selected using the `-storage` [340] option:

```
shell> trepctl backup -storage file
```

A backup will always be attempted, but the timeout to wait for the backup to be started during the command-line session can be specified using the `-limit` [340] option. The default is to wait indefinitely. However, in a scripted environment you may want to request the backup and continue performing other operations. The `-limit` [340] option specifies how long trepctl should wait before returning.

For example, to wait five seconds before returning:

```
shell> trepctl -service alpha backup -limit 5
Backup is pending; check log for status
```

The backup request has been received, but not completed within the allocated time limit. The command will return. Checking the logs shows the timeout:

```
...  management.OpenReplicatorManager Backup request timed out: seconds=5
```

Followed by the successful completion of the backup, indicated by the URI provided in the log showing where the backup file has been stored.

```
... backup.BackupTask Storing backup result...
... backup.FileSystemStorageAgent Allocated backup location: »
    uri =storage://file-system/store-0000000003.properties
... backup.FileSystemStorageAgent Stored backup storage file: »
    file=/opt/continuent/backups/store-0000000003-mysqldump_2013-07-15_18-14_11.sql.gz length=0
... backup.FileSystemStorageAgent Stored backup storage properties: »
    file=/opt/continuent/backups/store-0000000003.properties length=314
... backup.BackupTask Backup completed normally: »
    uri=storage://file-system/store-0000000003.propertiess
```

The URI can be used during a restore.

9.23.3.2. trepctl capabilities Command

The `capabilities` command outputs a list of the supported capabilities for this replicator instance.

`trepctl` capabilities

The information output will depend on the configuration and current role of the replicator service. Different services on the same host may have different capabilities. For example:

```
shell> trepctl capabilities
Replicator Capabilities
  Roles:             [master, slave]
  Replication Model: push
  Consistency Check: true
  Heartbeat:         true
  Flush:             true
```

The fields output are as follows:

- *Roles*

  Indicates whether the replicator can be a *master* or *slave*, or both.

- *Replication Model*

  The model used by the replication system. The default model for MySQL for example is push, where information is extracted from the binary log and pushed to Replicas that apply the transactions. The pull model is used for heterogeneous deployments.

- *Consistency Check*

  Indicates whether the internal consistency check is supported. For more information see Section 9.23.3.3, "trepctl check Command".

- *Heartbeat*

  Indicates whether the heartbeat service is supported. For more information see Section 9.23.3.7, "trepctl heartbeat Command".

- *Flush*

  Indicates whether the trepctl flush operation is supported.

9.23.3.3. trepctl check Command

The `check` command operates by running a CRC check on the schema or table specified, creating a temporary table containing the check data and values during the process. The data collected during this process is then written to a consistency table within the replication configuration schema and is used to verify the table data consistency on the Primary and the Replica.

Warning

Because the check operation is creating a temporary table containing a CRC of each row within the specified schema or specific table, the size of the temporary table created can be quite large as it consists of CRC and row count information for each row of each table (within the specified row limits). The configured directory used by MySQL for temporary table creation will need a suitable amount of space to hold the temporary data.

9.23.3.4. trepctl clear Command

The trepctl clear command deletes any dynamic properties configured within the replicator service.

`trepctl` clear

Dynamic properties include the current active role for the service. The dynamic information is stored internally within the replicator, and also stored within a properties file on disk so that the replicator can be restarted.

For example, the replicator role may be temporarily changed to receive information from a different host or to act as a Primary in place of a Replica. The replicator can be returned to the initial configuration for the service by clearing this dynamic property:

```
shell> trepctl clear
```

9.23.3.5. trepctl clients Command

Outputs a list of the that have been connected to the Primary service since it went online. If a Replica service goes offline or is stopped, it will still be reported by this command.

`trepctl` clients [`-json`]

Where:

Table 9.42. trepctl clients Command Options

Option	Description
`-json` [342]	Output the information as JSON

The command outputs the list of clients and the management port on which they can be reached:

```
shell> trepctl clients
Processing clients command...
host4:10000
host2:10000
host3:10000
Finished clients command...
```

A JSON version of the output is available when using the `-json` [342] option:

```
shell> trepctl clients -json
[
{
"rmiPort": "10000",
"rmiHost": "host4"
},
{
"rmiPort": "10000",
"rmiHost": "host2"
},
{
"rmiPort": "10000",
"rmiHost": "host3"
}
]
```

The information is divided first by host, and then by the RMI management port.

9.23.3.6. trepctl flush Command

On a Primary, the trepctl flush command synchronizes the database with the transaction history log, flushing the in memory queue to the THL file on disk. The operation is not supported on a Replica.

`trepctl` flush [`-limit s`]

Internally, the operation works by inserting a heartbeat event into the queue, and then confirming when the heartbeat event has been committed to disk.

To flush the replicator:

```
shell> trepctl flush
Master log is synchronized with database at log sequence number: 3622
```

The flush operation is always initiated, and by default trepctl will wait until the operation completes. Using the `-limit` option, the amount of time the command-line waits before returning can be specified:

```
shell> trepctl flush -limit 1
```

9.23.3.7. trepctl heartbeat Command

Inserts a heartbeat into the replication stream, which can be used to identify replication points.

`trepctl` heartbeat [`-name`]

The heartbeat system is a way of inserting an identifiable event into the THL that is independent of the data being replicated. This can be useful when performing different operations on the data where specific checkpoints must be identified.

To insert a standard heartbeat:

```
shell> trepctl heartbeat
```

When performing specific operations, the heartbeat can be given an name:

```
shell> trepctl heartbeat -name dataload
```

Heartbeats insert a transaction into the THL using the transaction metadata and can be used to identify whether replication is operating between replicator hosts by checking that the sequence number has been replicated to the Replica. Because a new transaction is inserted, the sequence number is increased, and this can be used to identify if transactions are being replicated to the Replica without requiring changes to the database. To check replication using the heartbeat:

1. Check the current transaction sequence number on the Primary:

```
shell> trepctl status
Processing status command...
NAME                     VALUE
----                     -----
```

```
appliedLastEventId     : mysql-bin.000009:0000000000008998;0
appliedLastSeqno       : 3630
...
```

2. Insert a heartbeat event:

```
shell> trepctl heartbeat
```

3. Check the sequence number again:

```
shell> trepctl status
Processing status command...
NAME                     VALUE
----                     -----
appliedLastEventId     : mysql-bin.000009:0000000000009310;0
appliedLastSeqno       : 3631
```

4. Check that the sequence number on the Replica matches:

```
shell> trepctl status
Processing status command...
NAME                     VALUE
----                     -----
appliedLastEventId     : mysql-bin.000009:0000000000009310;0
appliedLastSeqno       : 3631
```

Heartbeats are given implied names, but can be created with explicit names that can be tracked during specific events and operations.

For example, when loading a specific set of data, the information may be loaded and then a backup executed on the Replica before enabling standard replication. This can be achieved by configuring the Replica to go offline when a specific heartbeat event is seen, loading the data on the Primary, inserting the heartbeat when the load has finished, and then performing the Replica backup:

1. On the Replica:

```
Replica shell> trepctl offline-deferred -at-heartbeat dataload
```

The trepctl offline-deferred configures the Replica to continue in the online state until the specified event, in this case the heartbeat, is received. The deferred state can be checked by looking at the status output, and the *offlineRequests* field:

```
Processing status command...
NAME                     VALUE
----                     -----
appliedLastEventId     : mysql-bin.000009:0000000000008271;0
appliedLastSeqno       : 3627
appliedLatency         : 0.704
...
offlineRequests        : Offline at heartbeat event: dataload
```

2. On the Primary:

```
Primary shell> mysql newdb < newdb.load
```

3. Once the data load has completed, insert the heartbeat on the Primary:

```
Primary shell> trepctl heartbeat -name dataload
```

The heartbeat will appear in the transaction history log after the data has been loaded and will identify the end of the load.

4. When the heartbeat is received, the Replica will go into the offline state. Now a backup can be created with all of the loaded data replicated from the Primary. Because the Replica is in the offline state, no further data or changes will be recorded on the Replica

This method of identifying specific events and points within the transaction history log can be used for a variety of different purposes where the point within the replication stream without relying on the arbitrary event or sequence number.

9.23.3.7.1. trepctl heartbeat Internal Implementation

Internally, the heartbeat system operates through a tag added to the metadata of the THL entry and through a dedicated `heartbeat` table within the schema created for the replicator service. The table contains the sequence number, event ID, timestamp and heartbeat name. The heartbeat information is written into a special record within the transaction history log. A sample THL entry can be seen in the output below:

```
SEQ# = 3629 / FRAG# = 0 (last frag)
- TIME = 2013-07-19 12:14:57.0
- EPOCH# = 3614
- EVENTID = mysql-bin.000009:0000000000008681;0
- SOURCEID = host1
- METADATA = [mysql_server_id=1687011;dbms_type=mysql;is_metadata=true;service=alpha;
     shard=tungsten_alpha;heartbeat=dataload]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
```

```
- OPTIONS = [##charset = UTF-8, autocommit = 1, sql_auto_is_null = 0,
    foreign_key_checks = 1, unique_checks = 1, sql_mode = 'IGNORE_SPACE',
    character_set_client = 33, collation_connection = 33, collation_server = 8]
- SCHEMA = tungsten_alpha
- SQL(0) = UPDATE tungsten_alpha.heartbeat SET source_tstamp= '2013-07-19 12:14:57',
  salt= 9, name= 'dataload'  WHERE id= 1
```

During replication, Replicas identify the heartbeat and record this information into their own `heartbeat` table. Because the heartbeat is recorded into the transaction history log, the specific sequence number of the transaction, and the event itself can be easily identified.

9.23.3.8. trepctl load Command

Load the replicator service.

`trepctl` load

Load the replicator service. The service name must be specified on the command-line, even when only one service is configured:

```
shell> trepctl load
Operation failed: You must specify a service name using -service
```

The service name can be specified using the `-service` option:

```
shell> trepctl -service alpha load
Service loaded successfully: name=alpha
```

9.23.3.9. trepctl offline Command

The trepctl offline command puts the replicator into the offline state, stopping replication.

`trepctl` offline [`-all-services`] [`-immediate`]

To put the replicator offline:

```
shell> trepctl offline
```

While offline:

- Transactions are not extracted from the source dataserver.
- Transactions are not applied to the destination dataserver.

Certain operations on the replicator, including updates to the operating system and dataserver should be performed while in the offline state.

By default, the replicator goes offline in deferred mode, allowing the current transactions being read from the binary log, or applied to the dataserver to complete, the sequence number table in the database is updated, and the replicator is placed offline, stopping replication.

To stop replication immediately, within the middle of an executing transaction, use the `-immediate` option:

```
shell> trepctl offline -immediate
```

9.23.3.10. trepctl offline-deferred Command

The trepctl offline-deferred sets a future sequence, event or heartbeat as the trigger to put the replicator in the offline state.

`trepctl` offline-deferred [`-at-event event`] [`-at-heartbeat [heartbeat]`] [`-at-seqno seqno`] [`-at-time YYYY-MM-DD_hh:mm:ss`]

Where:

Table 9.43. trepctl offline-deferred Command Options

Option	Description
`-at-event event` [345]	Go offline at the specified event
`-at-heartbeat [heartbeat]` [345]	Go offline when the specified heartbeat is identified
`-at-seqno seqno` [345]	Go offline at the specified sequence number
`-at-time YYYY-MM-DD_hh:mm:ss` [345]	Go offline at the specified time

The trepctl offline-deferred command can be used to put the replicator into an offline state at some future point in the replication stream by identifying a specific trigger. The replicator must be online when the trepctl offline-deferred command is given; if the replicator is not online, the command is ignored.

The offline process performs a clean offline event, equivalent to executing trepctl offline. See Section 9.23.3.9, "trepctl offline Command".

The supported triggers are:

- `-at-seqno` [345]

  Specifies a transaction sequence number (GTID) where the replication will be stopped. For example:

  ```
  shell> trepctl offline-deferred -at-seqno 3800
  ```

  The replicator goes into offline at the end of the matching transaction. In the above example, sequence 3800 would be applied to the dataserver, then the replicator goes offline.

- `-at-event` [345]

  Specifies the event where replication should stop:

  ```
  shell> trepctl offline-deferred -at-event 'mysql-bin.000009:0000000000088140;0'
  ```

  Because there is not a one-to-one relationship between global transaction IDs and events, the replicator will go offline at a transaction that has an event ID higher than the deferred event ID. If the event specification is located within the middle of a THL transaction, the entire transaction is applied.

- `-at-heartbeat` [345]

  Specifies the name of a specific heartbeat to look for when replication should be stopped.

- `-at-time` [345]

  Specifies a time (using the format YYYY-MM-DD_hh:mm:ss) at which replication should be stopped. The time must be specified in full (date and time to the second).

  ```
  shell> trepctl offline-deferred -at-time 2013-09-01_00:00:00
  ```

  The transaction being executed at the time specified completes, then the replicator goes offline.

If any specified deferred point has already been reached, then the replicator will go offline anyway. For example, if the current sequence number is 3800 and the deferred sequence number specified is 3700, then the replicator will go offline immediately just as if the trepctl offline command has been used.

When a trigger is reached, For example if a sequence number is given, that sequence will be applied and then the replicator will go offline.

The status of the pending trepctl offline-deferred setting can be identified within the status output within the *`offlineRequests`* field:

```
shell> trepctl status
...
offlineRequests        : Offline at sequence number: 3810
```

Multiple trepctl offline-deferred commands can be given for each corresponding trigger type. For example, below three different triggers have been specified, sequence number, time and heartbeat event, with the status showing each deferred event separated by a semicolon:

```
shell> trepctl status
...
offlineRequests        : Offline at heartbeat event: dataloaded;Offline at »
    sequence number: 3640;Offline at time: 2013-09-01 00:00:00 EDT
```

Offline deferred settings are cleared when the replicator is put into the offline state, either manually or automatically.

9.23.3.11. trepctl online Command

The trepctl online command puts the replicator into the online state. During the state change from offline to online various options can be used to control how the replicator goes back on line. For example, the replicator can be placed online, skipping one or more faulty transactions or disabling specific configurations.

`trepctl` online [`-all-services`] [`-base-seqno x`] [`-force`] [`-from-event event`] [`-no-checksum`] [`-skip-seqno seqdef`] [`-until-event event`] [`-until-heartbeat [name]`] [`-until-seqno seqno`] [`-until-time YYYY-MM-DD_hh:mm:ss`]

Where:

Table 9.44. trepctl online Command Options

Option	Description
`-all-services`	Place online all available services

Option	Description
`-base-seqno x`	On a Primary, restart replication using the specified sequence number
`-force`	Force the online state
`-from-event event`	Start replication from the specified event
`-no-checksum`	Disable checksums for all events when going online
`-skip-seqno seqdef`	Skip one, multiple, or ranges of sequence numbers before going online
`-until-event event`	Define an event when replication will stop
`-until-heartbeat [name]`	Define a heartbeat when replication will stop
`-until-seqno seqno`	Define a sequence no when replication will stop
`-until-time YYYY-MM-DD_hh:mm:ss`	Define a time when replication will stop

The trepctl online command attempts to switch replicator into the online state. The replicator may need to be put online because it has been placed offline for maintenance, or due to a failure.

To put the replicator online use the standard form of the command:

```
shell> trepctl online
```

Going online may fail if the reason for going offline was due to a fault in processing the THL, or in applying changes to the dataserver. The replicator will refuse to go online if there is a fault, but certain failures can be explicitly bypassed.

9.23.3.11.1. Going Online from Specific Transaction Points

If there is one, or more, event in the THL that could not be applied to the Replica because of a mismatch in the data (for example, a duplicate key), the event or events can be skipped using the `-skip-seqno` option. For example, the status shows that a statement failed:

```
shell> trepctl status
...
pendingError           : Event application failed: seqno=5250 fragno=0 »
    message=java.sql.SQLException: Statement failed on slave but succeeded on master
...
```

To skip the single sequence number, `5250`, shown:

```
shell> trepctl online -skip-seqno 5250
```

The sequence number specification can be specified according to the following rules:

- A single sequence number:

  ```
  shell> trepctl online -skip-seqno 5250
  ```

- A sequence range:

  ```
  shell> trepctl online -skip-seqno 5250-5260
  ```

- A comma-separated list of individual sequence numbers and/or ranges:

  ```
  shell> trepctl online -skip-seqno 5250,5251,5253-5260
  ```

9.23.3.11.2. Going Online from a Base Sequence Number

Note

To set the position of the replicator, the dsctl command can also be used.

Alternatively, the base sequence number, the transaction ID where replication should start, can be specified explicitly:

```
shell> trepctl online -base-seqno 5260
```

Warning

Use of `-base-seqno` should be restricted to replicators in the *`master`* role only. Use on Replicas may lead to duplication or corruption of data.

9.23.3.11.3. Going Online from a Specific Event

> **Note**
>
> To set the position of the replicator, the dsctl command can also be used.

If the source event (for example, the MySQL binlog position) is known, this can be used as the reference point when going online and restarting replication:

```
shell> trepctl online -from-event 'mysql-bin.000011:0000000000002552;0'
```

When used, replication will start from the next event within the THL. The event ID provided must be valid. The event cannot be found in the THL, the operation will fail.

9.23.3.11.4. Going Online Until Specific Transaction Points

There are times when it is useful to be able to online until a specific point in time or in the replication stream. For example, when performing a bulk load parallel replication may be enabled, but only a single applier stream is required once the load has finished. The replicator can be configured to go online for a limited period, defined by transaction IDs, events, heartbeats, or a specific time.

The replicator must be in the offline state before the deferred online specifications are made. Multiple deferred online states can be specified in the same command when going online.

The setting of a future offline state can be seen by looking at the *offlineRequests* field when checking the status:

```
shell> trepctl status
...
minimumStoredSeqNo     : 0
offlineRequests        : Offline at sequence number: 5262;Offline at time: 2014-01-01 00:00:00 EST
pendingError           : NONE
...
```

If the replicator goes offline for any reason before the deferred offline state is reached, the deferred settings are lost.

9.23.3.11.4.1. Going Online Until Specified Sequence Number

To go online until a specific transaction ID, use `-until-seqno`:

```
shell> trepctl online -until-seqno 5260
```

This will process all transactions up to, and including, sequence 5260, at which point the replicator will go offline.

9.23.3.11.4.2. Going Online Until Specified Event

To go online until a specific event ID:

```
shell> trepctl online -until-event  'mysql-bin.000011:0000000000003057;0'
```

Replication will go offline when the event ID up to the specified event has been processed.

9.23.3.11.4.3. Going Online Until Heartbeat

To go online until a heartbeat event:

```
shell> trepctl online -until-heartbeat
```

Heartbeats are inserted into the replication stream periodically, replication will stop once the heartbeat has been seen before the next transaction. A specific heartbeat can also be specified:

```
shell> trepctl online -until-heartbeat load-finished
```

9.23.3.11.4.4. Going Online Until Specified Time

To go online until a specific date and time:

```
shell> trepctl online -until-time 2014-01-01_00:00:00
```

Replication will go offline once the transaction being processed at the time specified has completed.

9.23.3.11.5. Going Online by Force

In situations where the replicator needs to go online, the online state can be forced. This changes the replicator state to online, but provides no guarantees that the online state will remain in place if another, different, error stops replication.

```
shell> trepctl online -force
```

9.23.3.11.6. Going Online without Validating Checksum

In the event of a checksum problem in the THL, checksums can be disabled using the `-no-checksum` option:

```
shell> trepctl online -no-checksum
```

This will bring the replicator online without reading or writing checksum information.

> **Important**
>
> Use of the `-no-checksum` option disables both the reading and writing of checksums on log records. If starting the replicator without checksums to get past a checksum failure, the replicator should be taken offline again once the offending event has been replicated. This will avoid generating too many local records in the THL without checksums.

9.23.3.12. trepctl perf Command

Display a list of all the internal properties. The list can be filtered.

`trepctl` perf [`-r`]

The perf outputs performance information on a stage by stage basis from the current replicator. The information has been reformatted and extracted from the existing replicator status, task and stage information available through other commands and requests, but reformatted and with values calculated to make identifying specific performance metrics quicker.

For example, on a typical extraction replicator:

```
Statistics since last put online 9265.385s ago
Stage       | Seqno | Latency |      Events |  Extraction |   Filtering |    Applying |       Other |       Total
binlog-to-q |  1604 |  8.779s |          14 |     60.173s |      0.109s |      0.015s |      0.004s |     60.301s
                        Avg time per Event |      4.298s |      0.008s |      0.000s |      0.001s |      4.307s
                          Filters in stage | colnames -> pkey
q-to-thl    |  1604 | 10.613s |          14 |     56.858s |      0.020s |      5.247s |      0.028s |     62.153s
                        Avg time per Event |      4.061s |      0.001s |      0.002s |      0.375s |      4.440s
                          Filters in stage | enumtostring -> settostring
```

On an applier:

```
Statistics since last put online 38.418s ago
Stage         | Seqno | Latency |      Events |  Extraction |   Filtering |    Applying |       Other |       Total
remote-to-thl |  3246 |  1.143s |          42 |     37.831s |      0.001s |      0.403s |      0.011s |     38.246s
                        Avg time per Event |      0.901s |      0.000s |      0.000s |      0.010s |      0.911s
thl-to-q      |  3246 |  1.209s |        1654 |     37.113s |      0.005s |      1.090s |      0.098s |     38.306s
                        Avg time per Event |      0.022s |      0.000s |      0.000s |      0.001s |      0.023s
q-to-dbms     |  3235 |  3.746s |        1644 |     22.226s |      0.019s |     15.242s |      0.338s |     37.825s
                        Avg time per Event |      0.014s |      0.000s |      0.000s |      0.009s |      0.023s
                          Filters in stage | mysqlsessions -> pkey
```

The individual statistics shown are as follows:

- All statistics within the replicator are reset when the replicator goes `ONLINE`. The statistics shown are therefore displayed relative to the current uptime for the replicator.
- For each stage, the following information is shown:
  - Stage name
  - Seqno — this is the current *SEQNO* [587] number for the specified stage. A difference in sequence numbers is possible (as seen in the applier example above) during startup or synchronisation.
  - Latency — the latency of this stage compared to the commit time of the original transaction.
  - Events — the number of THL events processed by this stage.

  Statistics are then shown for each stage, two rows, first for the time to process all of the specified events, and then an average processing time for the events processed during that time within that stage. The individual statistics shown are as follows:

  - Extraction — the time taken to extract the event from the current source. On an extractor, this is the source database (for example, the binary log in MySQL). On other stages this is the time to read from disk or the remote replicator the THL event.
  - Filtering — the time taken to process the events through the filters configured in the specified stage.
  - Applying — the time taken to apply the event to the end of the stage, whether that is to THL on disk, the next queue in preparation for the next stage, or the target database.

- Other — the time taken for other parts of the stage process, this includes waiting for thread management, updating internal structures, and recording information in the target datasource system, such as `trep_commit_seqno`.

- Filters in stage — The list of filters configured for this stage in the order in which they are applied to the event.

For convenience, the performance display can be set to refresh with a configured interval using the trepctl perf -r 5 command.

In the event that the replicator is currently offline, no statistics are displayed:

```
shell> trepctl perf
Currently not online; performance stats not available
State: Safely Offline for 6.491s
```

9.23.3.13. trepctl properties Command

Display a list of all the internal properties. The list can be filtered.

`trepctl` properties [`-filter name`] [`-values`]

The list of properties can be used to determine the current configuration:

```
shell> trepctl properties
{
"replicator.store.thl.log_file_retention": "7d",
"replicator.filter.bidiSlave.allowBidiUnsafe": "false",
"replicator.extractor.dbms.binlog_file_pattern": "mysql-bin",
"replicator.filter.pkey.url": »
    "jdbc:mysql:thin://host2:3306/tungsten_alpha?createDB=true",
...
}
```

Note

Passwords are not displayed in the output.

The information is output as a JSON object with key/value pairs for each property and corresponding value.

The list can be filtered using the `-filter` option:

```
shell> trepctl properties -filter shard
{
"replicator.filter.shardfilter": »
    "com.continuent.tungsten.replicator.shard.ShardFilter",
"replicator.filter.shardbyseqno": »
    "com.continuent.tungsten.replicator.filter.JavaScriptFilter",
"replicator.filter.shardbyseqno.shards": "1000",
"replicator.filter.shardfilter.enforceHome": "false",
"replicator.filter.shardfilter.unknownShardPolicy": "error",
"replicator.filter.shardbyseqno.script": »
    "../../tungsten-replicator//samples/extensions/javascript/shardbyseqno.js",
"replicator.filter.shardbytable.script": »
    "../../tungsten-replicator//samples/extensions/javascript/shardbytable.js",
"replicator.filter.shardfilter.enabled": "true",
"replicator.filter.shardfilter.allowWhitelisted": "false",
"replicator.shard.default.db": "stringent",
"replicator.filter.shardbytable": »
    "com.continuent.tungsten.replicator.filter.JavaScriptFilter",
"replicator.filter.shardfilter.autoCreate": "false",
"replicator.filter.shardfilter.unwantedShardPolicy": "error"
}
```

The value or values from filtered properties can be retrieved by using the `-values` option:

```
shell>  trepctl properties -filter site.name -values
default
```

If a filter that would select multiple values is specified, all the values are listed without field names:

```
shell> trepctl properties -filter shard -values
com.continuent.tungsten.replicator.shard.ShardFilter
com.continuent.tungsten.replicator.filter.JavaScriptFilter
1000
false
../../tungsten-replicator//samples/extensions/javascript/shardbyseqno.js
error
../../tungsten-replicator//samples/extensions/javascript/shardbytable.js
true
```

```
false
stringent
com.continuent.tungsten.replicator.filter.JavaScriptFilter
false
error
```

9.23.3.14. trepctl purge Command

Forces all logins on the attached database, other than those directly related to Tungsten Cluster, to be disconnected. The command is only supported on a Primary, and can be used to disconnect users before a switchover or taking a Primary offline to prevent further use of the system.

`trepctl` purge [`-limit s`] [`-y`]

Where:

Table 9.45. trepctl purge Command Options

Option	Description
`-limit s` [350]	Specify the waiting time for the operation
`-y` [350]	Indicates that the command should continue without interactive confirmation

Warning

Use of the command will disconnect running users and queries and may leave the database is an unknown state. It should be used with care, and only when the dangers and potential results are understood.

To close the connections:

```
shell> trepctl purge
Do you really want to purge non-Tungsten DBMS sessions? [yes/NO]
```

You will be prompted to confirm the operation. To skip this confirmation and purge connections, use the `-y` [350] option:

```
shell> trepctl purge -y
Directing replicator to purge non-Tungsten sessions
Number of sessions purged: 0
```

An optional parameter, `-wait` [350], defines the period of time that the operation will wait before returning to the command-line.

An optional parameter, `-limit` [350], defines the period of time that the operation will wait before returning to the command-line.

9.23.3.15. trepctl qs Command

The trepctl qs (quickstatus) command provides a quicker, simpler, status display for the replicator showing only the critical information in a human-readable form. For example:

```
shell> trepctl qs
State: alpha Online for 4.21s, running for 1781.766s
Latency: 18.0s from source DB commit time on thl://ubuntuheterosrc.mcb:2112/ into target database
         1216.315s since last source commit
Sequence: 4804 last applied, 0 transactions behind (0-4804 stored) estimate 0.00s before synchronization
```

The information presented is as follows:

- State: alpha Online for 4.21s, running for 1781.766s

  The top line shows the basic status information about the replicator:

  - The name of the service [`alpha`].
  - The replicator's current state [`Online`] and the time in that state.
  - The amount of time the replicator has been running.

- Latency: 18.0s from source DB commit time on thl://ubuntuheterosrc.mcb:2112/ into target database

  The second lines shows the latency information, the information shown is based on the role of the replicator. The above line is shown on an applier, where the latency information shows the write delay into the target database, where the information is coming from, and applying to the target database. For a Primary (extractor) the information shown describes the latency from extraction into the THL files:

```
State: alpha Online for 1699091.442s, running for 1699093.138s
Latency: 0.113s from DB commit time on ubuntuheterosrc into THL
         1679.354s since last database commit
Sequence: 4859 last applied, 0 transactions behind (0-4859 stored) estimate 0.00s before synchronization
```

- 1216.315s since last source commit

  The next line shows the interval since the last time there was a database commit. On a Primary (extractor) is the time between the last database commit to the binary log and the information being written to THL. On a Replica, it's the time between the last database commit *on the source database* and when the transaction was written to the target.

- Sequence: 4804 last applied, 0 transactions behind (0-4804 stored) estimate 0.00s before synchronization

  The last line shows the sequence information:

  - The last applied sequence number (to THL on a Primary, or to the target database on a Replica).
  - The number of transactions behind the current stored transaction list. This is an indication on a Replica of how far behind in transactions (not latency) the Replica is from the Primary.
  - The range of transactions currently stored (from minimum to maximum stored sequence number).
  - An estimate of the how long it will take to apply the outstanding transactions. The calculation is made by determining the average rate transactions are being applied (either extraction or applying) against the number of outstanding transactions. It assumes all outstanding transactions are of an equal size. The actual THL transaction size is not taken into account. For information on THL sizes, try the thl list -sizes command.

If the replicator is offline due to being deliberately placed offline using trepctl offline then the basic information and status is shown:

```
shell> trepctl qs
State: Safely Offline for 352.775s
```

In the event of a replicator failure of some kind this will be reported in the output:

```
State: alpha Faulty (Offline) for 2.613s
Error Reason: SEQNO 4859 did not apply
    Error: CSV loading failed: schema=test table=msg CSV file=/opt/continuent/tmp/staging/alpha/staging0/test-msg-4859.csv
» message=Wrapped com.continuent.tungsten.replicator.ReplicatorException: OS command failed: command=cqlsh --keyspace=test
» --execute="copy stage_xxx_msg (tungsten_opcode,tungsten_seqno,tungsten_row_id,tungsten_commit_timestamp,id,msg) from
» '/opt/continuent/tmp/staging/alpha/staging0/test-msg-4859.csv' with NULL='NULL';" rc=1 stdout= stderr=Connection
» error: ('Unable to complete the operation against any hosts', {})
```

9.23.3.16. trepctl reset Command

The trepctl reset command resets an existing replicator service, performing the following operations:

- Deleting the local THL and relay directories
- Removes the Tungsten schema from the dataserver
- Removes any dynamic properties that have previously been set

The service name must be specified, using `-service`.

`trepctl` reset [`-all`] [`-db`] [`-relay`] [`-thl`] [`-y`]

Where:

Table 9.46. trepctl reset Command Options

Option	Description
`-all` [352]	Deletes the thl directory, relay logs directory and tungsten database for the service.
`-db` [352]	Deletes the tungsten_{service_name} database for the service
`-relay` [352]	Deletes the relay directory for the service
`-thl` [352]	Deletes the thl directory for the service
`-y` [352]	Indicates that the command should continue without interactive confirmation

To reset a replication service, the replication service must be offline and the service name must be specified:

```
shell> trepctl offline
```

Execute the trepctl reset command:

```
shell> trepctl -service alpha reset
Do you really want to delete replication service alpha completely? [yes/NO]
```

You will be prompted to confirm the deletion. To ignore the interactive prompt, use the -y [352] option:

```
shell> trepctl -service alpha reset -y
```

Then put the replicator back online again:

```
shell> trepctl online
```

You can also reset only part of the overall service by including one of the following options:

- Reset all components of the service.
- Reset the THL. This is equivalent to running thl purge.
- Reset the relay log contents.
- Reset the database, including emptying the trep_commit_seqno and other control tables.

9.23.3.17. trepctl restore Command

Restores the database on a host from a previous backup.

trepctl capabilities

Once the restore has been completed, the node will remain in the OFFLINE state. The datasource should be switched ONLINE using trepctl:

```
shell> trepctl online
```

Any outstanding events from the Primary will be processed and applied to the Replica, which will catch up to the current Primary status over time.

9.23.3.18. trepctl setdynamic Command

The trepctl setdynamic command allows you to change certain dynamic properties without the need to execute tpm update

trepctl setdynamic [-property] [-value]

Where:

Table 9.47. trepctl setdynamic Command Options

Option	Description
-property	Specify the property to change
-value	Specify the value of the specified -property

To change a property, specify the property using the -property parameter.

> **Important**
>
> To change a property dynamically, the service must first be OFFLINE

```
shell> trepctl setdynamic -property <property>
```

The list of properties that can be dynamically changed are as follows:

- replicator.autoRecoveryMaxAttempts : This allows you to dynamically alter the behaior of the autoRecovery options. A value specificed greater than 0 will enable the autoRevovery. Set a value of 0 to disable.

  The following example enables autoRecovery with the MaxAttempts value of 10

  ```
  shell> trepctl -service beta setdynamic -property replicator.autoRecoveryMaxAttempts -value 10
  ```

  The following example disables autoRecovery

```
shell> trepctl -service beta setdynamic -property replicator.autoRecoveryMaxAttempts -value 0
```

9.23.3.19. trepctl setrole Command

The trepctl setrole command changes the role of the replicator service. This command can be used to change a configured host between Replica and Primary roles, for example during switchover.

`trepctl` setrole [`-role master` | `slave` | `relay` | `thl-applier` | `thl-client` | `thl-server`] [`-uri`]

Where:

Table 9.48. trepctl setrole Command Options

Option	Description
`-role`	Replicator role
`-uri` [353]	URI of the Primary

To change the role of a replicator, specify the role using the `-role` parameter. The replicator must be offline when the role change is issued:

```
shell> trepctl setrole -role master
```

When setting a Replica, the URI of the Primary can be optionally supplied:

```
shell> trepctl setrole -role slave -uri thl://host1:2112/
```

See Section 6.3.5, "Understanding Replicator Roles" for more details on each role.

9.23.3.20. trepctl shard Command

The trepctl shard command provides and interface to the replicator shard system definition system.

`trepctl` shard [`-delete shard`] [`-insert shard`] [`-list`] [`-update shard`]

Where:

Table 9.49. trepctl shard Command Options

Option	Description
`-delete shard`	Delete a shard definition
`-insert shard`	Add a new shard definition
`-list`	List configured shards
`-update shard`	Update a shard definition

The replicator shard system is used during multi-site replication configurations to control where information is replicated.

For more information, see Section 3.3, "Deploying Multi-Site/Active-Active Clustering"Section 3.2, "Deploying Composite Active/Passive Clustering".

9.23.3.20.1. Listing Current Shards

To obtain a list of the currently configured shards:

```
shell> trepctl shard -list
shard_id master critical
alpha    sales   true
```

The shard map information can also be captured and then edited to update existing configurations:

```
shell> trepctl shard -list>shard.map
```

9.23.3.20.2. Inserting a New Shard Configuration

To add a new shard map definition, either enter the information interactively:

```
shell> trepctl shard -insert
Reading from standard input
...
```

```
1 new shard inserted
```

Or import from a file:

```
shell> trepctl shard -insert  < shard.map
Reading from standard input
1 new shard inserted
```

9.23.3.20.3. Updating an Existing Shard Configuration

To update a definition:

```
shell> trepctl shard -update  < shard.map
Reading from standard input
1 shard updated
```

9.23.3.20.4. Deleting a Shard Configuration

To delete a single shard definition, specify the shard name:

```
shell> trepctl shard -delete alpha
```

9.23.3.21. trepctl status Command

The trepctl status command provides status information about the selected data service. The status information by default is a generic status report containing the key fields of status information. More detailed service information can be obtained by specifying the status name with the `-name` parameter.

The format of the command is:

`trepctl` status [`-json`] [`-name channel-assignments` | `services` | `shards` | `stages` | `stores` | `tasks` | `watches`] [`-r`]

Where:

Table 9.50. trepctl status Command Options

Option	Description
`-json`	Output the information in JSON format
`-name`	Select a specific group of status information
`-r`	Refresh the status display

For example, to get the basic status information:

```
shell> trepctl status
Processing status command...
NAME                     VALUE
----                     -----
appliedLastEventId     : mysql-bin.000007:0000000000001353;0
appliedLastSeqno       : 2504
appliedLatency         : 0.53
channels               : 1
clusterName            : default
currentEventId         : mysql-bin.000007:0000000000001353
currentTimeMillis      : 1369233160014
dataServerHost         : host1
extensions             :
latestEpochNumber      : 2500
masterConnectUri       :
masterListenUri        : thl://host1:2112/
maximumStoredSeqNo     : 2504
minimumStoredSeqNo     : 0
offlineRequests        : NONE
pendingError           : NONE
pendingErrorCode       : NONE
pendingErrorEventId    : NONE
pendingErrorSeqno      : -1
pendingExceptionMessage: NONE
pipelineSource         : jdbc:mysql:thin://host1:3306/
relativeLatency        : 1875.013
resourcePrecedence     : 99
rmiPort                : 10000
role                   : master
seqnoType              : java.lang.Long
serviceName            : alpha
serviceType            : local
```

```
simpleServiceName      : alpha
siteName               : default
sourceId               : host1
state                  : ONLINE
timeInStateSeconds     : 1874.512
transitioningTo        :
uptimeSeconds          : 1877.823
version                : Tungsten Replicator 5.4.1 build 41
Finished status command...
```

For more information on the field information output, see Section E.2, “Generated Field Reference”.

The `-r #` can be used to automatically refresh the output at the specified interval. For example, trepctl status -r 5 will refresh the output every 5 seconds.

9.23.3.21.1. Getting Detailed Status

More detailed information about selected areas of the replicator status can be obtained by using the `-name` option.

9.23.3.21.1.1. Detailed Status: Channel Assignments

When using a single threaded replicator service, the trepctl status -name channel-assignments will output an empty status. In parallel replication deployments, the trepctl status -name channel-assignments listing will output the list of schemas and their assigned channels within the configured channel quantity configuration. For example, in the output below, only two channels are shown, although five channels were configured for parallel apply:

```
shell> trepctl status -name channel-assignments
Processing status command (channel-assignments)...
NAME      VALUE
----      -----
channel : 0
shard_id: test
NAME      VALUE
----      -----
channel : 0
shard_id: tungsten_alpha
Finished status command (channel-assignments)...
```

9.23.3.21.1.2. Detailed Status: Services

The trepctl status -name services status output shows a list of the currently configure internal services that are defined within the replicator.

```
shell> trepctl status -name services
Processing status command (services)...
NAME              VALUE
----              -----
accessFailures  : 0
active          : true
maxChannel      : -1
name            : channel-assignment
storeClass      : com.continuent.tungsten.replicator.channel.ChannelAssignmentService
totalAssignments: 0
Finished status command (services)...
```

9.23.3.21.1.3. Detailed Status: Shards

The trepctl status -name shards status output lists the individual shards in operation, most useful when parallel apply has been configured within the replicator, showing a summary of last applied sequences and the corresponding binlog references.

In an environemnt not configured with parallel apply, the shards output will just show a single entry

9.23.3.21.1.4. Detailed Status: Stages

The trepctl status -name stages status output lists the individual stages configured within the replicator, showing each stage, configuration, filters and other parameters applied at each replicator stage:

```
shell> trepctl status -name stages
Processing status command (stages)...
NAME                VALUE
----                -----
applier.class     : com.continuent.tungsten.replicator.thl.THLStoreApplier
applier.name      : thl-applier
blockCommitRowCount: 1
committedMinSeqno : 15
extractor.class   : com.continuent.tungsten.replicator.thl.RemoteTHLExtractor
extractor.name    : thl-remote
name              : remote-to-thl
```

```
processedMinSeqno  : -1
taskCount          : 1
NAME                 VALUE
----                 -----
applier.class      : com.continuent.tungsten.replicator.thl.THLParallelQueueApplier
applier.name       : parallel-q-applier
blockCommitRowCount: 10
committedMinSeqno  : 15
extractor.class    : com.continuent.tungsten.replicator.thl.THLStoreExtractor
extractor.name     : thl-extractor
name               : thl-to-q
processedMinSeqno  : -1
taskCount          : 1
NAME                 VALUE
----                 -----
applier.class      : com.continuent.tungsten.replicator.applier.MySQLDrizzleApplier
applier.name       : dbms
blockCommitRowCount: 10
committedMinSeqno  : 15
extractor.class    : com.continuent.tungsten.replicator.thl.THLParallelQueueExtractor
extractor.name     : parallel-q-extractor
filter.0.class     : com.continuent.tungsten.replicator.filter.TimeDelayFilter
filter.0.name      : delay
filter.1.class     : com.continuent.tungsten.replicator.filter.MySQLSessionSupportFilter
filter.1.name      : mysqlsessions
filter.2.class     : com.continuent.tungsten.replicator.filter.PrimaryKeyFilter
filter.2.name      : pkey
name               : q-to-dbms
processedMinSeqno  : -1
taskCount          : 5
Finished status command (stages)...
```

9.23.3.21.1.5. Detailed Status: Stores

The trepctl status -name stores status output lists the individual internal stores used for replicating THL data. This includes both physical (on disk) THL storage and in-memory storage. This includes the sequence number, file size and retention information.

For example, the information shown below is taken from a Primary service, showing the stages, `binlog-to-q` which reads the information from the binary log, and the in-memory `q-to-thl` that writes the information to THL.

```
shell> trepctl status -name stages
Processing status command (stages)...
NAME                 VALUE
----                 -----
applier.class      : com.continuent.tungsten.replicator.storage.InMemoryQueueAdapter
applier.name       : queue
blockCommitRowCount: 1
committedMinSeqno  : 224
extractor.class    : com.continuent.tungsten.replicator.extractor.mysql.MySQLExtractor
extractor.name     : dbms
name               : binlog-to-q
processedMinSeqno  : 224
taskCount          : 1
NAME                 VALUE
----                 -----
applier.class      : com.continuent.tungsten.replicator.thl.THLStoreApplier
applier.name       : autoflush-thl-applier
blockCommitRowCount: 10
committedMinSeqno  : 224
extractor.class    : com.continuent.tungsten.replicator.storage.InMemoryQueueAdapter
extractor.name     : queue
name               : q-to-thl
processedMinSeqno  : 224
taskCount          : 1
Finished status command (stages)...
```

When running parallel replication, the output shows the store name, sequence number and status information for each parallel replication channel:

```
shell> trepctl status -name stores
Processing status command (stores)...
NAME                     VALUE
----                     -----
activeSeqno            : 15
doChecksum             : false
flushIntervalMillis    : 0
fsyncOnFlush           : false
logConnectionTimeout   : 28800
logDir                 : /opt/continuent/thl/alpha
logFileRetainMillis    : 604800000
logFileSize            : 100000000
maximumStoredSeqNo     : 16
```

```
minimumStoredSeqNo      : 0
name                    : thl
readOnly                : false
storeClass              : com.continuent.tungsten.replicator.thl.THL
timeoutMillis           : 2147483647
NAME                      VALUE
----                      -----
criticalPartition       : -1
discardCount            : 0
estimatedOfflineInterval: 0.0
eventCount              : 1
headSeqno               : 16
intervalGuard           : AtomicIntervalGuard (array is empty)
maxDelayInterval        : 60
maxOfflineInterval      : 5
maxSize                 : 10
name                    : parallel-queue
queues                  : 5
serializationCount      : 0
serialized              : false
stopRequested           : false
store.0                 : THLParallelReadTask task_id=0 thread_name=store-thl-0 »
                          hi_seqno=16 lo_seqno=16 read=1 accepted=1 discarded=0 events=0
store.1                 : THLParallelReadTask task_id=1 thread_name=store-thl-1 »
                          hi_seqno=16 lo_seqno=16 read=1 accepted=0 discarded=1 events=0
store.2                 : THLParallelReadTask task_id=2 thread_name=store-thl-2 »
                          hi_seqno=16 lo_seqno=16 read=1 accepted=0 discarded=1 events=0
store.3                 : THLParallelReadTask task_id=3 thread_name=store-thl-3 »
                          hi_seqno=16 lo_seqno=16 read=1 accepted=0 discarded=1 events=0
store.4                 : THLParallelReadTask task_id=4 thread_name=store-thl-4 »
                          hi_seqno=16 lo_seqno=16 read=1 accepted=0 discarded=1 events=0
storeClass              : com.continuent.tungsten.replicator.thl.THLParallelQueue
syncInterval            : 10000
Finished status command (stores)...
```

9.23.3.21.1.6. Detailed Status: Tasks

The trepctl status -name tasks command outputs the current list of active tasks within a given service, with one block for each stage within the replicator service.

```
shell> trepctl status -name tasks
Processing status command (tasks)...
NAME                    VALUE
----                    -----
appliedLastEventId    : mysql-bin.000038:0000000011253929;-1
appliedLastSeqno      : 1604
appliedLatency        : 8.779
applyTime             : 0.015
averageBlockSize      : 3.500
cancelled             : false
commits               : 4
currentBlockSize      : 0
currentLastEventId    : mysql-bin.000038:0000000011253929;-1
currentLastFragno     : 11
currentLastSeqno      : 1604
eventCount            : 14
extractTime           : 60.173
filterTime            : 0.109
lastCommittedBlockSize: 12
lastCommittedBlockTime: 59.145
otherTime             : 0.004
stage                 : binlog-to-q
state                 : extract
taskId                : 0
timeInCurrentEvent    : 8804.187
NAME                    VALUE
----                    -----
appliedLastEventId    : mysql-bin.000038:0000000011253929;-1
appliedLastSeqno      : 1604
appliedLatency        : 10.613
applyTime             : 5.247
averageBlockSize      : 2.800
cancelled             : false
commits               : 5
currentBlockSize      : 0
currentLastEventId    : mysql-bin.000038:0000000011253929;-1
currentLastFragno     : 11
currentLastSeqno      : 1604
eventCount            : 14
extractTime           : 56.858
filterTime            : 0.02
lastCommittedBlockSize: 12
lastCommittedBlockTime: 5.092
```

```
otherTime             : 0.028
stage                 : q-to-thl
state                 : extract
taskId                : 0
timeInCurrentEvent    : 8802.323
Finished status command (tasks)...
```

The list of tasks and information provided depends on the role of the host, the number of stages, and whether parallel apply is enabled.

9.23.3.21.1.7. Detailed Status: Watches

The trepctl status -name watches command outputs the current list of tasks the replicator is waiting on before a specific action.

For example, if you issue trepctl offline-deferred -at-seqno x, the the output of watches will show the stages waiting on the specific seqno.

The following example show the use of offline-deferred and the subsequent resulting output from watches

```
shell> trepctl offline-deferred -at-seqno 234
shell> trepctl status -name watches
Processing status command (watches)...
NAME       VALUE
----       -----
action   : cancel tasks
cancelled: false
committed: false
done     : false
matched  : [[0:false]]
predicate: SeqnoWatchPredicate seqno=234
stage    : remote-to-thl
NAME       VALUE
----       -----
action   : cancel tasks
cancelled: false
committed: false
done     : false
matched  : [[0:false]]
predicate: SeqnoWatchPredicate seqno=234
stage    : thl-to-q
NAME       VALUE
----       -----
action   : cancel tasks
cancelled: false
committed: false
done     : false
matched  : [[0:false]]
predicate: SeqnoWatchPredicate seqno=234
stage    : q-to-dbms
Finished status command (watches)...
```

9.23.3.21.2. Getting JSON Formatted Status

Status information can also be requested in JSON format. The content of the information is identical, only the representation of the information is different, formatted in a JSON wrapper object, with one key/value pair for each field in the standard status output.

Examples of the JSON output for each status output are provided below. For more information on the fields displayed, see Section E.2, “Generated Field Reference”.

trepctl status JSON Output

```
{
"uptimeSeconds": "2128.682",
"masterListenUri": "thl://host1:2112/",
"clusterName": "default",
"pendingExceptionMessage": "NONE",
"appliedLastEventId": "mysql-bin.000007:0000000000001353;0",
"pendingError": "NONE",
"resourcePrecedence": "99",
"transitioningTo": "",
"offlineRequests": "NONE",
"state": "ONLINE",
"simpleServiceName": "alpha",
"extensions": "",
"pendingErrorEventId": "NONE",
"sourceId": "host1",
"serviceName": "alpha",
"version": "Tungsten Replicator 5.4.1 build 41",
"role": "master",
"currentTimeMillis": "1369233410874",
"masterConnectUri": "",
"rmiPort": "10000",
```

```
"siteName": "default",
"pendingErrorSeqno": "-1",
"appliedLatency": "0.53",
"pipelineSource": "jdbc:mysql:thin://host1:3306/",
"pendingErrorCode": "NONE",
"maximumStoredSeqNo": "2504",
"latestEpochNumber": "2500",
"channels": "1",
"appliedLastSeqno": "2504",
"serviceType": "local",
"seqnoType": "java.lang.Long",
"currentEventId": "mysql-bin.000007:0000000000001353",
"relativeLatency": "2125.873",
"minimumStoredSeqNo": "0",
"timeInStateSeconds": "2125.372",
"dataServerHost": "host1"
}
```


9.23.3.21.2.1. Detailed Status: Channel Assignments JSON Output

```
shell> trepctl status -name channel-assignments -json
[
   {
      "channel" : "0",
      "shard_id" : "cheffy"
   },
   {
      "channel" : "0",
      "shard_id" : "tungsten_alpha"
   }
]
```

9.23.3.21.2.2. Detailed Status: Services JSON Output

```
shell> trepctl status -name services -json
[
   {
      "totalAssignments" : "2",
      "accessFailures" : "0",
      "storeClass" : "com.continuent.tungsten.replicator.channel.ChannelAssignmentService",
      "name" : "channel-assignment",
      "maxChannel" : "0"
   }
]
```

9.23.3.21.2.3. Detailed Status: Shards JSON Output

```
shell> trepctl status -name shards -json
[
   {
      "stage" : "q-to-dbms",
      "appliedLastEventId" : "mysql-bin.000007:0000000007224342;0",
      "appliedLatency" : "63.099",
      "appliedLastSeqno" : "2514",
      "eventCount" : "16",
      "shardId" : "cheffy"
   }
]
```

9.23.3.21.2.4. Detailed Status: Stages JSON Output

```
shell> trepctl status -name stages -json
[
   {
      "applier.name" : "thl-applier",
      "applier.class" : "com.continuent.tungsten.replicator.thl.THLStoreApplier",
      "name" : "remote-to-thl",
      "extractor.name" : "thl-remote",
      "taskCount" : "1",
      "committedMinSeqno" : "2504",
      "blockCommitRowCount" : "1",
      "processedMinSeqno" : "-1",
      "extractor.class" : "com.continuent.tungsten.replicator.thl.RemoteTHLExtractor"
   },
   {
      "applier.name" : "parallel-q-applier",
      "applier.class" : "com.continuent.tungsten.replicator.storage.InMemoryQueueAdapter",
      "name" : "thl-to-q",
      "extractor.name" : "thl-extractor",
      "taskCount" : "1",
      "committedMinSeqno" : "2504",
      "blockCommitRowCount" : "10",
```

```
      "processedMinSeqno" : "-1",
      "extractor.class" : "com.continuent.tungsten.replicator.thl.THLStoreExtractor"
   },
   {
      "applier.name" : "dbms",
      "applier.class" : "com.continuent.tungsten.replicator.applier.MySQLDrizzleApplier",
      "filter.2.name" : "bidiSlave",
      "name" : "q-to-dbms",
      "extractor.name" : "parallel-q-extractor",
      "filter.1.name" : "pkey",
      "taskCount" : "1",
      "committedMinSeqno" : "2504",
      "filter.2.class" : "com.continuent.tungsten.replicator.filter.BidiRemoteSlaveFilter",
      "filter.1.class" : "com.continuent.tungsten.replicator.filter.PrimaryKeyFilter",
      "filter.0.class" : "com.continuent.tungsten.replicator.filter.MySQLSessionSupportFilter",
      "blockCommitRowCount" : "10",
      "filter.0.name" : "mysqlsessions",
      "processedMinSeqno" : "-1",
      "extractor.class" : "com.continuent.tungsten.replicator.storage.InMemoryQueueAdapter"
   }
]
```


9.23.3.21.2.5. Detailed Status: Stores JSON Output


```
shell> trepctl status -name stores -json
[
   {
      "logConnectionTimeout" : "28800",
      "doChecksum" : "false",
      "name" : "thl",
      "flushIntervalMillis" : "0",
      "logFileSize" : "100000000",
      "logDir" : "/opt/continuent/thl/alpha",
      "activeSeqno" : "2561",
      "readOnly" : "false",
      "timeoutMillis" : "2147483647",
      "storeClass" : "com.continuent.tungsten.replicator.thl.THL",
      "logFileRetainMillis" : "604800000",
      "maximumStoredSeqNo" : "2565",
      "minimumStoredSeqNo" : "2047",
      "fsyncOnFlush" : "false"
   },
   {
      "storeClass" : "com.continuent.tungsten.replicator.storage.InMemoryQueueStore",
      "maxSize" : "10",
      "storeSize" : "7",
      "name" : "parallel-queue",
      "eventCount" : "119"
   }
]
```


9.23.3.21.2.6. Detailed Status: Tasks JSON Output


```
shell> trepctl status -name tasks -json
[
   {
      "filterTime" : "0.0",
      "stage" : "remote-to-thl",
      "currentLastFragno" : "1",
      "taskId" : "0",
      "currentLastSeqno" : "2615",
      "state" : "extract",
      "extractTime" : "604.297",
      "applyTime" : "16.708",
      "averageBlockSize" : "0.982     ",
      "otherTime" : "0.017",
      "appliedLastEventId" : "mysql-bin.000007:0000000111424440;0",
      "appliedLatency" : "63.787",
      "currentLastEventId" : "mysql-bin.000007:0000000111424440;0",
      "eventCount" : "219",
      "appliedLastSeqno" : "2615",
      "cancelled" : "false"
   },
   {
      "filterTime" : "0.0",
      "stage" : "thl-to-q",
      "currentLastFragno" : "1",
      "taskId" : "0",
      "currentLastSeqno" : "2615",
      "state" : "extract",
      "extractTime" : "620.715",
      "applyTime" : "0.344",
      "averageBlockSize" : "1.904     ",
```

```
    "otherTime" : "0.006",
    "appliedLastEventId" : "mysql-bin.000007:0000000111424369;0",
    "appliedLatency" : "63.834",
    "currentLastEventId" : "mysql-bin.000007:0000000111424440;0",
    "eventCount" : "219",
    "appliedLastSeqno" : "2615",
    "cancelled" : "false"
  },
  {
    "filterTime" : "0.263",
    "stage" : "q-to-dbms",
    "currentLastFragno" : "1",
    "taskId" : "0",
    "currentLastSeqno" : "2614",
    "state" : "apply",
    "extractTime" : "533.471",
    "applyTime" : "61.618",
    "averageBlockSize" : "1.160     ",
    "otherTime" : "24.052",
    "appliedLastEventId" : "mysql-bin.000007:0000000110392640;0",
    "appliedLatency" : "63.178",
    "currentLastEventId" : "mysql-bin.000007:0000000110392711;0",
    "eventCount" : "217",
    "appliedLastSeqno" : "2614",
    "cancelled" : "false"
  }
]
```


9.23.3.21.2.7. Detailed Status: Tasks JSON Output

```
shell> trepctl status -name watches -json
```

9.23.3.22. trepctl unload Command

Unload the replicator service.

`trepctl` unload [`-y`]

Unload the replicator service entirely. An interactive prompt is provided to confirm the shutdown:

```
shell> trepctl unload
Do you really want to unload replication service alpha? [yes/NO]
```

To disable the prompt, use the `-y` [361] option:

```
shell> trepctl unload -y
Service unloaded successfully: name=alpha
```

The name of the service unloaded is provided for confirmation.

9.23.3.23. trepctl wait Command

The trepctl wait command waits for the replicator to enter a specific state, or for a specific sequence number to be applied to the dataserver.

`trepctl` wait [`-applied seqno`] [`-limit s`] [`-state st`]

Where:

Table 9.51. trepctl wait Command Options

Option	Description
`-applied seqno` [361]	Specify the sequence number to be waited for
`-limit s` [362]	Specify the number of seconds to wait for the operation to complete
`-state st` [361]	Specify a state to be waited for

The command will wait for the specified occurrence, of either a change in the replicator status (i.e. `ONLINE`), or for a specific sequence number to be applied. For example, to wait for the replicator to go into the `ONLINE` state:

```
shell> trepctl wait -state ONLINE
```

This can be useful in scripts when the state maybe changed (for example during a backup or restore operation), allowing for an operation to take place once the requested state has been reached. Once reached, trepctl returns with exit status 0.

To wait a specific sequence number to be applied:

```
shell> trepctl wait -applied 2000
```

This can be useful when performing bulk loads where the sequence number where the bulk load completed is known, or when waiting for a specific sequence number from the Primary to be applied on the Replica. Unlike the offline-deferred operation, no change in the replicator is made. Instead, trepctl simply returns with exit status 0 when the sequence number has bee successfully applied.

If the optional `-limit` [362] option is used, then trepctl waits for the specified number of seconds for the request event to occur. For example, to wait for 10 seconds for the replicator to go online:

```
shell> trepctl wait -state ONLINE -limit 10
Wait timed out!
```

If the requested event does not take place before the specified time limit expires, then trepctl returns with the message 'Wait timed out!', and an exit status of 1.

9.24. The tpasswd Command

Table 9.52. tpasswd Common Options

Option	Description
`--create`, `-c`	Creates a new user/password
`--delete`, `-d`	Delete a user/password combination
`-e`, `--encrypted.password`	Encrypt the password
`--file`, `-f`	Specify the location of the security.properties file
`-help`, `-h`	Display help text
`-p`, `--password.file.location`	Specify the password file location
`--target`, `-t`	Specify the target application
`-ts`, `--truststore.location`	

9.25. The tungsten_find_orphaned Command

The tungsten_find_orphaned command was added in versions 5.4.1 and 6.1.1

The tungsten_find_orphaned command assists with locating orphaned events in both the MySQL binary logs as well as in the THL.

This program is designed to handle three failure scenarios:

1. Orphaned MySQL binary logs that were not extracted into THL before a failover
2. Orphaned THL on old Primary that did not make it to the new Primary
3. Orphaned Replica THL on new Primary or online Replica of the new Primary that did not get applied to the database before getting promoted to new Primary

The default action with no arguments is Scenario 1 to locate orphaned MySQL binary logs which have not been extracted into THL on an old Primary before recovery.

For Scenarios 1 and 2

By default, the tungsten_find_orphaned command expects to be run on a (possibly failed) Primary before recovery.

Once any new Replica THL is appended to any existing extracted THL, the tungsten_find_orphaned command will be unable to find the delta between the binlogs and the THL.

If any events are located in the binlogs that do not exist in the THL on disk, they will be counted, and a summary displayed at the end.

Instructions on how to display any actual orphaned events in the binary logs will be provided as well.

For Scenario 2

If the latestEpochNumber from the new Primary `trepctl status`output is provided via the `-e {seqno}`option, tungsten_find_orphaned will check for THL differences from old to new Primaries.

For Scenario 3

Use --new on a NEW Primary to attempt to automatically locate the latest trepsvc.log file and determine if there is orphaned THL which exists on disk but had not yet been applied to the database.

If tungsten_find_orphaned is unable to auto-locate the trepsvc.log file, please specify the full path to the latest one using --log (or -l).

Examples:

Run on old Primary to find orphaned binary logs not extracted to thl before failover with verbose output (Scenario 1):

```
shell> tungsten_find_orphaned -v
```

Locate THL on an old Primary that was not transferred to the new Primary before failover (Scenario 2):

```
shell> tungsten_find_orphaned -v -e {latestEpochNumber_from_new_Primary}
```

Run on new Primary to find unapplied THL (Scenario 3):

```
shell> tungsten_find_orphaned -v -n
```

9.26. The tungsten_find_position Command

The tungsten_find_position command was added in versions 5.4.0 and 6.1.0

The tungsten_find_position assists with locating event information in the THL and producing a dsctl set command as output.

The tungsten_find_position command performs the following steps:

- Get the MySQL binary log position to search for from the CLI and validate
- Validate paths and commands
- Load all available service names and validate any specified service against that list
- Check if this Replicator is in the Primary role
- Locate the supplied binary log position in the available THL
- Parse the THL found, if any
- Generate the dsctl command and display

Table 9.53. tungsten_find_position Options

Option	Description
--debug, -d	Enable additional debug output.
--help, -h	Show help text
--path, -p	Specify the full path to the executable directory where the thl and trepctl commands are located.
--quiet, -q	Prevent final message from being output.
--test, -t	Test mode - do not perform the actual update on the files
--thl	Specify the full path to the thl command executable file.
--trepctl	Specify the full path to the trepctl command executable file.
--verbose, -v	Show verbose output

Below is a sample session:

```
shell> tungsten_find_position mysql-bin.000030:0000000000001981
dsctl set -reset -seqno 4 -epoch 2 -event-id "mysql-bin.000030:0000000000001981;-1" -source-id "db1"
```

9.27. The tungsten_find_seqno Command

The tungsten_find_seqno command was added in versions 5.4.0 and 6.1.0 From v7.0.3, the command is a wrapper for tpm find-seqno

The tungsten_find_seqno assists with locating event information in the THL and producing a dsctl set command as output.

The tungsten_find_seqno command performs the following steps:

- Get the Replicator sequence number to search for from the CLI and validate
- Validate paths and commands
- Load all available service names and validate any specified service against that list
- Check if this Replicator is in the Primary role
- Locate the supplied seqno in the available THL
- Parse the THL found, if any
- Generate the dsctl command and display

Table 9.54. tungsten_find_seqno Options

Option	Description
`--debug`, `-d`	Enable additional debug output.
`--help`, `-h`	Show help text
`--path`, `-p`	Specify the full path to the executable directory where the thl and trepctl commands are located.
`--quiet`, `-q`	Prevent final message from being output.
`--test`, `-t`	Test mode - do not perform the actual update on the files
`--thl`	Specify the full path to the thl command executable file.
`--trepctl`	Specify the full path to the trepctl command executable file.
`--verbose`, `-v`	Show verbose output

Below is a sample session:

```
shell> tungsten_find_seqno 4
dsctl set -reset -seqno 4 -epoch 2 -event-id "mysql-bin.000030:0000000000001981;-1" -source-id "db1"
```

9.28. The tungsten_get_mysql_datadir Script

The tungsten_get_mysql_datadir command will gather and display actual running values for the data directory (datadir) checked against multiple sources (running mysql value, mysqld default value and the tungsten configuration) and then resolve any sym-links to the physical destination.

```
tungsten_get_mysql_datadir
```

Where:

The sudo command is used along with the which command to located the `mysqld` executable so as to gather the defaults.

9.29. The tungsten_get_status Script

The tungsten_get_status command will display datasources and replicators for all nodes in all services, along with seqno and latency values.

> **Note**
>
> This script will only gather information for Standalone, Composite Active/Active or Composite Active/Passive clusters

9.30. The tungsten_get_ports Script

The tungsten_get_ports command will display the running Tungsten processes and the associated TCP ports that those processes are listening on.

Example:

```
shell> tungsten_get_ports
REPLICATOR[3678] 2112 THL
REPLICATOR[3678] 8091 Prometheus
REPLICATOR[3678] 8097 REST API
REPLICATOR[3678] 10000 RMI/JMX
REPLICATOR[3678] 10001 RMI/JMX
```

```
REPLICATOR[3678] 32000 Wrapper Liveness Checks
REPLICATOR[3678] 42679 INTERNAL RMI
MANAGER[4117] 7800 Group Communications
MANAGER[4117] 8090 REST API
MANAGER[4117] 8092 Prometheus
MANAGER[4117] 9997 RMI/JMX
MANAGER[4117] 11999 Router Gateway Port for Connector
MANAGER[4117] 12000 RMI/JMX
MANAGER[4117] 32001 Wrapper Liveness Checks
MANAGER[4117] 42957 INTERNAL RMI
MANAGER[4117] 46131 INTERNAL RMI
CONNECTOR[4551] 3100 RMI/JMX
CONNECTOR[4551] 3101 RMI/JMX
CONNECTOR[4551] 3306 MySQL R/W
CONNECTOR[4551] 3307 MySQL R/O
CONNECTOR[4551] 8093 Prometheus
CONNECTOR[4551] 8096 REST API
CONNECTOR[4551] 32002 Wrapper Liveness Checks
```

9.31. The tungsten_health_check Script

The tungsten_health_check may be used less frequently than Section 9.33, "The tungsten_monitor Script" to check the cluster against known best practices. It implements the Tungsten Script Interface as well as these additional options.

tungsten_health_check [--dataservices] [--diagnostic-package] [--directory] [--email] [--force] [--from] [--help, -h] [--ignore] [--info, -i] [--json] [--lock-dir] [--lock-timeout] [--mail] [--net-ssh-option=key=value] [--notice, -n] [--show-differences] [--subject] [--test-failover] [--test-recover] [--test-switch] [--validate] [--verbose, -v]

Where:

Table 9.55. tungsten_health_check Command-line Options

Option	Description
--dataservices	This list of dataservices to monitoring to
--diagnostic-package	Create a diagnostic package if any issues are found
--directory	The $CONTINUENT_ROOT directory to use for running this command. It will default to the directory you use to run the script.
--email	Email address to send to when mailing any notifications
--force	Continue operation even if script validation fails
--from	The from address for sending messages
--help, -h	Show help text
--ignore	Ignore notices that use this key
--info, -i	Display info, notice, warning, and error messages
--json	Output all messages and the return code as a JSON object
--lock-dir	Directory to store log and lock files in
--lock-timeout	The number of minutes to sleep a notice after sending it
--mail	Path to the mail program to use for sending messages
--net-ssh-option=key=value	Provide custom SSH options to use for SSH communication to other hosts.
--notice, -n	Display notice, warning, and error messages
--show-differences	Show any differences in Tungsten configuration
--subject	Email subject line
--test-failover	Test failover for each managed dataservice
--test-recover	Test recover for each managed dataservice
--test-switch	Test the switch command for each managed dataservice
--validate	Only run script validation
--verbose, -v	Verbose

Each time the tungsten_health_check runs, it will run a standard set of checks. Additional checks may be turned on using command line options.

- Check for errors using tpm validate
- Check that all servers in the dataservice are running the same version of Continuent Tungsten

The script can be run manually:

```
shell> tungsten_health_check
```

All messages will be sent to `/opt/continuent/share/tungsten_health_check/lastrun.log`.

Sending results via email

The tungsten_health_check is able to send you an email when problems are found. It is suggested that you run the script as root so it is able to use the mail program without warnings.

Alerts are cached to prevent them from being sent multiple times and flooding your inbox. You may pass `--reset` to clear out the cache or `--lock-timeout` to adjust the amount of time this cache is kept. The default is 3 hours.

```
shell> tungsten_health_check --from=you@yourcompany.com --to=group@yourcompany.com
```

Showing manual configuration file changes

The tpm validate command will fail if you have manually changed a configuration file. The file differences may be added if you include the `--show-differences` argument.

Testing Continuent Tungsten functionality

Continuent Tungsten includes a testing infrastructure that you can use at any time. By adding the `--test-switch`, `--test-failover` or `--test-recover` arguments to the command, we will test these operations on each database server.

> **Caution**
>
> This will have an impact on dataservice availability. Limit this operation to maintenance windows or times when you can experience managed outages.

Compatibility

The script only works with MySQL at this time.

9.32. The tungsten_merge_logs Script

The tungsten_merge_logs command is designed to aid troubleshooting by consolidating the various log files into one place ordered by time.

```
tungsten_merge_logs
```

Where:

With no options specified, the tungsten_merge_logs script will gather all log files in the current directory and below.

For example:

```
shell> cd
shell> tpm diag --all
shell> tar xvzf ungsten-diag-2021-11-15-16-37-33.tgz
shell> cd tungsten-diag-2021-11-15-16-37-33
shell> tungsten_merge_logs
```

Would result in something like the following:

```
New merged log file ./merged.log created!
```

All logs files are gathered by default.

If you specify any of `--connector`, `--replicator` or `--manager`, then only the log files for the specifed components will be gathered.

Using multiple options will aggregate the logs from the specified components.

Use of the `--log-limit` option works as follows:

- a loglimit of 1 means gather the base file only, i.e. trepsvc.log
- a loglimit of 2 means gather the base file and the first backup file, i.e. trepsvc.log and trepsvc.log.1

- a loglimit of 3 means gather the base file and the first two backup files, i.e. trepsvc.log, trepsvc.log.1 and trepsvc.log.2

The {TIMESTAMP} must be specified as a single argument wrapped in quotes, in the format of 'yyyy/mm/dd hh:mm:ss', including a single space between the date and time. Hours are in 24-hour time, and all values should be left-padded with zeros. For example:

```
shell> tungsten_merge_logs --before '2021/09/27 21:58:02'
```

9.33. The tungsten_monitor Script

The tungsten_monitor script provides a mechanism for monitoring the cluster state when monitoring tools like Nagios aren't available. It implements the Tungsten Script Interface as well as these additional options.

tungsten_monitor [--check-log] [--connector-timeout] [--dataservices] [--diagnostic-package] [--directory] [--disk] [--elb-script] [--email] [--force] [--help, -h] [--ignore] [--info, -i] [--json] [--latency] [--lock-dir] [--lock-timeout] [--mail] [--max-backup-age] [--net-ssh-option] [--notice, -n] [--reset] [--subject] [--validate] [--verbose, -v]

Where:

Table 9.56. tungsten_monitor Command-line Options

Option	Description
--check-log	Email any lines in the log file that match the egrep expression. --check-log=tungsten-manager/log/tmsvc.log:OFFLINE
--connector-timeout	Number of seconds to wait for a connector response
--dataservices	This list of dataservices to monitoring to
--diagnostic-package	Create a diagnostic package if any issues are found
--directory	The $CONTINUENT_ROOT directory to use for running this command. It will default to the directory you use to run the script.
--disk	Display a warning if any disk usage is above this percentage
--elb-script	The xinetd script name that is responding to ELB liveness checks
--email	Email address to send to when mailing any notifications
--force	Continue operation even if script validation fails
--help, -h	Show help text
--ignore	Ignore notices that use this key
--info, -i	Display info, notice, warning, and error messages
--json	Output all messages and the return code as a JSON object
--latency	The maximum allowed latency for replicators
--lock-dir	Directory to store log and lock files in
--lock-timeout	The number of minutes to sleep a notice after sending it
--mail	Path to the mail program to use for sending messages
--max-backup-age	Maximum age in seconds of valid backups
--net-ssh-option	Provide custom SSH options to use for communication to other hosts.
--notice, -n	Display notice, warning, and error messages
--reset	Remove all entries from the lock directory
--subject	Email subject line
--validate	Only run script validation
--verbose, -v	Verbose

General Operation

Each time the tungsten_monitor runs, it will run a standard set of checks. The set of checks will be determined automatically based on the current node configuration (for example, connector-timeout check will only run if the node has a connector installed). Additional checks may be turned on using command line options.

- Check that all Tungsten services for this host are running

- Check that all replication services and datasources are ONLINE
- Check that replication latency does not exceed a specified amount
- Check that the local connector is responsive
- Check disk usage

An example of adding it to crontab:

```
shell> crontab -l
10 * * * * /opt/continuent/tungsten/cluster-home/bin/tungsten_monitor >/dev/null 2>/dev/null
```

All messages will be sent to `/opt/continuent/share/tungsten_monitor/lastrun.log`.

Note that when all tungsten_monitor checks pass, the script will not print anything to the standard output.

Sending results via email

The tungsten_monitor is able to send you an email when problems are found. It is suggested that you run the script as root so it is able to use the mail program without warnings.

Alerts are cached to prevent them from being sent multiple times and flooding your inbox. You may pass `--reset` to clear out the cache or `--lock-timeout` to adjust the amount of time this cache is kept. The default is 3 hours.

```
shell> crontab -l
10 * * * * /opt/continuent/tungsten/cluster-home/bin/tungsten_monitor --from=you@yourcompany.com \
    --to=group@yourcompany.com >/dev/null 2>/dev/null
```

Monitoring log files

The tungsten_monitor can optionally monitor log files for certain keywords. This example will alert you to any lines in `trepsvc.log` that include OFFLINE.

shell> **`tungsten_monitor`** --check-log=tungsten-replicator/log/trepsvc.log:OFFLINE

Monitoring backup status

Knowing you have a recent backup is an important part any Tungsten deployment. The tungsten_monitor will look for the latest backup across all datasources and compare it to the value `--max-backup-age`. This example will let you know if a valid backup has not been taken in 3 days.

```
shell> tungsten_monitor --max-backup-age=259200
```

Compatibility

The script only works with MySQL at this time.

9.34. The tungsten_mysql_ssl_setup Script

> **Note**
>
> This script was introduced in version 7.1.1.

The tungsten_mysql_ssl_setup command is a utility script that acts as a direct replacement for the mysql_ssl_rsa_setup command which is not included with either Percona Server or MariaDB. This command will be called by tpm cert gen mysqlcerts instead of mysql_ssl_rsa_setup.

9.35. The tungsten_newrelic_event Command

The tungsten_newrelic_event script utilises existing tunsten monitor scripts and inserts the results into New Relic.

By default all of the following Nagios check scripts under `$CONTINUENT_ROOT/tungsten/cluster-home/bin` are executed and the results of each are inserted into NewRelic as the associated EventType.

Executable	EventType
check_tungsten_latency	CheckTungstenLatency
check_tungsten_online	CheckTungstenOnline
check_tungsten_policy	CheckTungstenPolicy

Executable	EventType
check_tungsten_progress	CheckTungstenProgress
check_tungsten_services -r -c	CheckTungstenServices
check_tungsten_services -r	CheckTungstenNode
check_tungsten_services -c	CheckTungstenConnector

If you specify a check to execute by using one or more cli args, then only those checks specified will be run.

curl must be installed and available on the PATH.

You must provide your New Relic Account ID and your New Relic Insights API Insert Key for the script to function.

You may obtain the API Insert Key at https://insights.newrelic.com/accounts/{New Relic Account ID}/manage/api_keys

```
tungsten_monitor
```

Where:

Usage

```
shell> tungsten_newrelic_event --account {New Relic Account ID} --key {New Relic Insights API Insert Key} [args]
```

9.36. The tungsten_nagios_backups Command

9.37. The tungsten_nagios_online Command

9.38. The tungsten_post_process Command

The tungsten_post_process command assists with the graceful maintenance of the static cross-site replicator configuration files on disk.

The tungsten_post_process command performs the following steps:

- Locates, reads and parses the various INI configuration files.

  Below is the list of possible INI files and file match patterns:

  - `{$HOME}/tungsten.ini`
  - `/etc/tungsten/tungsten*.ini`

    Note

    Please note that all files in the `/etc/tungsten` directory starting with `tungsten` and ending in `.ini` will be used.
  - `/etc/tungsten.ini`
- Identifies cross-site services that are local to the node, as well as the main local service.

  Warning

  Only Replicator options and properties for specific entry types are currently supported.

  The supported stanzas are as follows:

  - `{service}.replicator`
  - `{service}_from_{service}`

  Below is an example INI file showing section identifiers only:

```
[defaults]
[defaults.replicator]
[east]
[east.replicator]
[west]
[east_from_west]
```

```
[west_from_east]
```

Of the above example section identifiers, only the following would be used by tungsten_post_process:

- `east.replicator`
- `east_from_west`
- `west_from_east`

The remaining example section identifiers (`defaults`, `defaults.replicator`, `east` and `west`) would be ignored.

- Gathers configuration options and properties defined for each identified local service.
- Locates the associated configuration file on disk and gets the existing value for the option key.
- Interactively prompts for confirmation. This may be bypassed using the `-y` option to tungsten_post_process.
- Filter out any files that are not static replicator configurations.
- The tungsten_post_process command will then do one edit-in-place per ini option per local service.
- The script will check to make sure the value has been updated.
- Finally, there will be a summary message and helpful instructions about next steps. This may be bypassed using the `-q` option to tungsten_post_process.

Table 9.57. tungsten_post_process Options

Option	Description
`--debug`, `-d`	Enable additional debug output.
`--help`, `-h`	Show help text
`--quiet`, `-q`	Prevent final message from being output.
`--test`, `-t`	Test mode - do not perform the actual update on the files
`--verbose`, `-v`	Show verbose output
`--yes`, `-y`	Bypass interactive confirmation prompt

Below is a sample session:

```
shell> tungsten_post_process
About to update the following config file(s):

/opt/continuent/tungsten/tungsten-replicator/conf/static-east_from_north.properties
/opt/continuent/tungsten/tungsten-replicator/conf/static-east_from_west.properties

Do you wish to continue? [y/N] y

Done!

tungsten_post_process updated 0 configuration options successfully and skipped 6

Pick one node and set Maintenance mode so the manager does not try to bring the replicator online when you don't want it to:

  echo "set policy maintenance" | cctrl

Then take the Replicator offline gracefully on one node:

  trepctl -all-services offline

Restart the Replicator:

  replicator restart

Bring all services online:

  trepctl -all-services online

Check the status:

  trepctl services

Repeat as needed.

When all nodes are done, pick one node and execute:
```

```
echo "set policy automatic" | cctrl
```

> **Note**
>
> From release 6.1.6 onwards, the tungsten_post_process will be automatically called by tpm during `update` and `install` [450] to ensure any cross-site specific configuration is applied at the correct time

9.39. The tungsten_provision_thl Command

The tungsten_provision_thl command can be used to generate the THL required to provision a database with information from a MySQL Primary to a Replica. Because of the way the tool works, the tool is most useful in heterogeneous deployments where the data must be formatted and processed by the replicator for effective loading into the target database.

The tool operates as follows:

1. A mysqldump of the current database is taken from the current Primary.
2. The generated SQL from mysqldump is then modified so that the data is loaded into tables using the `BLACKHOLE` engine type. These statements still generate information within the MySQL binary log, but do not create any data.
3. A sandbox MySQL server is started, using the MySQL Sandbox tool.
4. A duplicate replicator is started, pointing to the sandbox MySQL instance, but sharing the same THL port and THL directory.
5. The modified SQL from mysqldump is loaded, generating events in the binary log which are extracted by the sandbox replicator.

Because the sandbox replicator works on the same THL port as the standard Primary replicator, the Replicas will read the THL from the sandbox replicator. Also, because it uses the same THL directory, the THL will be written into additional THL files. It doesn't matter whether there are existing THL data files, the new THL will be appended into files in the same directory.

The tool has the following pre-requisites, in addition to the main Appendix B, *Prerequisites* for Tungsten Replicator:

- A tarball of the Tungsten Replicator must be available so that the duplicate replicator can be created. The full path to the file should be used.
- The MySQL Sandbox tool must have been installed. For more information, see MySQL Sandbox.

  Installing MySQL Sandbox requires the `ExtUtils::MakeMaker` and `Test::Simple` Perl modules. You may install these through CPAN or a package manager:

  ```
  shell> yum install -y perl-ExtUtils-MakeMaker perl-Test-Simple
  ```

  After those packages are available, you can proceed with building MySQL Sandbox and installing it. If you do not have sudo access, make sure that `~/MySQL-Sandbox-3.0.44/bin` is added to `$PATH`

  ```
  shell> cd ~
  shell> wget https://launchpad.net/mysql-sandbox/mysql-sandbox-3/mysql-sandbox-3/+download/MySQL-Sandbox-3.0.44.tar.gz
  shell> tar -xzf MySQL-Sandbox-3.0.44.tar.gz
  shell> cd MySQL-Sandbox-3.0.44
  shell> perl Makefile.PL
  shell> make
  shell> make test
  shell> sudo make install
  ```

- A tarball of a MySQL release must be available to create the sandbox MySQL environment. The release should match the installed version of MySQL. The full path to the file should be used.
- The replicator deployment should already be installed. The Primary should be `OFFLINE`, but the command can place the replicator offline automatically as part of the provisioning process.

Once these prerequisites have been met, the basic method of executing the command is to specify the location of the Tungsten Replicator tarball, MySQL tarball and the databases that you want to provision:

```
shell> tungsten_provision_thl \
      --tungsten-replicator-package=/home/tungsten/tungsten-clustering-5.4.1-41.tar.gz \
      --mysql-package=/home/tungsten/mysql-5.6.20-linux-glibc2.5-x86_64.tar.gz \
      --schemas=test
NOTE >>The THL has been provisioned to mysql-bin.000025:493 on host1:3306
```

The command reports the MySQL binary log point and host on which the THL has been provisioned. Put the Tungsten Replicator back online from the reported position:

```
shell> trepctl online -from-event 000025:493
```

The Tungsten Replicator will start extracting from that position and continue with any additional changes. Check all Replicas to be sure they are online. The Replicas services will process all extracted entries.

9.39.1. Provisioning from RDS

The tungsten_provision_thl script is designed to run from a replication Primary connected to a standard MySQL instance. The standard commands will not work if you are using RDS as a Primary.

The simplest method is to add the `--extract-from` [372] argument to your command. This will make the script compatible with RDS. The drawback is that we are not able to guarantee a consistent provisioning snapshot in RDS unless changes to the database are stopped. The script will monitor the binary log position during the provisioning process and alert you if there are changes. After the script completes, run trepctl online to resume extraction from the Primary at the current binary log position.

```
shell> tungsten_provision_thl \
      --extract-from=rds \
      --tungsten-replicator-package=/home/tungsten/tungsten-clustering-5.4.1-41.tar.gz \
      --mysql-package=/home/tungsten/mysql-5.6.20-linux-glibc2.5-x86_64.tar.gz \
      --schemas=test
```

If you aren't able to stop access to the database, the script can provision from an RDS Read Replica. Before running tungsten_provision_thl, replication to the replica must be stopped. This may be done by running CALL mysql.rds_stop_replication; in an RDS shell. Call tungsten_provision_thl with the `--extract-from` [372] and `--extract-from-host` [373] arguments. The script will read the correct Primary position based on the Replica replication position. After completion, resume extraction from the Primary using the standard procedure.

```
# Run `CALL mysql.rds_stop_replication();` on the RDS Read Replica
shell> tungsten_provision_thl \
      --extract-from=rds-read-replica \
      --extract-from-host=rds-host2 \
      --tungsten-replicator-package=/home/tungsten/tungsten-clustering-5.4.1-41.tar.gz \
      --mysql-package=/home/tungsten/mysql-5.6.20-linux-glibc2.5-x86_64.tar.gz \
      --schemas=test
NOTE >>The THL has been provisioned to mysql-bin.000025:493 on rds-host1:3306
# Run `CALL mysql.rds_start_replication();` on the RDS Read Replica
```

9.39.2. tungsten_provision_thl Reference

The format of the command is:

`tungsten_provision_thl` [`--cleanup-on-failure`] [`--clear-logs`] [`--directory`] [`--extract-from` mysql-native-slave | `rds` | `rds-read-replica` | `tungsten-slave`] [`--extract-from-host`] [`--extract-from-port`] [`--help`, `-h`] [`--info`, `-i`] [`--java-file-encoding`] [`--json`] [`--mysql-package`] [`--net-ssh-option`] [`--notice`, `-n`] [`--offline`] [`--online`] [`--quiet`, `-q`] [`--sandbox-directory`] [`--sandbox-mysql-port`] [`--sandbox-password`] [`--sandbox-rmi-port`] [`--sandbox-user`] [`--schemas`] [`--service`] [`--tungsten-replicator-package`] [`--validate`] [`--verbose`, `-v`]

Where:

- `--cleanup-on-failure` [372]

Option	`--cleanup-on-failure` [372]
Description	Cleanup the sandbox installations when the provision process fails
Value Type	boolean
Default	false

- `--clear-logs` [372]

Option	`--clear-logs` [372]
Description	Delete all THL and relay logs for the service
Value Type	boolean
Default	false

- `--directory` [372]

Option	`--directory` [372]
Description	Use this installed Tungsten directory as the base for all operations
Value Type	string

- `--extract-from` [372]

Option	--extract-from [372]	
Description	The type of server you are going to extract from	
Value Type	string	
Valid Values	mysql-native-slave	A MySQL native Replica with binary logging enabled
	rds	An Amazon RDS instance
	rds-read-replica	An Amazon RDS read replica instance
	tungsten-slave	An instance with Tungsten Cluster already installed with generated THL

– --extract-from-host [373]

Option	--extract-from-host [373]
Description	The hostname of a different MySQL server that will be used as the source for mysqldump
Value Type	string

The hostname of a different MySQL server that will be used as the source for mysqldump. When given, the script will use SHOW SLAVE STATUS to determine the binary log position on the Primary server. You must run STOP SLAVE prior to executing tungsten_provision_thl.

– --extract-from-port [373]

Option	--extract-from-port [373]
Description	The listening port of a different MySQL server that will be used as the source for mysqldump
Value Type	numeric

– --help [373]

Option	--help [373]
Aliases	-h [373]
Description	Display the help message
Value Type	string

– --info [373]

Option	--info [373]
Aliases	-i [373]
Description	Provide information-level messages
Value Type	string

– --java-file-encoding [373]

Option	--java-file-encoding [373]
Description	Java platform charset
Value Type	string

– --json [373]

Option	--json [373]
Description	Provide return code and logging messages as a JSON object after the script finishes
Value Type	string

– --mysql-package [373]

Option	--mysql-package [373]
Description	The location of a the MySQL tar.gz package
Value Type	string

– `--net-ssh-option` [374]

Option	`--net-ssh-option` [374]
Description	Sets additional options for SSH usage by the system, such as port numbers and passwords.
Value Type	string
Default	default

Sets options for the `Net::SSH` Ruby module. This allows you to set explicit SSH options, such as changing the default network communication port, password, or other information. For example, using `--net-ssh-option=port=80` [374] will use port 80 for SSH communication in place of the default port 22.

For more information on the options, see http://net-ssh.github.com/ssh/v2/api/classes/Net/SSH.html#M000002.

– `--notice` [374]

Option	`--notice` [374]
Aliases	`-n` [374]
Description	Provide notice-level messages
Value Type	string

– `--offline` [374]

Option	`--offline` [374]
Description	Put required replication services offline before processing
Value Type	boolean
Default	false

– `--online` [374]

Option	`--online` [374]
Description	Put required replication services online after successful processing
Value Type	boolean
Default	false

– `--quiet` [374]

Option	`--quiet` [374]
Aliases	`-q` [374]
Description	Execute with the minimum of output
Value Type	string

– `--sandbox-directory` [374]

Option	`--sandbox-directory` [374]
Description	The location to use for storing the temporary replicator and MySQL server
Value Type	string

– `--sandbox-mysql-port` [374]

Option	`--sandbox-mysql-port` [374]
Description	The listening port for the MySQL Sandbox
Value Type	string
Default	3307

– `--sandbox-password` [374]

Option	`--sandbox-password` [374]

Description	The password for the MySQL sandbox user
Value Type	string
Default	secret

- `--sandbox-rmi-port` [375]

Option	`--sandbox-rmi-port` [375]
Description	The listening port for the temporary Tungsten Replicator
Value Type	string
Default	10002

- `--sandbox-user` [375]

Option	`--sandbox-user` [375]
Description	The MySQL user to create and use in the MySQL Sandbox
Value Type	string
Default	tungsten

- `--schemas` [375]

Option	`--schemas` [375]
Description	The provision process will be limited to these schemas
Value Type	string

- `--service` [375]

Option	`--service` [375]
Description	Replication service to read information from
Value Type	string
Default	alpha

- `--tungsten-replicator-package` [375]

Option	`--tungsten-replicator-package` [375]
Description	The location of a fresh Tungsten Replicator tar.gz package
Value Type	string

- `--validate` [375]

Option	`--validate` [375]
Description	Run the script validation for the provided options and files
Value Type	boolean
Default	false

- `--verbose` [375]

Option	`--verbose` [375]
Aliases	`-v` [375]
Description	Provide verbose-level error messages
Value Type	string

9.40. The tungsten_provision_slave Script

The tungsten_provision_slave script allows you to easily provision, or reprovision, a database server using information from a remote host. It implements the Tungsten Script Interface as well as these additional options.

tungsten_provision_slave [--clear-logs] [--direct] [--directory] [-f, --force] [--help, -h] [--info, -i] [--json] [--mysqldump] [--net-ssh-option] [--notice, -n] [--offline] [--offline-timeout] [--online] [--service] [--source] [--source-directory] [--validate] [--verbose, -v] [--xtrabackup]

Where:

Table 9.58. tungsten_provision_slave Command-line Options

Option	Description
--clear-logs	Delete all THL and relay logs for the service
--direct	Use the MySQL data directory for staging and preparation
--directory	The $CONTINUENT_ROOT directory to use for running this command. It will default to the directory you use to run the script.
--force, -f	Continue operation even if script validation fails
--help, -h	Show help text
--info, -i	Display info, notice, warning, and error messages
--json	Output all messages and the return code as a JSON object
--mysqldump	Use mysqldump for generating the information
--net-ssh-option	Provide custom SSH options to use for SSH communication to other hosts.
--notice, -n	Display notice, warning, and error messages
--offline	Put required replication services offline before processing
--offline-timeout	Put required replication services offline before processing
--online	Put required replication services online after successful processing
--service	Replication service to read information from
--source	Server to use as a source for the backup
--source-directory	Directory on --source to find installed software
--validate	Only run script validation
--verbose, -v	Show verbose information during processing
--xtrabackup	Use xtrabackup for generating the information

Important

It is recommend to run this script in a utility such as screen in case the terminal gets disconnected.

The script will automatically put all replication services offline prior to beginning. If the services were online, the script will put them back online following a successful completion. All THL logs will be cleared prior to going online. The replicator will start replication from the position reflected on the source host.

Provisioning will fail from a Replica that is stopped, or if the Replica is not in either the ONLINE or OFFLINE:NORMAL state. This can be overridden by using the -f or --force options.

When provisioning Primaries, for example in fan-in or Composite Active/Active topologies, or when recovering a failed Primary in a standard Primary-Replica topology, the service must be reset with the trepctl reset after the command is finished. The service must also be reset on all Replicas.

For more information on Fan-In topolgies, see Deploying a Fan-In Topology

The --service argument is used to determine which database server should be provisioned. If there are multiple services defined in the replicator and one of those is a Primary, the Primary service must be specified.

If the installation directory on --source is different from the target, specify --source-directory to specify where it can be found. This option should point to an installation that is running the --service replication service. The --source-directory option is not required if the software is installed to the same directory on both servers.

Using xtrabackup

The script will use Xtrabackup by default. It will run validation prior to starting to make sure the needed scripts are available. The provision process will run Xtrabackup on the source server and stream the contents to the server you are provisioning. Passing the --direct option will empty the MySQL data directory prior to doing the backup and place the streaming backup there. After taking the backup, the script will prepare the directory and restart the MySQL server.

Using mysqldump

If you have a small dataset or don't have Xtrabackup, you may pass the `--mysqldump` option to use it. It implements the Tungsten Script Interface as well as these additional options.

Compatibility

The script only works with MySQL at this time.

9.41. The tungsten_reset_manager Command

The tungsten_reset_manager command was added in versions 5.3.7 and 6.0.5

The tungsten_reset_manager assists with the graceful reset of the `manager`'s dynamic state files on disk.

- The tungsten_reset_manager command stops the manager and then deletes the manager's dynamic state files.
- For a proper service-wide reset to work, this command needs to be run on every node within the local cluster to ensure all managers have been stopped at the same time. This prevents any manager from storing an old state in memory.
- The dynamic state files are automatically rebuilt when the manager is started.
- The `{TUNGSTEN_HOME}/tungsten/cluster-home/conf/cluster/{SERVICE_NAME}/datasource/` directory needs to be emptied, for example, given a service name of `alpha` and a TUNGSTEN_HOME of `/opt/continuent`, the full path would be `/opt/continuent/tungsten/cluster-home/conf/cluster/alpha/datasource/`.
- The tungsten_reset_manager command requires the cluster to be in MAINTENANCE mode first.

```
shell> tungsten_reset_manager
Policy is not MAINTENANCE.

Please select one node only and execute `echo "set policy maintenance" | cctrl`

If you are sure the policy is maintenance you may proceed by using -f or --force
```

- By default, the command expects the manager to be running so the policy may be checked. If you are sure the policy is maintenance you may proceed by using ether the `-f` or `--force` flags.

Table 9.59. tungsten_reset_manager Options

Option	Description
`--debug`, `-d`	Enable additional debug output.
`--force`, `-f`	Bypass manager and policy checks
`--help`, `-h`	Show help text
`--verbose`, `-v`	Show verbose output
`--yes`, `-y`	Bypass interactive confirmation prompt

Below is a sample session.

First, set policy to maintenance on a single node only:

```
shell> echo "set policy maintenance" | cctrl
Tungsten Clustering 6.0.4 build 27
north: session established, encryption=false, authentication=false
[LOGICAL] /alpha > set policy maintenance
policy mode is now MAINTENANCE
[LOGICAL] /alpha >
Exiting...
```

Warning

Enable maintenance mode on a single host only.

On all nodes in the local cluster, execute the tungsten_reset_manager command:

```
shell> tungsten_reset_manager
About to stop the manager and empty directory:
   /opt/continuent/tungsten/cluster-home/conf/cluster/north/datasource

Do you wish to continue? [y/N] y
```

```
Stopping Tungsten Manager Service...
Stopped Tungsten Manager Service.
Manager directory /opt/continuent/tungsten/cluster-home/conf/cluster/north/datasource cleared.

Done!

Make sure all nodes have been cleared first, then execute `manager start` on each node one-by-one, starting with the Primary.

When all managers are running, pick one node and execute `echo "set policy automatic" | cctrl`
```

Once the tungsten_reset_manager command has completed successfully on all nodes in the local cluster, execute the manager start command on all nodes:

```
shell> manager start
Starting Tungsten Manager Service...
Waiting for Tungsten Manager Service.........
running: PID:3562
```

Once the `manager` has started successfully on all nodes in the local cluster, set policy to automatic on a single node only:

```
shell> echo "set policy automatic" | cctrl
Tungsten Clustering 6.0.4 build 27
north: session established, encryption=false, authentication=false
[LOGICAL] /alpha > set policy automatic
policy mode is now AUTOMATIC
[LOGICAL] /alpha >
Exiting...
```

Warning

Enable automatic mode on a single host only.

At this point, the manager state should be completely back to normal. Check it using the cctrl> `ls` command.

9.42. The tungsten_send_diag Script

The tungsten_send_diag command is a utility script which assists in the upload of files to Continuent support.

tungsten_send_diag may be used in place of the Section 10.5.4, "tpm diag Command" to generate a diagnostic package.

`tungsten_send_diag` [`--case`, `-c`] [`--contentType`] [`--debug`] [`--diag`, `-d`] [`--email`, `-e`] [`--file`, `-f`] [`--help`, `-h`] [`--tpm`, `-t`] [`--verbose`, `-v`]

Where:

Table 9.60. tungsten_send_diag Command-line Options

Option	Description
`--case`, `-c`	Specify the support case number
`--contentType`	Specify the Content-Type for a file you are uploading
`--debug`	Debug mode is VERY chatty, avoid it unless you really need it.
`--diag`, `-d`	Automatically generate a tpm diag zip file and upload it
`--email`, `-e`	Email address to embed into the uploaded file name
`--file`, `-f`	File name to upload
`--help`, `-h`	Show help text
`--tpm`, `-t`	Full path to the tpm command you wish to use to execute a tpm diag
`--verbose`, `-v`	Show verbose output

You must specify either `--diag`, `--tpm`, or `--file`, but not both. For example:

```
shell> tungsten_send_diag --diag -c 1234
```

To have tpm diag gather all nodes, add the `--args '--all'`, for example:

```
shell> tungsten_send_diag --diag -c 1234 --args '--all'
```

You must specify either `--email` or `--case`, and you may provide both if you wish. For example:

```
shell> tungsten_send_diag -f example.zip -e you@yourdomain.com -c 1234
```

Using `--tpm` to specify one or more tpm commands implies the `--diag` option, you do not need to specify `--diag` if you use `--tpm` (or `-t`). For example:

```
shell> tungsten_send_diag -c 1234 -t /opt/replicator/tungsten/tools/tpm
```

You may generate multiple diags by specifying multiple tpm binaries with multiple arguments, i.e.:

```
shell> tungsten_send_diag -c 1234 -t /opt/continuent/tungsten/tools/tpm -t /opt/replicator/tungsten/tools/tpm
```

9.43. The tungsten_set_position Script

The tungsten_set_position updates the `trep_commit_seqno` table to reflect the given THL sequence number or provided information. It implements the Tungsten Script Interface as well as these additional options.

`tungsten_set_position` [`--clear-logs`] [`--epoch`] [`--event-id`] [`--high`] [`--low`] [`--offline`] [`--offline-timeout`] [`--online`] [`--replicate-statements`] [`--seqno`] [`--service`] [`--source`] [`--source-directory`] [`--source-id`] [`--sql`]

Where:

Table 9.61. tungsten_set_position Command-line Options

Option	Description
`--clear-logs`	Delete all THL and relay logs for the service
`--epoch`	The epoch number to use for updating the trep_commit_seqno table
`--event-id`	The event id to use for updating the trep_commit_seqno table
`--high`	Display events ending with this sequence number
`--low`	Display events starting with this sequence number
`--offline`	Put required replication services offline before processing
`--offline-timeout`	Put required replication services offline before processing
`--online`	Put required replication services online after successful processing
`--replicate-statements`	Execute the events so they will be replicated if the service is a Primary
`--seqno`	The sequence number to use for updating the trep_commit_seqno table
`--service`	Replication service to read information from
`--source`	Determine metadata for the --after, --low, --high statements from this host
`--source-directory`	Directory on --source to find installed software
`--source-id`	The source id to use for updating the trep_commit_seqno table
`--sql`	Only output the SQL statements needed to update the schema

General Operation

In order to update the trep_commit_seqno table, the replication service must be offline. You may pass the `--offline` option to do that for you. The `--online` option will put the replication services back online at successful completion.

In most cases you will want to pass the `--clear-logs` argument so that all THL and relay logs are delete from the server following provisioning. This ensures that any corrupted or inconsistent THL records are removed prior to replication coming back online.

The `--service` argument is used to determine which database server should be provisioned.

If the installation directory on `--source` is different from the target, specify `--source-directory` to specify where it can be found. This option should point to an installation that is running the `--service` replication service. The `--source-directory` option is not required if the software is installed to the same directory on both servers.

This command will fail if there is more than one record in the `trep_commit_seqno` table. This may happen if parallel replication does not stop cleanly. You may bypass that error with the --force option.

Update trep_commit_seqno with information from a THL event

This will read the THL information from the host specified as `--source`.

```
shell> tungsten_set_position --seqno=5273 --source=db1
```

Update trep_commit_seqno with specific information

The script will also accept specific values to update the `trep_commit_seqno` table. This may be used when bringing a new Primary service online or when the THL event is no longer available.

```
shell> tungsten_set_position --seqno=5273 --epoch=5264
    --source-id=db1
```

```
shell> tungsten_set_position --seqno=5273 --epoch=5264
    --source-id=db1 --event-id=mysql-bin.000025:0000000000000421
```

Compatibility

The script only works with MySQL at this time.

9.44. The tungsten_show_processlist Script

The tungsten_show_processlist is a read-only script which will show the output from tungsten show processlist; on all available Connectors.

This requires the mysql command-line client and a running manager for cctrl to poll.

```
tungsten_show_processlist
```

Where:

9.45. The tungsten_skip_seqno Script

The tungsten_skip_seqno allows events to be skipped based on filters, allowing the Tungsten Replicator to come back online with less manual intervention.

```
tungsten_skip_seqno
```

Where:

General Operation

By default, the tungsten_skip_seqno command will:

- Gather a list of replicator service names using trepctl services | grep serviceName
- Start an inifinite loop
- Loop thru all services or use the service specified on the cli using the `--service` option
- Check the service status via trepctl -service {serviceName_here} status -json
- If the `pendingErrorSeqno` is not -1, then process the error state
- By default, if there is an error condition, a detailed message is displayed, and the user may skip the seqno interactively
- if the tungsten_skip_seqno command is called with `--auto` then the seqno with the error will be skipped automatically
- if the maximum number of loops has been reached (default: 100), the script will exit. Use `--max` to adjust this value
- Sleep for 3 seconds by default, then iterate

9.46. The undeployall Command

The undeployall command removes startup the startup and reboot scripts crteated by deployall, disabling automatic startup and shutdown of available services.

To use, the tool should be executed with superuser privileges, either directly using sudo, or by logging in as the superuser and running the command directly:

```
shell> sudo deployall
 Removing any system startup links for /etc/init.d/treplicator ...
   /etc/rc0.d/K80treplicator
   /etc/rc1.d/K80treplicator
   /etc/rc2.d/S80treplicator
```

```
/etc/rc3.d/S80treplicator
/etc/rc4.d/S80treplicator
/etc/rc5.d/S80treplicator
/etc/rc6.d/K80treplicator
```

To enable the scripts on the system, use deployall.

9.47. The zabbix_tungsten_latency Command

The zabbix_tungsten_latency command reports a 0 (False) or 1 (True) depending on whether the latency across the nodes in the cluster is above a specific level.

Table 9.62. zabbix_tungsten_latency Options

Option	Description
-c	Report a critical status if the latency is above this level
-w	Report a warning status if the latency is above this level

The -w and -c options must be specified on the command line, and the critical figure must be higher than the warning figure. For example:

```
shell> zabbix_tungsten_latency -w 0.1 -c 0.5
0
```

9.48. The zabbix_tungsten_online Command

The zabbix_tungsten_online command checks whether all the services for a given service and host are online and running.

Within a Tungsten Cluster service, the replicator, manager and connector services are checked. All must be online for a 0 (True) response.

Table 9.63. zabbix_tungsten_online Options

Option	Description
-h	Display the help text
-s	Specify the service you would like to check (default: all available services)

By default, the script will check all manager and replication services for the localhost

> **Note**
>
> Prior to v6.1.16, the default behavior was to check all nodes within a cluster

To also check the manager services on the other cluster nodes, use -a

You can also check the cluster-wide composite status using -c

> **Warning**
>
> Using -a or -c on multiple nodes will alert on all monitored nodes for the same offline service

The command outputs a 0 (True) or a 1 (False) status.

For example:

```
shell> zabbix_tungsten_online
0
```

If you have multiple services installed, use the -s to specify the service:

```
shell> zabbix_tungsten_online -s alpha
0
```

9.49. The zabbix_tungsten_progress Command

The zabbix_tungsten_progress command determines whether the replicator is actually making progress by executing a heartbeat operation and monitoring for this operation to complete within an optional time period (default is 1 second).

Table 9.64. zabbix_tungsten_progress Options

Option	Description
-t	Give a time period during which progress should be identified

The command outputs a 0 (True) or 1 (False) Status

The time delay can be added on busy systems to ensure that the replicator is progressing

For example, to wait 5 seconds to ensure the replicator is progressing:

```
shell> zabbix_tungsten_progress  -t 5
0
```

Optionally, specify the replication service name using the -s option. This is normally only needed for Composite Active/Active deployments where there is no single default replication service.

```
shell> zabbix_tungsten_progress -t 5 -s east_from_west
0
```

9.50. The zabbix_tungsten_services Command

The zabbix_tungsten_services command provides a simple check to confirm whether configured services are currently running. The command must be executed with a command-line option specifying which services should be checked and confirmed.

Table 9.65. check_tungsten_services Options

Option	Description
-c	Check the Connector service status.
-h	Display the help text.
-r	Check the replication services status.

The command outputs a 0 (True) or 1 (False) Status

> **Note**
>
> The zabbix_tungsten_services only confirms that the services and processes are running; their state is not confirmed. To check state with a similar interface, use the zabbix_tungsten_online command.

To check the services:

- To check the replicator services:

```
shell> zabbix_tungsten_services -r
0
```

- To check the replicator and manager services are executing:

```
shell> zabbix_tungsten_services -r
0
```

- To check the connector services:

```
shell> zabbix_tungsten_services -c
0
```

Chapter 10. The tpm Deployment Command

tpm, or the Tungsten Package Manager, is a complete configuration, installation and deployment tool for Tungsten Cluster. It includes some utility commands to simplify those and other processes. In order to provide a stable system, all configuration changes must be completed using tpm. tpm makes use of ssh enabled communication and the sudo support as required by the Appendix B, *Prerequisites*.

tpm can operate in two different ways when performing a deployment:

- tpm staging configuration — a tpm configuration is created by defining the command-line arguments that define the deployment type, structure and any additional parameters. tpm then installs all the software on all the required hosts by using ssh to distribute Tungsten Cluster and the configuration, and optionally automatically starts the services on each host. tpm manages the entire deployment, configuration and upgrade procedure.
- tpm INI configuration — tpm uses an INI file to configure the service on the local host. The INI file must be create on each host that will run Tungsten Cluster. tpm only manages the services on the local host; in a multi-host deployment, upgrades, updates, and configuration must be handled separately on each host.

For a more detailed comparison of the two systems, see Section 10.1, "Comparing Staging and INI tpm Methods".

During the staging-based configuration, installation and deployment, the tpm tool works as follows:

- tpm creates a local configuration file that contains the basic configuration information required by tpm. This configuration declares the basic parameters, such as the list of hosts, topology requirements, username and password information. These parameters describe top-level information, which tpm translates into more detailed configuration according to the topology and other settings.
- Within staging-based configuration, each host is accessed (using ssh), and various checks are performed, for example, checking database configuration, whether certain system parameters match required limits, and that the environment is suitable for running Tungsten Cluster.
- During an installation or upgrade, tpm copies the current distribution to each remote host.
- The core configuration file is then used to translate a number of template files within the configuration of each component of the system into the configuration properties files used by Tunsten. The configuration information is shared on every configured host within the service; this ensures that in the event of a host failure, the configuration can be recovered.
- The components of Tungsten Cluster are then started (installation) or restarted according to the configuration options.

Where possible, these steps are conducted in parallel to speed up the process and limit the interruption to services and operations.

This method of operation ensures:

- Active configurations and properties are not updated until validation is completed. This prevents a running installation from being affected by an incompatible or potentially dangerous change to the configuration.
- Enables changes to be made to the staging configuration before the configuration is deployed.
- Services are not stopped/restarted unnecessarily.
- During an upgrade or update, the time required to reconfigure and restart is kept to a minimum.

Because of this safe approach to performing configuration, downtime is minimized, and the configuration is always based on files that are separate from, and independent of, the live configuration.

> **Important**
>
> tpm always creates the active configuration from the combination of the template files and parameters given to tpm. This means that changes to the underlying property files within the configuration are overwritten by tpm when the service is configured or updated.

In addition to the commands that tpm supports for the installation and configuration, the command also supports a number of other utility and information modes, for example, the fetch command retrieves existing configuration information to your staging, while query returns information about an active configuration.

Using tpm is divided up between the commands that define the operation the command will perform, which are covered in Section 10.5, "tpm Commands"; configuration options, which determine the parameters that configure individual services, which are detailed in Section 10.8, "tpm Configuration Options"; and the options that alter the way tpm operates, covered in Section 10.3, "tpm Staging Configuration".

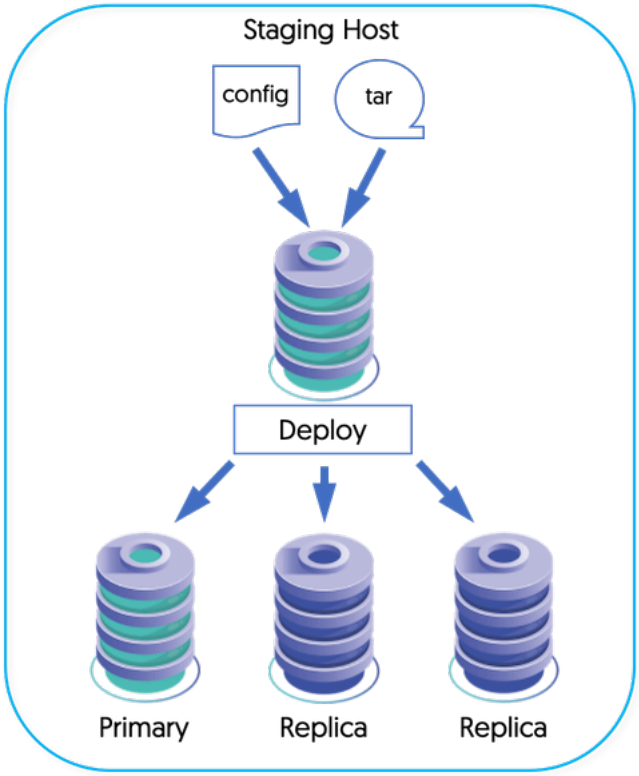
10.1. Comparing Staging and INI tpm Methods

tpm supports two different deployment methodologies. Both configure one or more Tungsten services, in a safe and secure manner, but differ in the steps and process used to complete the installation. The two methods are:

- Staging Directory

When using the staging directory method, a single configuration that defines all services and hosts within the deployment is created. tpm then communicates with all the hosts you are configuring to install and configure the different services required. This is best when you have a consistent configuration for all hosts and do not have any configuration management tools for your systems.

Figure 10.1. tpm Staging Based Deployment



- `INI` File

  When using the `INI` file method, configuration for each service must be made individually using an `INI` configuration file on each host. This is ideal for deployments where you have a configuration management system (e.g. Puppet and Chef) to manage the `INI` file. It also works very well for deployments where the configuration for each system is different from the others.

Figure 10.2. tpm INI Based Deployment

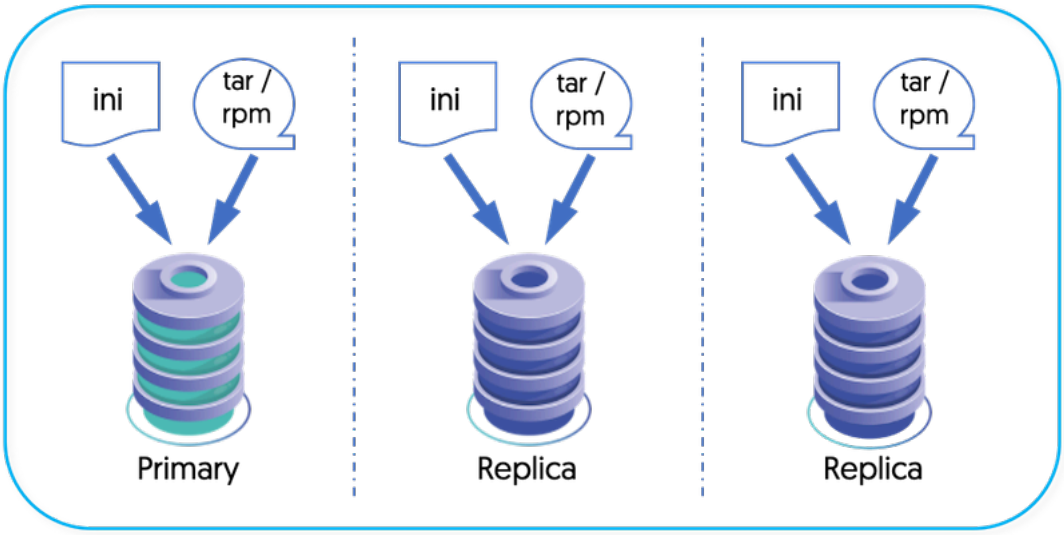


Table 10.1. TPM Deployment Methods

Feature	Staging Directory	INI File
Deploy Multiple Services	Yes	Yes
Deploy to Multiple Hosts	Yes	No
Individual Host-based Configuration	Yes	Yes
Single-Step Upgrade	Yes	No
Requires SSH Configuration	Yes	No
RPM Support	Yes	Yes

> **Note**
>
> Check the output of tpm query staging to determine which method your current installation uses. The output for an installation from a staging directory will start with `# Installed from tungsten@staging-host:/opt/continuent/software/tungsten-clustering-5.4.1-41`. An installation based on an INI file may include this line but the hostname will reference the current host and there will be an `/etc/tungsten/tungsten.ini` file present.

To install a three-node service using the staging method:

1. Extract Tungsten Cluster on your staging server.
2. On each host:
   a. Complete all the Appendix B, *Prerequisites*, including setting the ssh keys.
3. Execute the tpm configure and tpm install commands to configure and deploy the service from the staging server.

To install a three-node service using the `INI` method:

1. On each host:
   a. Extract Tungsten Cluster.
   b. Complete all the Appendix B, *Prerequisites*.
   c. Create the `INI` file containing your configuration.
   d. Execute the tpm install command to deploy the service.

When using the staging method, upgrades and updates to the configuration must be made using tpm from the staging directory. Configuration methods can be swapped from staging to `INI` only by manually recreating the `INI` file with the new configuration and running tpm update.

10.2. Processing Installs and Upgrades

The tpm command is designed to coordinate the deployment activity across all hosts in a dataservice. This is done by completing a stage on all hosts before moving on. These operations will happen on each host in parallel and tpm will wait for the results to come back before moving on.

- Copy deployment files to each server

  At this stage, only the tpm command is copied over so we can run validation checks locally on each machine.

  The configuration is also transferred to each server and checked for completeness. This will run some commands to make sure that we have all of the settings needed to run a full validation.

- Validate the configuration settings

  Each host will validate the configuration based on validation classes. This will do things like check file permissions and database credentials. If errors are found during this stage, they will be summarized and the script will exit.

```
#####################################################################
# Validation failed
#####################################################################
#####################################################################
# Errors for host3
#####################################################################
ERROR >> host3 >> Password specified for app@% does not match the running instance on »
   tungsten@host3:13306 (WITH PASSWORD). This may indicate that the user has a password »
```

```
   using the old format. (MySQLConnectorPermissionsCheck)
#####################################################################
# Errors for host2
#####################################################################
ERROR >> host2 >> Password specified for app@% does not match the running instance on »
   tungsten@host2:13306 (WITH PASSWORD). This may indicate that the user has a password »
   using the old format. (MySQLConnectorPermissionsCheck)
#####################################################################
# Errors for host1
#####################################################################
ERROR >> host1 >> Password specified for app@% does not match the running instance on »
   tungsten@host1:13306 (WITH PASSWORD). This may indicate that the user has a password »
   using the old format. (MySQLConnectorPermissionsCheck)
```

At this point you should verify the configuration settings and retry the tpm install command. Any errors found during this stage may be skipped by running tpm configure alpha --skip-validation-check=MySQLConnectorPermissionsCheck. When re-running the tpm install command this check will be bypassed.

- Deploy and write configuration files

  If validation is successful, we will move on to deploying and writing the actual configuration files. The tpm command uses a JSON file that summarizes the configuration. The Tungsten processes use many different files to store the configuration and tpm is responsible for writing them.

  The `/opt/continuent/releases` directory will start to collect multiple directories after you have run multiple upgrades. We keep the previous versions in case a downgrade is needed or for review at a later date. If your upgrade has been successful, you can remove old directories. Make sure you do not remove the directory that is linked to by the `/opt/continuent/tungsten` symlink.

  > **Note**
  >
  > Do not change configuration files by hand. This will cause future updates to fail. One of the validation checks compares the file that tpm written with the current file. If there are differences, validation will fail.
  >
  > This is done to make sure that any configuration changes made by hand are not wiped out without giving you a chance to save them. You can run tpm query modified-files to see what, if any, changes have been made.

- Start Tungsten services

  After the installation is fully configured, the tpm command will start services on all of the hosts if the tpm option `--start` [466] was set. This process is slightly different depending on if you are doing a clean install or and upgrade.

  - Install

    1. Check if `--start` [466] or `--start-and-report` [466] were provided in the configuration
    2. Start the Tungsten Replicator and Tungsten Manager on all hosts
    3. Wait for the Tungsten Manager to become responsive
    4. Start the Tungsten Connector on all hosts

  - Upgrade

    1. Put all dataservices into *`MAINTENANCE`* mode
    2. Stop the Tungsten Replicator and Tungsten Manager on all nodes
    3. Start the Tungsten Replicator and Tungsten Manager on all hosts if the services were previously running
    4. Wait for the Tungsten Manager to become responsive
    5. Stop the old Tungsten Connector and Start the new Tungsten Connector on all hosts. This step is done one host at a time so that there is always one Tungsten Connector running. If `--no-connectors` [459] was provided on the command line then this will not occur. You must go to each server running Tungsten Connector and run tpm promote-connector.

10.3. tpm Staging Configuration

Before installing your hosts, you must provide the desired configuration. This will be done with one or more calls to tpm configure as seen in Chapter 2, *Deployment*. These calls place the given parameters into a staging configuration file that will be used during installation. This is done for dataservices, composite dataservices and replication services.

Instead of a subcommand, tpm configure accepts a service name or the word `defaults` as a subcommand. This identifies what you are configuring.

When configuring defaults, the defaults affect all configured services, with individual services able to override or set their own parameters.

```
shell> tpm configure [service_name|defaults] [tpm options] [service configuration options]
```

In addition to the Section 10.8, “tpm Configuration Options”, the common options in Table 10.4, “tpm Common Options” may be given.

The tpm command will store the staging configuration in the staging directory that you run it from. This behavior is changed if you have `$CONTINUENT_PROFILES` or `$REPLICATOR_PROFILES` defined in the environment. If present, tpm will store the staging configuration in that directory. Doing this will allow you to upgrade to a new version of the software without having to run the tpm fetch command.

If you are running Tungsten Cluster, the tpm command will only use `$CONTINUENT_PROFILES`.

If you are running Tungsten Replicator, the tpm command will use `$REPLICATOR_PROFILES` if it is available, before using `$CONTINUENT_PROFILES`.

10.3.1. Configuring default options for all services

```
shell> ./tools/tpm configure defaults \
    --replication-user=tungsten \
    --replication-password=secret \
    --replication-port=13306
```

These options will apply to all services in the configuration file. This is useful when working with a composite dataservice or multiple independent services. These options may be overridden by calls to tpm configure service_name or tpm configure service_name --hosts.

10.3.2. Configuring a single service

```
shell> ./tools/tpm configure alpha \
    --master=host1 \
    --members=host1,host2,host3 \
    --home-directory=/opt/continuent \
    --user=tungsten
```

The configuration options provided following the service name will be associated with the 'alpha' dataservice. These options will override any given with tpm configure defaults.

> Relationship of `--members` [455], `--slaves` [466] and `--master` [454]
>
> Each dataservice will use some combination of these options to define the hosts it is installed on. They define the relationship of servers for each dataservice.
>
> If you specify `--master` [454] and `--slaves` [466]; `--members` [455] will be calculated as the unique join of both values.
>
> If you specify `--master` [454] and `--members` [455]; `--slaves` [466] will be calculated as the unique difference of both values.

10.3.3. Configuring a single host

```
shell> ./tools/tpm configure alpha \
    --hosts=host3 \
    --backup-method=xtrabackup-incremental
```

This will apply the `--repl-backup-method` [434] option to just the host3 server. Multiple hosts may be given as a comma-separated list. The names used in the `--members` [455], `--slaves` [466], `--master` [454], `--connectors` [440] options should be used when calling `--hosts` [450]. These values will override any given in tpm configure defaults or tpm configure alpha.

10.3.4. Reviewing the current configuration

You may run the tpm reverse command to review the list of configuration options. This will run in the staging directory and in your installation directory. It is a good idea to run this command prior to installation and upgrades to validate the current settings.

```
shell> ./tools/tpm reverse
# Defaults for all data services and hosts
tools/tpm configure defaults \
--application-password=secret \
--application-port=3306 \
--application-user=app \
--replication-password=secret \
--replication-port=13306 \
--replication-user=tungsten \
--start-and-report=true \
--user=tungsten
# Options for the alpha data service
```

```
tools/tpm configure alpha \
--connectors=host1,host2,host3 \
--master=host1 \
--members=host1,host2,host3
```

The output includes all of the tpm configure commands necessary to rebuild the configuration. It includes all default, dataservice and host specific configuration settings. Review this output and make changes as needed until you are satisfied.

10.3.5. Installation

After you have prepared the configuration file, it is time to install.

```
shell> ./tools/tpm install
```

This will install all services defined in configuration. The installation will be done as explained in Section 10.2, "Processing Installs and Upgrades". This will include the full set of `--members` [455], `--slaves` [466], `--master` [454], and `--connectors` [440].

10.3.5.1. Installing a set of specific services

```
shell> ./tools/tpm install alpha,bravo
```

All hosts included in the alpha and bravo services will be installed. The installation will be done as explained in Section 10.2, "Processing Installs and Upgrades".

10.3.5.2. Installing a set of specific hosts

```
shell> ./tools/tpm install --hosts=host1,host2
```

Only `host1` and `host2` will be installed. The installation will be done as explained in Section 10.2, "Processing Installs and Upgrades".

10.3.6. Upgrades from a Staging Directory

This process must be run from the staging directory in order to run properly. Determine where the current software was installed from.

```
shell> tpm query staging
tungsten@staging-host:/opt/continuent/software/tungsten-clustering-5.4.1-41
```

This outputs the hostname and directory where the software was installed from. Make your way to that host and the parent directory before proceeding. Unpack the new software into the `/opt/continuent/software` directory and make it your current directory.

```
shell> tar zxf tungsten-clustering-5.4.1-41.tar.gz
shell> cd tungsten-clustering-5.4.1-41
```

Warning

Before performing and upgrade, please ensure that you have checked the Appendix B, *Prerequisites*, as software and system requirements may have changed between versions and releases.

Before any update, the current configuration must be known. If the `$CONTINUENT_PROFILES` or `$REPLICATOR_PROFILES` environment variables were used in the original deployment, these can be set to the directory location where the configuration was stored.

Alternatively, the update can be performed by fetching the existing configuration from the deployed directory by using the tpm fetch command:

```
shell> ./tools/tpm fetch --reset --directory=/opt/continuent \
    --hosts=host1,autodetect
```

This will load the configuration into the local staging directory. Review the current configuration before making any configuration changes or deploying the new software.

```
shell> ./tools/tpm reverse
```

This will output the current configuration of all services defined in the staging directory. You can then make changes using tpm configure before pushing out the upgrade. Run tpm reverse again before tpm update to confirm your changes were loaded correctly.

```
shell> ./tools/tpm configure service_name ...
shell> ./tools/tpm update --replace-release
```

Important

The use of `--replace-release` is not mandatory for minor configuration changes. however it is highly recommended when upgrading between versions.

> Using this option will ensure that underlying metadata and property files are cleanly rebuilt, thus ensuring any new or deprecated properties between releases are correctly added/removed acordingly.

This will update the configuration file and then push the updates to all hosts. No additional arguments are needed for the tpm update command since the configuration has already been loaded.

> **Note**
>
> The tpm update command may cause a brief outage while restarting the connectors. This will occur if you are upgrading to a new version You can avoid that with:
>
> ```
> shell> ./tools/tpm update dataservice --no-connectors
> ```
>
> The connectors must be updated separately on each server by running:
>
> ```
> shell> tpm promote-connector
> ```

The tpm command will use connector graceful-stop 30 followed by connector start [304] when upgrading versions. If that command fails then a regular connector stop [305] is run. This behavior is also applied when using tools/tpm update --replace-release.

10.3.7. Configuration Changes from a Staging Directory

Where, and how, you make configuration changes depends on where you want the changes to be applied.

Making Configuration Changes to the Current Host

You may make changes to a specific host from the `/opt/continuent/tungsten` directory.

```
shell> ./tools/tpm update service_name --thl-log-retention=14d
```

This will update the local configuration with the new settings and restart the replicator. You can use the tpm help update command to see which components will be restarted.

```
shell> ./tools/tpm help update | grep thl-log-retention
--thl-log-retention How long do you want to keep THL files?
```

If you make changes in this way then you must be sure to run tpm fetch from your staging directory prior to any further changes. Skipping this step may result in you pushing an old configuration from the staging directory.

Making Configuration Changes to all hosts

This process must be run from the staging directory in order to run properly. Determine where the current software was installed from.

```
shell> tpm query staging
tungsten@staging-host:/opt/continuent/software/tungsten-clustering-5.4.1-41
```

This outputs the hostname and directory where the software was installed from. Make your way to that host and directory before proceeding.

```
shell> ./tools/tpm fetch --reset --directory=/opt/continuent \
    --hosts=host1,autodetect
```

This will load the configuration into the local staging directory. Review the current configuration before making any configuration changes or deploying the new software.

```
shell> ./tools/tpm reverse
```

This will output the current configuration of all services defined in the staging directory. You can then make changes using tpm configure before pushing out the upgrade. Run tpm reverse again before tpm update to confirm your changes were loaded correctly.

```
shell> ./tools/tpm configure service_name ...
shell> ./tools/tpm update
```

This will update the configuration file and then push the updates to all hosts. No additional arguments are needed for the tpm update command since the configuration has already been loaded.

> **Note**
>
> The tpm update command may cause a brief outage while restarting the connectors. This will occur if you are upgrading to a new version You can avoid that with:
>
> ```
> shell> ./tools/tpm update dataservice --no-connectors
> ```

The connectors must be updated separately on each server by running:

```
shell> tpm promote-connector
```

10.3.8. Converting from INI to Staging

If you currently use the INI installation method and wish to convert to using the Staging method, there is currently no easy way to do that. The procedure involves uninstalling fully on each node, then reinstalling from scratch.

If you still wish to convert from the INI installation method to using the Staging method, use the following procedure:

1. Place cluster[s] in Maintenance Mode:

   ```
   shell> cctrl
   cctrl> set policy maintenance
   ```

2. On the staging node, extract the software into `/opt/continuent/software/{extracted_dir}`

   ```
   shell> cd /opt/continuent/software
   shell> tar zxf tungsten-clustering-5.4.1-41.tar.gz
   ```

   ### Important

   If this is an Composite Active/Active topology using v5 or earlier, make sure you extract both the clustering and replication packages.

3. Create the text file `config.sh` based on the output from tpm reverse:

   ```
   shell> cd tungsten-clustering-5.4.1-41
   shell> tpm reverse > config.sh
   ```

   Review the new `config.sh` script to confirm everything is correct, making any needed edits. When ready, create the new configuration:

   ```
   shell> sh config.sh
   ```

   ### Important

   If you are using an Composite Active/Active topology using v5 or earlier, repeat these steps using the replicator staging directory. For example:

   ```
   shell> cd tungsten-replicator-5.4.1-41
   shell> /opt/replicator/tungsten/tools/tpm reverse > config.sh
   shell> sh config.sh
   ```

   Review the new configuration:

   ```
   shell> tools/tpm reverse
   ```

   See Section 10.3, “tpm Staging Configuration” for more information.

4. On all nodes, uninstall the Tungsten software:

   ### Warning

   Executing this step WILL cause an interruption of service.

   ```
   shell> tpm uninstall --i-am-sure
   ```

   ### Important

   If you are using an Composite Active/Active topology using v5 or earlier, repeat these steps using the replicator tpm command. For example:

   ```
   shell> /opt/replicator/tungsten/tools/tpm uninstall --i-am-sure
   ```

5. On all nodes, rename the `tungsten.ini` file:

   ```
   shell> mv /etc/tungsten/tungsten.ini /etc/tungsten/tungsten.ini.old
   ```

6. On the staging node only, change to the extracted directory and execute the tpm install command:

   ```
   shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
   shell> ./tools/tpm install
   ```

Important

If you are using an Composite Active/Active topology using v5 or earlier, repeat the install using the replicator staging directory. For example:

```
shell> cd /opt/continuent/software/tungsten-replicator-5.4.1-41
shell> ./tools/tpm install
```

7. Once all steps have been completed and the cluster(s) are stable, take each cluster out of maintenance mode by setting the policy back to automatic:

```
shell> cctrl
cctrl> set policy automatic
```

10.4. tpm INI File Configuration

tpm can use an INI file to manage host configuration. This is a fundamental difference from the normal model for using tpm. When using an INI configuration, the tpm command will only work with the local server.

In order to configure Tungsten on your server using an INI file you must still complete all of the Appendix B, *Prerequisites*. Copying SSH keys between your servers is optional but setting them up makes sure that certain scripts packaged with Continuent Tungsten will still work.

10.4.1. Creating an INI file

When using an INI configuration, installation and updates will still be done using the tpm command. Instead of providing configuration information on the command line, the tpm command will look for an INI file in three files:

1. `$ENV{HOME}/tungsten.ini`.
2. `/etc/tungsten/tungsten.ini`
3. `/etc/tungsten.ini`

tpm will automatically search all `tungsten*.ini` files within the `/etc/tungsten` directory.

An alternative directory can be searched using `--ini` [405] option to tpm. This option can also be used to specify a specific ini file if you choose to name the file something different, for example `--ini /my/directory/myconfig.ini`

The INI file(s) must be readable by the tungsten system user.

Here is an example of a `tungsten.ini` file that would setup a simple dataservice.

```
shell> vi /etc/tungsten/tungsten.ini
```

```
[alpha]
master=host1
members=host1,host2,host3
connectors=host1,host2,host3

[defaults]
application-user=app_user
application-password=secret
application-port=3306
replication-user=tungsten
replication-password=secret
replication-port=13306
start-and-report=true
user=tungsten
```

The property names in the INI file are the same as what is used on the command line. Simply remove the leading `--` characters and add it to the proper section. Each section in the INI file replaces a single tpm configure call. The section name inside of the square brackets is used as the service name. In the case of the `[defaults]` section, this will act like the tpm configure defaults command.

Include any host-specific options in the appropriate section. This configuration will only apply to the local server, so there is no need to put host-specific settings in a different section.

10.4.2. Installation with INI File

Once you have created the `tungsten.ini` file, the tpm command will recognize it and use it for configuration. Unpack the software into `/opt/continuent/software` and run the tpm install command.

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
```

```
shell> ./tools/tpm install
```

or

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> ./tools/tpm install --ini /my/directory/myconfig.ini
```

The tpm command will read the `tungsten.ini` file and setup all dataservices on the current server.

10.4.3. Upgrades with an INI File

Use the tpm update command to upgrade to the latest version.

```
shell> cd /opt/continuent/software
shell> tar zxf tungsten-clustering-5.4.1-41.tar.gz
shell> cd tungsten-clustering-5.4.1-41
shell> ./tools/tpm update --replace-release
```

> **Important**
>
> The use of `--replace-release` is not mandatory for minor configuration changes. however it is highly recommended when upgrading between versions.
>
> Using this option will ensure that underlying metadata and property files are cleanly rebuilt, thus ensuring any new or deprecated properties between releases are correctly added/removed acordingly.

After unpacking the new software into the staging directory, the tpm update command will read the `tungsten.ini` configuration and install the new software. All services will be stopped and the new services will be started.

> **Note**
>
> The tpm update command may cause a brief outage while restarting the connectors. This will occur if you are upgrading to a new version You can avoid that with:
>
> ```
> shell> ./tools/tpm update dataservice --no-connectors
> ```
>
> The connectors must be updated separately on each server by running:
>
> ```
> shell> tpm promote-connector
> ```

During the lifetime of the cluster, switches may happen and the current Primary may well be a different node than what is reflected in the static ini file in the `master=` line. Normally, this difference is ignored during an update or an upgrade.

However, if a customer has some kind of procedure (i.e. automation) which hand-edits the ini configuration file `master=` line at some point, and such hand-edits do not reflect the current reality at the time of the update/upgrade, an update/upgrade will fail and the cluster may be left in an indeterminate state.

> **Warning**
>
> The best practice is to NOT change the `master=` line in the INI configuration file after installation.
>
> There is still a window of opportunity for failure. The update will continue, passing the `CurrentTopologyCheck` test and potentially leaving the cluster in an indeterminate state if the `master=` option is set to a hostname that is not the current Primary or the current host.

10.4.4. Configuration Changes with an INI file

The tpm update also allows you to apply any configuration changes. Start by making any necessary changes to the `tungsten.ini` file. Then proceed to running tpm update.

```
shell> cd /opt/continuent/tungsten
shell> ./tools/tpm update
```

This will read the `tungsten.ini` file and apply the settings. The tpm command will identify what services likely need to be restarted and will just restart those. You can manually restart the desired services if you are unsure if the new configuration has been applied.

> **Note**
>
> The tpm update command may cause a brief outage while restarting the connectors. This will occur if you are upgrading to a new version You can avoid that with:
>
> ```
> shell> ./tools/tpm update dataservice --no-connectors
> ```

The connectors must be updated separately on each server by running:

```
shell> tpm promote-connector
```

10.4.5. Converting from Staging to INI

If you currently use the Staging installation method and wish to convert to using INI files, use the following procedure.

You can also try using the script in Section 10.4.6, "Using the `translatetoini.pl` Script".

1. Place cluster[s] in Maintenance Mode:

```
shell> cctrl
cctrl> set policy maintenance
```

2. Create the text file `/etc/tungsten/tungsten.ini` on each node. They will normally all be the same.

```
shell> sudo mkdir /etc/tungsten
shell> sudo chown -R tungsten: /etc/tungsten
shell> chmod 700 /etc/tungsten
shell> touch /etc/tungsten/tungsten.ini
shell> chmod 600 /etc/tungsten/tungsten.ini
```

Each section in the INI file replaces a single tpm configure call. The section name inside of [square brackets] is used as the service name. In the case of the [defaults] section, this will act like the tpm configure defaults command. The property names in the INI file are the same as what is used on the command line. Simply remove the leading -- characters and add it to the proper section.

For example, to seed the `tungsten.ini` file, use the output of tpm reverse:

```
shell> tpm reverse > /etc/tungsten/tungsten.ini
```

Edit the new ini file and clean it up as per the rules above. For example, using vim:

```
shell> vim /etc/tungsten/tungsten.ini
:%s/tools\/^tpm configure /[/g
:%s/^--//g
:%s/\s*\\$//g
```

> **Important**
>
> In the above example, you MUST manually add the trailing square bracket] to the end of the defaults tag and to the end of every service name section. Just search for the opening square bracket [and make sure there is a matching closing square bracket for every one.

See Section 10.4.1, "Creating an INI file" for more information.

3. On every node, extract the software into `/opt/continuent/software/{extracted_dir}`

> **Warning**
>
> Make sure you have the same release that is currently installed.

```
shell> cd /opt/continuent/software
shell> tar zxf tungsten-clustering-5.4.1-41.tar.gz
```

> **Important**
>
> If this is an Composite Active/Active topology, using v5 or earlier, make sure you extract both the clustering and replication packages.

4. On each node, change to the extracted directory and execute the tpm command:

> **Warning**
>
> Execute this step on the Replicas first, then switch the Primary - this procedure will restart the Tungsten services so switch your Primary to avoid interruption of service. See Section 6.14.3, "Performing Maintenance on an Entire Dataservice" for more information.

```
shell> cd /opt/continuent/software/tungsten-clustering-5.4.1-41
shell> ./tools/tpm update
```

This will read the `tungsten.ini` file and apply the settings. The tpm command will identify what services likely need to be restarted and will just restart those. You can manually restart the desired services if you are unsure if the new configuration has been applied.

Note

The tpm update command may cause a brief outage while restarting the connectors. This will occur if you are upgrading to a new version You can avoid that with:

```
shell> ./tools/tpm update dataservice --no-connectors
```

The connectors must be updated separately on each server by running:

```
shell> tpm promote-connector
```

5. If you have an Composite Active/Active topology, using v5 or earlier, you must also update the cross-site replicators:

   On each node, change to the extracted replicator directory and execute the tpm command:

```
shell> cd /opt/continuent/software/tungsten-replicator-5.4.1-41
shell> ./tools/tpm update
```

6. Once all steps have been completed and the cluster(s) are stable, take each cluster out of maintenance mode by setting the policy back to automatic:

```
shell> cctrl
cctrl> set policy automatic
```

10.4.6. Using the `translatetoini.pl` Script

You can download a script from the documentation library, translatetoini.pl. You must have a copy of Perl installed to be able to execute the script.

To use the script, you can either run the script and paste in the staging output, or pipe the output from tpm reverse directly into the script. When supplying the staging output, you should supply the output from the within the configured staging directory. For example:

```
shell> ./tools/tpm reverse|../translatetoini.pl
```

The script will create the file `tungsten.ini` in the current directory containing the converted output.

To change the destination, use the `--filename` option:

```
shell> ./tools/tpm reverse|../translatetoini.pl --filename=t.ini
```

You can also combine multiple staging configurations into a single INI conversion by appending to an existing INI file by adding the `--append` option:

```
shell> ./tools/tpm reverse|../translatetoini.pl --append
```

You should always check the INI file before using it for a live installation to ensure that all of the options and parameters have been identified and configured properly.

A training video is available on how to perform the staging to INI file conversion using the translatetoini.pl script:

Click here for a video of the INI conversion procedure, showing the full process from start to finish...

10.5. tpm Commands

All calls to tpm will follow a similar structure, made up of the command, which defines the type of operation, and one or more options.

```
shell> tpm command [sub command] [tpm options] [command options]
```

The command options will vary for each command. The core tpm options are:

Table 10.2. tpm Core Options

Option	Description
`--force` [395], `-f` [395]	Do not display confirmation prompts or stop the configure process for errors
`--help` [395], `-h` [395]	Displays help message
`--info` [395], `-i` [395]	Display info, notice, warning and error messages
`--notice` [395], `-n` [395]	Display notice, warning and error messages

Option	Description
`--preview` [395], `-p` [395]	Displays the help message and preview the effect of the command line options
`--profile file` [395]	Sets name of config file
`--quiet` [395], `-q` [395]	Only display warning and error messages
`--verbose` [395], `-v` [395]	Display debug, info, notice, warning and error messages

– `--force` [395]

Forces the deployment process to complete even if there are warning or error messages that would normally cause the process the to fail. Forcing the installation also ignores all confirmation prompts during installation and always attempts to complete the process.

– `--help` [395]

Displays the help message for tpm showing the current options, commands and version information.

– `--info` [395]

Changes the reporting level to include information, notice, warning and error messages. Information level messages include annotations of the current process and stage in the deployment, such as configuration or generating files and configurations. This shows slightly more information than the default, but less than the full debug level offered by `--verbose` [395].

– `--notice` [395]

Sets the output level to include notice, warning, and error messages. Notice level messages include information about further steps or actions that should be taken, or things that should be noted without indicating a failure or error with the configuration options select.

– `--preview` [395]

– `--profile file` [395]

Specify the name of the configuration file to be used. This can be useful if you are performing multiple configurations or deployments from the same staging directory. The entire configuration and deployment information is stored in the file before installation is started. By specifying a different file you can have multiple deployments and configurations without requiring separate staging directories.

– `--quiet` [395]

Changes the error reporting level so that only warning and error messages are displayed. This mode can be useful in automated deployments as it provides output only when a warning or error exists. All other messages, including informational ones, are suppressed.

– `--verbose` [395]

Displays a much more detailed output of the status and progress of the deployment. In verbose mode, tpm annotates the entire process describing both what it is doing and all debug, warning and other messages in the output.

The tpm utility handles operations across all hosts in the dataservice. This is true for simple and composite dataservices. The coordination requires SSH connections between the hosts according to the Appendix B, *Prerequisites*. There are two exceptions for this:

1. When the `--hosts` [450] argument is provided to a command; that command will only be carried out on the hosts listed. Multiple hosts may be given as a comma-separated list. The names used in the `--members` [455], `--slaves` [466], `--master` [454], `--connectors` [440] arguments should be used when calling `--hosts` [450].

2. When you are using an INI configuration file (see Section 10.4, “tpm INI File Configuration”) all calls to tpm will only affect the current host.

The installation process starts in a staging directory. This is different from the installation directory where Tungsten Cluster will ultimately be placed but may be a sub-directory. In most cases we will install to `/opt/continuent` but use `/opt/continuent/software` as a staging directory. The release package should be unpacked in the staging directory before proceeding. See the Section B.1, “Staging Host Configuration” for instructions on selecting a staging directory.

Table 10.3. tpm Commands

Option	Description
configure	Configure a data service within the global configuration
connector	Open a connection to the configured connector using mysql
diag	Obtain diagnostic information

Option	Description
fetch	Fetch configuration information from a running service
firewall	Display firewall information for the configured services
help	Show command help information
install	Install a data service based on the existing and runtime parameters
mysql	Open a connection to the configured MySQL server
promote	Make a previously configured and prepared directory and make it the active
promote-connector	Restart the connectors in the active configuration
query	Query the active configuration for information
reset	Reset the cluster on each host
reset-thl	Reset the THL for a host
uninstall	Uninstall software from host(s)
update	Update an existing configuration or software version
validate	Validate the current configuration
validate-update	Validate the current configuration and update

10.5.1. tpm ask Command

tpm ask can be used to query values from the common configuration

Usage:

```
tpm ask [args] [context] {value_or_function_name} [argument]
```

`[context]` : The optional context may be one of: `common` (default), `keys`, `all` or `function`

If you specify a context of:

- `common` or no context: Extract the variable from the perl common object
- `all`: Extract every available variable from the perl common object
- `keys`: Extract all available variable names from the perl common object
- `functions`: Extract the available function names from the perl common object
- `function`: Extract the return value of the named function from within the perl_common object. You may specify an optional argument to the function.

Examples:

```
shell> tpm ask keys
shell> tpm ask all
shell> tpm ask functions
shell> tpm ask services
shell> tpm ask isCAA
shell> tpm ask function managerEnabled
shell> tpm ask function cleanBool false
```

Arguments:

10.5.2. tpm configure Command

The configure command to tpm creates a configuration file within the current profiles directory

10.5.3. tpm connector Command

This will open a MySQL CLI connection to the local Tungsten Connector using the current values for `--application-user` [433], `--application-password` [432] and `--application-port` [432].

```
shell> tpm connector
```

Warning

This command will fail if the mysql utility is not available or if the local server does not have a running Tungsten Connector.

Important

The MySQL 5.7/8.0 command-line client will now attempt to connect via SSL by default, which will fail on the Connector unless it is configured for SSL operations. You may add the `--skip-ssl` option to bypass this issue. See Section 5.13.3, "Configuring Connector SSL" for more information about using SSL with the Connector.

10.5.3.1. tpm connector `--hosts` Command

Limits the connection to the list of specified hosts. For example:

```
shell> tpm connector --hosts host1,host2
```

Would limit the connection to the connector on one of the specified hosts. The hostname must be specified in the same form as it is in the configuration.

10.5.3.2. tpm connector `--dataservice-name` Command

Limit the command to the hosts in the specified dataservice. Mutliple dataservices can be specified by providing each dataservice separated by a comman.

```
shell> tpm connector --dataservice-name east
```

10.5.3.3. tpm connector `--samples` Command

Provides sample configuration information for various common development environments:

```
shell> tpm connector --samples
Bash                        mysql -hdemo-c11 -P3306 -uapp_user -ppassword
Perl::dbi                   $dbh=DBI->connecti('DBI:mysql:host=demo-c11;port=3306', 'app_user', 'password')
PHP::mysqli                 $dbh = new mysqli('demo-c11', 'app_user', 'password', 'schema', '3306');
PHP::pdo                    $dbh = new PDO('mysql:host=demo-c11;port=3306', 'app_user', 'password');
Python::mysql.connector     dbh = mysql.connector.connect(user='app_user', password='password', host='demo-c11', port=3306, database='schema')
Java::DriverManager         dbh=DriverManager.getConnection("jdbc:mysql://demo-c11:3306/schema", "app_user", "password")
```

10.5.4. tpm diag Command

The tpm diag command will create a ZIP file including log files, current dataservice status and a number of OS metrics.

```
shell> tpm diag
NOTE  >> host1 >> Diagnostic information written to /home/tungsten/tungsten-diag-2013-10-09-21-04-23.zip
```

The operation of tpm diag differs between installation types (Staging vs INI). This is outlined below:

- With Staging-method deployments, the tpm diag command can be issued in two ways:
  - The tpm diag command alone will obtain diagnostics from all hosts in the cluster.
  - The tpm diag --hosts host1,host2,hostN command will obtain diagnostics from the specified host(s) only.
- Within an INI installation, the behaviour will depend on a number of factors, these are outlined below
  - For versions prior to 5.3.7, and version 6.0.0 to 6.0.4
    - The tpm diag command alone will attempt to obtain diagnostics from all hosts in the cluster if ssh has been configured and the other hosts can be reached.
  - For versions 5.3.7 to 5.4.0, and versions 6.0.5 onwards
    - The tpm diag command alone will ONLY obtain diagnostics from the local host on which the command is executed.
    - The tpm diag --hosts host1,host2,hostN command will obtain diagnostics from the specified host(s) only.
    - The tpm diag -a|--allhosts command will attempt to obtain diagnostics from all hosts in the cluster if ssh has been configured and the other hosts can be reached. The output of tpm diag will provide feedback detailing the hosts that were reached.

The structure of the created file will depend on the configured hosts, but will include all the logs for each accessible host configured in individual directories for each host.

tungsten_send_diag

If the host you are running the diag from has external internet connectivity, you may also wish to consider using tungsten_send_diag. This will run tpm diag for you and automatically upload the resulting file to Continuent Support. For more information on using this, see Section 9.42, "The tungsten_send_diag Script"

10.5.5. tpm fetch Command

There are some cases where you would like to review the configuration or make changes prior to the upgrade. In these cases it is possible to fetch the configuration and process the upgrade as different steps.

```
shell> ./tools/tpm fetch \
    --directory=/opt/continuent \
    --hosts=host1,autodetect
```

This will load the configuration into the local staging directory. You can then make changes using tpm configure before pushing out the upgrade.

The tpm fetch command supports the following arguments:

- `--hosts` [450]

  A comma-separated list of the known hosts in the cluster. If `autodetect` is included, then tpm will attempt to determine other hosts in the cluster by checking the configuration files for host values.

- `--user` [471]

  The username to be used when logging in to other hosts.

- `--directory` [446]

  The installation directory of the current Tungsten Cluster installation. If `autodetect` is specified, then tpm will look for the installation directory by checking any running Tungsten Cluster processes.

10.5.6. tpm firewall Command

The tpm firewall command displays port information required to configured a firewall. When used, the information shown is for the current host:

```
shell> tpm firewall
To host1
----------------------------------------------------------------------------
From application servers      9999
From connector servers        11999, 12000, 13306
From database servers         2112, 7800, 8090, 9997, 10999, 11999, 12000, 13306
```

The information shows which ports, on which hosts, should be opened to enable communication.

10.5.7. tpm help Command

The tpm help command outputs the help information for tpm showing the list of supported commands and options.

```
shell> tpm help
Usage: tpm help [commands,config-file,template-file] [general-options] [command-options]
----------------------------------------------------------------------------------------
General options:
-f, --force                   Do not display confirmation prompts or stop the configure »
                              process for errors
-h, --help                    Displays help message
--profile file                Sets name of config file (default: tungsten.cfg)
-p, --preview                 Displays the help message and preview the effect of the »
                              command line options
-q, --quiet                   Only display warning and error messages
-n, --notice                  Display notice, warning and error messages
-i, --info                    Display info, notice, warning and error messages
-v, --verbose                 Display debug, info, notice, warning and error messages
...
```

To get a list of available configuration options, use the config-file subcommand:

```
shell> tpm help config-file
#####################################################################
# Config File Options
#####################################################################
config_target_basename        [tungsten-clustering-5.4.1-41_pid10926]
```

```
deployment_command            Current command being run
remote_package_path           Path on the server to use for running tpm commands
deploy_current_package        Deploy the current Tungsten package
deploy_package_uri            URL for the Tungsten package to deploy
deployment_host               Host alias for the host to be deployed here
staging_host                  Host being used to install
...
```

10.5.8. tpm install Command

The tpm install command performs an installation based on the current configuration (if one has been previously created), or using the configuration information provided on the command-line.

For example:

```
shell> ./tools/tpm install alpha\
    --topology=master-slave \
    --master=host1 \
    --replication-user=tungsten \
    --replication-password=password \
    --home-directory=/opt/continuent \
    --members=host1,host2,host3 \
    --start
```

Installs a service using the command-line configuration.

```
shell> ./tools/tpm configure alpha\
    --topology=master-slave \
    --master=host1 \
    --replication-user=tungsten \
    --replication-password=password \
    --home-directory=/opt/continuent \
    --members=host1,host2,host3
shell> ./tools/tpm install alpha
```

Configures the service first, then performs the installation steps.

During installation, tpm checks for any host configuration problems and issues, copies the Tungsten Cluster software to each machine, creates the necessary configuration files, and if requests, starts and reports the status of the service.

If any of these steps fail, changes are backed out and installation is stopped.

10.5.9. tpm mysql Command

This will open a MySQL CLI connection to the local MySQL server using the current values for `--replication-user` [464], `--replication-password` [463] and `--replication-port` [463].

```
shell> tpm mysql
```

This command will fail if the mysql utility is not available or if the local server does not have a running database server.

10.5.10. tpm promote-connector Command

The tpm promote-connector command should be used after performing a tpm update or tpm promote with the `--no-connectors` [459] option.

When using this option with these commands, running connectors are not stopped and restarted with the latest configuration or application updates, which would otherwise interrupt active applications using the connector.

The tpm promote-connector stops and restarts the configured Connector services on all configured hosts using the currently active configuration:

```
shell> tpm promote-connector

NOTE  >> Command successfully completed
```

The tpm command will use connector graceful-stop 30 followed by connector start [304] when upgrading versions. If that command fails then a regular connector stop [305] is run. This behavior is also applied when using tools/tpm update --replace-release.

10.5.11. tpm query Command

The query command provides information about the current tpm installation. There are a number of subcommands to query specific information:

- tpm query config — return the full configuration values
- tpm query dataservices — return the list of dataservices
- tpm query default — return the list of configured default values
- tpm query deployments — return the configuration of all deployed hosts
- tpm query manifest — get the manifest information
- tpm query modified-files — return the list of files modified since installation by tpm
- tpm query staging — return the staging directory from where Tungsten Cluster was installed
- tpm query topology — return the current topology
- tpm query usermap — return the list of users organized by type from the `user.map`
- tpm query values — return the list of configured values
- tpm query version — get the version of the current installation

10.5.11.1. tpm query config

Returns a list of all of the configuration values, both user-specified and implied within the current configuration. The information is returned in the form a JSON value:

```
shell> tpm query config
{
  "__system_defaults_will_be_overwritten__": {
...
  "staging_directory": "/home/tungsten/tungsten-clustering-5.4.1-41",
  "staging_host": "tr-ms1",
  "staging_user": "tungsten"
}
```

10.5.11.2. tpm query dataservices

Returns the list of configured dataservices that have, or will be, installed:

```
shell> tpm query dataservices
alpha                          : PHYSICAL
```

10.5.11.3. tpm query deployments

Returns a list of all the individual deployment hosts and configuration information, returned in the form of a JSON object for each installation host:

```
shell> tpm query deployments
{
  "config_target_basename": "tungsten-clustering-5.4.1-41_pid22729",
  "dataservice_host_options": {
    "alpha": {
      "start": "true"
    }
...
  "staging_directory": "/home/tungsten/tungsten-clustering-5.4.1-41",
  "staging_host": "tr-ms1",
  "staging_user": "tungsten"
}
```

10.5.11.4. tpm query manifest

Returns the manifest information for the identified release of Tungsten Cluster, including the build, source and component versions, returned in the form of a JSON value:

```
shell>  tpm query manifest
{
  "date": "Wed Jun  3 16:54:37 UTC 2020",
  "fullVersion": "6.1.4",
  "git": {
    "URL": "file:///volumes/data/bamboo/home/xml-data/build-dir/_git-repositories-cache/dfe910bfa6ded0f410e78a8215885afe1a539172",
    "branch": "cnt-6.1.4-merge",
    "revision": "8b7939809ae685cf459d76d052a3c9916112306b"
```

```
  },
  "host": "bamboo",
  "hudson": {
    "URL": "",
    "buildId": 44,
    "buildNumber": 44,
    "buildTag": "",
    "jobName": ""
  },
  "product": "Tungsten Clustering",
  "productCode": "tungsten.clustering",
  "release": "tungsten-clustering-6.1.4-44",
  "releaseBaseName": "tungsten-clustering",
  "userAccount": "bamboo",
  "version": {
    "major": 6,
    "minor": 1,
    "revision": 4
  }
}
```

10.5.11.5. tpm query modified-files

Shows the list of configuration files that have been modified since the installation was completed. Modified configuration files cannot be overwritten during an upgrade process, using this command enables you identify which files contain changes so that these modifications can be manually migrated to the new installation. To restore or replace files with their original installation, copy the `.filename.orig` file.

10.5.11.6. tpm query staging

Returns the host and directory from which the current installation was created:

```
shell> tpm query staging
tungsten@host1:/home/tungsten/tungsten-clustering-5.4.1-41
```

This can be useful when the installation host and directory from which the original configuration was made need to be updated or modified.

10.5.11.7. tpm query topology

Returns the current topology and list of configured servers and roles in the form of a JSON object:

```
shell> tpm query topology
{
  "host1": "slave",
  "host2": "slave",
  "host3": "master"
}
```

10.5.11.8. tpm query usermap

Returns a summarized list of the currently configured users in the `user.map`:

```
shell> tpm query usermap
# user.map Summary

# Configured users
app_user ******** alpha

# Script entries


# DirectRead users


# Host-based routing entries
```

10.5.11.9. tpm query version

Returns the version for the identified version of Tungsten Cluster:

```
shell>  tpm query version
5.4.1-41
```

10.5.12. tpm reset Command

This command will clear the current state for all Tungsten services:

- Management metadata
- Replication metadata
- THL files
- Relay log files
- Replication position

If you run the command from an installed directory, it will only apply to the current server. If you run it from a staging directory, it will apply to all servers unless you specify the `--hosts` [450] option.

```
shell> {STAGING_DIR}/tools/tpm reset
or
shell> tpm reset
```

10.5.13. tpm reset-thl Command

This command will clear the current replication state for the Tungsten Replicator:

- THL files
- Relay log files
- Replication position

If you run the command from an installed directory, it will only apply to the current server. If you run it from a staging directory, it will apply to all servers unless you specify the `--hosts` [450] option.

```
shell> {STAGING_DIR}/tools/tpm reset-thl
or
shell> tpm reset-thl
```

10.5.14. tpm reverse Command

The tpm reverse command will show you the commands required to rebuild the configuration for the current directory. This is useful for doing an upgrade or when copying the deployment to another server.

```
shell> tpm reverse
# Defaults for all data services and hosts
tools/tpm configure defaults \
--application-password=secret \
--application-port=3306 \
--application-user=app \
--replication-password=secret \
--replication-port=13306 \
--replication-user=tungsten \
--start-and-report=true \
--user=tungsten
# Options for the alpha data service
tools/tpm configure alpha \
--connectors=host1,host2,host3 \
--master=host1 \
--members=host1,host2,host3
```

The tpm reverse command supports the following arguments:

- `--public`

  Hide passwords in the command output

- `--ini-format`

  Display output in ini format for use in `/etc/tungsten/tungsten.ini` and similar configuration files

10.5.15. tpm uninstall Command

The tpm uninstall command is used to remove the installation.

> **Warning**
>
> The uninstall command must be used with care. This is a destructive command and irreversible.

To uninstall the software, you need to issue the following command from the installed software staging directory on every host for INI installs, or from the staging host only for Staging Installs. Running the command on the staging hosts installed via the staging method, will cascade through all nodes in the topology.

```
shell> {STAGING_DIR}/tools/tpm uninstall --i-am-sure
```

10.5.16. tpm update Command

The tpm update command is used when applying configuration changes or upgrading to a new version. The process is designed to be simple and maintain availability of all services. The actual process will be performed as described in Section 10.2, "Processing Installs and Upgrades". The behavior of tpm update is dependent on two factors.

1. Are you upgrading to a new version or applying configuration changes to the current version?
2. The installation method used during deployment.

> **Note**
>
> Check the output of tpm query staging to determine which method your current installation uses. The output for an installation from a staging directory will start with `# Installed from tungsten@staging-host:/opt/continuent/software/tungsten-clustering-5.4.1-41`. An installation based on an INI file may include this line but there will be an `/etc/tungsten/tungsten.ini` file on each node.

Upgrading to a new version

If a staging directory was used; see Section 10.3.6, "Upgrades from a Staging Directory".

If an INI file was used; see Section 10.4.3, "Upgrades with an INI File"

Applying configuration changes to the current version

If a staging directory was used; see Section 10.3.7, "Configuration Changes from a Staging Directory".

If an INI file was used; see Section 10.4.4, "Configuration Changes with an INI file".

> **Warning**
>
> During the update process, the cluster will be in `MAINTENANCE` mode. This is intentional to prevent unwanted failovers during the proces, however it is important to understand that should the primary faill for genuine reasons NOT associated with the upgrade, then failover will also not happen at that time.
>
> It is important to ensure clusters are returned to the `AUTOMATIC` state as soon as all Maintenance operations are complete and the cluster is stable.

Special Considerations for the Connector

The tpm command will use connector graceful-stop 30 followed by connector start [304] when upgrading versions. If that command fails then a regular connector stop [305] is run.

This behavior is also applied when using tools/tpm update --replace-release.

The tpm command will use connector reconfigure [304] when changing connector settings without a version upgrade.

The use of connector reconfigure [304] is disabled for the following:

```
--application-port
--application-readonly-port
--router-gateway-port
--router-jmx-port
--conn-java-mem-size
```

If connector reconfigure [304] can't be used, connector graceful-stop 30 and connector start [304] are used.

10.5.17. tpm validate Command

The tpm validate command validates the current configuration before installation. The validation checks all prerequisites that apply before an installation, and assumes that the configured hosts are currently not configured for any Tungsten services, and no Tungsten services are currently running.

```
shell> {STAGING_DIR}/tools/tpm validate
.........
...
```

```
##################################################################
# Validation failed
##################################################################
...
```

The command can be run after performing a tpm configure and before a tpm install to ensure that any prerequisite or configuration issues are addressed before installation occurs.

10.5.18. tpm validate-update Command

The tpm validate-update command checks whether the configured hosts are ready to be updated. By checking the prerequisites and configuration of the dataserver and hosts, the same checks as made by tpm during a tpm install operation. Since there may have been changes to the requirements or required configuration, this check can be useful before attempting an update.

Using tpm validate-update is different from tpm validate in that it checks the environment based on the updated configuration, including the status of any existing services.

```
shell> {STAGING_DIR}/tools/tpm validate-update
....
WARN  >> host1 >> The process limit is set to 7812, we suggest a value»
    of at least 8096. Add 'tungsten       -    nproc  8096' to your »
    /etc/security/limits.conf and restart Tungsten processes. (ProcessLimitCheck)

WARN  >> host2 >> The process limit is set to 7812, we suggest a value»
     of at least 8096. Add 'tungsten       -    nproc  8096' to your »
    /etc/security/limits.conf and restart Tungsten processes. (ProcessLimitCheck)

WARN  >> host3 >> The process limit is set to 7812, we suggest a value »
    of at least 8096. Add 'tungsten       -    nproc  8096' to your »
    /etc/security/limits.conf and restart Tungsten processes. (ProcessLimitCheck)
.WARN  >> host3 >> MyISAM tables exist within this instance - These »
    tables are not crash safe and may lead to data loss in a failover »
    (MySQLMyISAMCheck)


NOTE  >> Command successfully completed
```

Any problems noted should be addressed before you perform the update using tpm update.

10.6. tpm Common Options

tpm accepts these options along with those in Section 10.8, “tpm Configuration Options”.

- On the command-line, using a double-dash prefix, i.e. `--skip-validation-check=MySQLConnectorPermissionsCheck` [406]
- In an INI file, without the double-dash prefix, i.e. `skip-validation-check=MySQLConnectorPermissionsCheck` [406]

Table 10.4. tpm Common Options

CmdLine Option	INI File Option	Description
`--enable-validation-check` [404]	`enable-validation-check` [404]	Enable a specific validation check, overriding any configured skipped checks
`--enable-validation-warnings` [405]	`enable-validation-warnings` [405]	Enable a specific validation warning, overriding any configured skipped warning
`--ini` [405]	`ini` [405]	Specify the location of the directory where INI files will be located, or specify a specific filename
`--net-ssh-option` [405]	`net-ssh-option` [405]	Set the Net::SSH option for remote system calls
`--property` [405], `--property=key+=value` [405], `--property=key=value` [405], `--property=key~=/match/replace/` [405]	`property` [405], `property=key+=value` [405], `property=key=value` [405], `property=key~=/match/replace/` [405]	Modify specific property values for the key in any file that the configure script touches.
`--remove-property` [406]	`remove-property` [406]	Remove the setting for a previously configured property
`--skip-validation-check` [406]	`skip-validation-check` [406]	Do not run the specified validation check.
`--skip-validation-warnings` [406]	`skip-validation-warnings` [406]	Do not display warnings for the specified validation check.

– `--enable-validation-check` [404]

Option	`--enable-validation-check` [404]

Config File Options	enable-validation-check [404]
Description	Enable a specific validation check, overriding any configured skipped checks
Value Type	string

The --enable-validation-check [404] will specifically enable a given validation check if the check had previously been set it be ignored in a previous invocation of the configuration through tpm. If a check fails, installation is canceled.

Setting both --skip-validation-check [406] and --enable-validation-check [404] is equivalent to explicitly disabling the specified check.

– --enable-validation-warnings [405]

Option	--enable-validation-warnings [405]
Config File Options	enable-validation-warnings [405]
Description	Enable a specific validation warning, overriding any configured skipped warning
Value Type	string

The --enable-validation-warnings [405] will specifically enable a given validation warning check if the check had previously been set it be ignored in a previous invocation of the configuration through tpm.

Setting both --skip-validation-warnings [406] and --enable-validation-warnings [405] is equivalent to explicitly disabling the specified check.

– --ini [405]

Option	--ini [405]
Config File Options	ini [405]
Description	Specify the location of the directory where INI files will be located, or specify a specific filename
Value Type	string
Default	/etc/tungsten/tungsten.ini

Specifies an alternative location, or file, for the INI files from the default.

– --net-ssh-option [405]

Option	--net-ssh-option [405]
Config File Options	net-ssh-option [405]
Description	Set the Net::SSH option for remote system calls
Value Type	string

Enables you to set a specific Net::SSH option. For example:

```
shell> tpm update ... --net-ssh-option=compression=zlib
```

– --property [405]

Option	--property [405]
Aliases	--property=key+=value [405], --property=key=value [405], --property=key~=/match/replace/ [405]
Config File Options	property [405], property=key+=value [405], property=key=value [405], property=key~=/match/replace/ [405]
Description	Modify specific property values for the key in any file that the configure script touches.
Value Type	string

The --property [405] option enables you to explicitly set property values in the target files. A number of different models are supported:

- key=value

  Set the property defined by key to the specified value without evaluating any template values or other rules.

- key+=value

  Add the value to the property defined by key. Template values and other options append their settings to the end of the specified property.

- key~=/match/replace/

Evaluate any template values and other settings, and then perform the specified Ruby regex operation to the property defined by `key`. For example `--property=replicator.key~=/(.*)/somevalue,\1/` will prepend `somevalue` before the template value for `replicator.key`.

– `--remove-property` [406]

Option	`--remove-property` [406]
Config File Options	`remove-property` [406]
Description	Remove the setting for a previously configured property
Value Type	string

Remove a previous explicit property setting. For example:

```
shell> tpm configure --remove-property=replicator.filter.pkey.addPkeyToInserts
```

– `--skip-validation-check` [406]

Option	`--skip-validation-check` [406]
Config File Options	`skip-validation-check` [406]
Description	Do not run the specified validation check.
Value Type	string

The `--skip-validation-check` [406] disables a given validation check. If any validation check fails, the installation, validation or configuration will automatically stop.

Warning

Using this option enables you to bypass the specified check, although skipping a check may lead to an invalid or non-working configuration.

You can identify a given check if an error or warning has been raised during configuration. For example, the default table type check:

```
...
ERROR >> centos >> The datasource root@centos:3306 (WITH PASSWORD) »
 uses MyISAM as the default storage engine (MySQLDefaultTableTypeCheck)
...
```

The check in this case is `MySQLDefaultTableTypeCheck` [416], and could be ignored using `--skip-validation-check=MySQLDefaultTableTypeCheck` [406].

Setting both `--skip-validation-check` [406] and `--enable-validation-check` [404] is equivalent to explicitly disabling the specified check.

– `--skip-validation-warnings` [406]

Option	`--skip-validation-warnings` [406]
Config File Options	`skip-validation-warnings` [406]
Description	Do not display warnings for the specified validation check.
Value Type	string

The `--skip-validation-warnings` [406] disables a given validation check.

You can identify a given check by examining the warnings generated during configuration. For example, the Linux swappiness warning:

```
...
WARN >> centos >> Linux swappiness is currently set to 60, on restart it will be 60, »
 consider setting this to 10 or under to avoid swapping. (SwappinessCheck)
...
```

The check in this case is `MySQLDefaultTableTypeCheck` [416], and could be ignored using `--skip-validation-warnings=SwappinessCheck` [406].

Setting both `--skip-validation-warnings` [406] and `--enable-validation-warnings` [405] is equivalent to explicitly disabling the specified warning.

10.7. tpm Validation Checks

During configuration and installation, tpm runs a number of configuration, operating system, datasource, and other validation checks to ensure that the correct environment, prerequisites and other settings will produce a valid, working, configuration.

All relevant checks are executed automatically unless specifically ignored (warnings) or disabled (checks) using the corresponding `--skip-validation-warnings` [406] or `--skip-validation-check` [406] options.

Table 10.5. tpm Validation Checks

Option	Description
BackupDirectoryWriteableCheck [410]	Checks that the configured backup directory is writeable
BackupDumpDirectoryWriteableCheck [410]	Checks the backup temp directory is writeable
BackupScriptAvailableCheck [410]	Checks that the configured backup script exists and can be executed
ClusterDiagnosticCheck [410]	
ClusterStatusCheck [410]	
CommitDirectoryCheck [410]	
ConfigurationStorageDirectoryCheck [410]	
ConfigureValidationCheck [411]	
ConfiguredDirectoryCheck [411]	
ConflictingReplicationServiceTHLPortsCheck [411]	
ConnectorChecks [411]	Ensures that the configured connector selection is valid
ConnectorDBVersionCheck [411]	
ConnectorListenerAddressCheck [411]	
ConnectorRWROAddressesCheck [411]	Ensure the RW and RO addresses are different
ConnectorSmartScaleAllowedCheck [411]	Confirms whether SmartScale is valid within the current configured parameters
ConnectorUserCheck [411]	
ConsistentReplicationCredentialsCheck [411]	
CurrentCommandCoordinatorCheck [412]	
CurrentConnectorCheck [412]	
CurrentReleaseDirectoryIsSymlink [412]	
CurrentTopologyCheck [412]	
CurrentVersionCheck [412]	
DatasourceBootScriptCheck [412]	
DifferentMasterSlaveCheck [412]	
DirectOracleServiceSIDCheck [412]	
EncryptionCheck [412]	
EncryptionKeystoreCheck [412]	
FileValidationCheck [412]	
FirewallCheck [412]	
GlobalHostAddressesCheck [413]	
GlobalHostOracleLibrariesFoundCheck [413]	
GlobalMatchingPingMethodCheck [413]	
GlobalRestartComponentsCheck [413]	
GroupValidationCheck [413]	
HdfsValidationCheck [413]	
HostLicensesCheck [413]	
HostOracleLibrariesFoundCheck [413]	
HostReplicatorServiceRunningCheck [413]	
HostSkippedChecks [413]	
HostnameCheck [413]	
HostsFileCheck [413]	
InstallServicesCheck [414]	
InstallationScriptCheck [414]	

Option	Description
InstallerMasterSlaveCheck [414]	Checks whether a Primary host has been defined for the configured service.
InstallingOverExistingInstallation [414]	
JavaUserTimezoneCheck [414]	
JavaVersionCheck [414]	
KeystoresCheck [414]	
KeystoresToCommitCheck [414]	
ManagerActiveWitnessConversionCheck [414]	
ManagerChecks [414]	
ManagerHeapThresholdCheck [414]	
ManagerListenerAddressCheck [414]	
ManagerPingMethodCheck [415]	
ManagerWitnessAvailableCheck [415]	
ManagerWitnessNeededCheck [415]	
MatchingHomeDirectoryCheck [415]	
MissingReplicationServiceConfigurationCheck [415]	
ModifiedConfigurationFilesCheck [415]	
MySQLAllowIntensiveChecks [415]	Enables searching MySQL INFORMATION_SCHEMA for validation checks
MySQLApplierLogsCheck [415]	
MySQLApplierPortCheck [415]	
MySQLApplierServerIDCheck [415]	
MySQLAvailableCheck [415]	Checks if MySQL is installed
MySQLBinaryLogsEnabledCheck [416]	Checks that binary logging has been enabled on MySQL
MySQLBinlogDoDbCheck [416]	
MySQLClientCheck [416]	Checks whether the MySQL client command tool is available
MySQLConfigFileCheck [416]	Checks the existence of a MySQL configuration file
MySQLConnectorBridgeModePermissionsCheck [416]	
MySQLConnectorPermissionsCheck [416]	
MySQLDefaultTableTypeCheck [416]	Checks the default table type for MySQL
MySQLDumpCheck [416]	Checks that the mysqldump command version matches the installed MySQL
MySQLGeneratedColumnCheck [416]	Checks whether MySQL virtual/generated columns are defined
MySQLInnoDBEnabledCheck [416]	
MySQLJsonDataTypeCheck [417]	
MySQLLoadDataInfilePermissionsCheck [417]	
MySQLLoginCheck [417]	Checks whether Tungsten Cluster can connect to MySQL using the configured credentials
MySQLMyISAMCheck [417]	Checks for the existence of MyISAM tables
MySQLNoMySQLReplicationCheck [417]	
MySQLPasswordSettingCheck [417]	
MySQLPermissionsCheck [417]	
MySQLReadableLogsCheck [417]	
MySQLSettingsCheck [417]	
MySQLSuperReadOnlyCheck [418]	Checks whether super_read_only has been enabled on MySQL
MySQLTriggerCheck [418]	

Option	Description
MySQLUnsupportedDataTypesCheck [418]	
MysqlConnectorCheck [418]	
MysqldumpAvailableCheck [418]	
MysqldumpSettingsCheck [418]	
NewDirectoryRequiredCheck [418]	
NtpdRunningCheck [418]	
OSCheck [418]	
OldServicesRunningCheck [418]	
OpenFilesLimitCheck [418]	
OpensslLibraryCheck [419]	
OracleLoginCheck [419]	
OraclePermissionsCheck [419]	
OracleRedoReaderMinerDirectoryCheck [419]	
OracleServiceSIDCheck [419]	
OracleVersionCheck [419]	
PGAvailableCheck [419]	
ParallelReplicationCheck [419]	
ParallelReplicationCountCheck [419]	
PgControlAvailableCheck [419]	
PgStandbyAvailableCheck [419]	
PgdumpAvailableCheck [419]	
PgdumpallAvailableCheck [420]	
PingSyntaxCheck [420]	
PortAvailabilityCheck [420]	
ProfileScriptCheck [420]	
RMIListenerAddressCheck [420]	
RelayDirectoryWriteableCheck [420]	Checks that the relay log directory can be written to
ReplicatorChecks [420]	
RestartComponentsCheck [420]	
RouterAffinityCheck [420]	
RouterBridgeModeDefaultCheck [420]	
RouterDelayBeforeOfflineCheck [420]	
RouterKeepAliveTimeoutCheck [421]	
RowBasedBinaryLoggingCheck [421]	Checks that Row-based binary logging has been enabled for heterogeneous deployments
RsyncAvailableCheck [421]	
RubyVersionCheck [421]	
SSHLoginCheck [421]	Checks connectivity to other hosts over SSH
ServiceTransferredLogStorageCheck [421]	
StartingStoppedServices [421]	
SudoCheck [421]	
SwappinessCheck [422]	Checks the swappiness OS configuration is within a recommended range
THLDirectoryWriteableCheck [422]	
THLListenerAddressCheck [422]	

Option	Description
THLSchemaChangeCheck [422]	Ensures that the existing THL format is compatible with the new release
THLStorageCheck [422]	Confirms the THL storage directory exists, is empty and writeable
THLStorageChecksum [422]	
TargetDirectoryDoesNotExist [422]	
TransferredLogStorageCheck [422]	
UpgradeSameProductCheck [422]	Ensures that the same product is being updated
VIPEnabledHostAllowsRootCommands [422]	
VIPEnabledHostArpPath [423]	
VIPEnabledHostIfconfigPath [423]	
VerticaUserGroupsCheck [423]	Checks that the Vertica user has the correct OS group membership
WhichAvailableCheck [423]	Checks the existence of a working which command
WriteableHomeDirectoryCheck [423]	Ensures the home directory can be written to
WriteableTempDirectoryCheck [423]	Ensures the temporary directory can be written to
XtrabackupAvailableCheck [423]	
XtrabackupDirectoryWriteableCheck [423]	
XtrabackupSettingsCheck [423]	

– BackupDirectoryWriteableCheck [410]

Option	BackupDirectoryWriteableCheck [410]
Description	Checks that the configured backup directory is writeable

Confirms that the directory defined in --backup-dir directory exists and can be written to.

– BackupDumpDirectoryWriteableCheck [410]

Option	BackupDumpDirectoryWriteableCheck [410]
Description	Checks the backup temp directory is writeable

Confirms that the directory defined in --backup-dump-dir directory exists and can be written to.

– BackupScriptAvailableCheck [410]

Option	BackupScriptAvailableCheck [410]
Description	Checks that the configured backup script exists and can be executed

Confirms that the script defined in --backup-script [435] exists and is executable.

– ClusterDiagnosticCheck [410]

Option	ClusterDiagnosticCheck [410]
Description	

– ClusterStatusCheck [410]

Option	ClusterStatusCheck [410]
Description	

– CommitDirectoryCheck [410]

Option	CommitDirectoryCheck [410]
Description	

– ConfigurationStorageDirectoryCheck [410]

Option	ConfigurationStorageDirectoryCheck [410]
Description	

– ConfigureValidationCheck [411]

Option	ConfigureValidationCheck [411]
Description	

– ConfiguredDirectoryCheck [411]

Option	ConfiguredDirectoryCheck [411]
Description	

– ConflictingReplicationServiceTHLPortsCheck [411]

Option	ConflictingReplicationServiceTHLPortsCheck [411]
Description	

– ConnectorChecks [411]

Option	ConnectorChecks [411]
Description	Ensures that the configured connector selection is valid

Checks that the list of connectors and the corresponding list of data services is valid.

– ConnectorDBVersionCheck [411]

Option	ConnectorDBVersionCheck [411]
Description	

– ConnectorListenerAddressCheck [411]

Option	ConnectorListenerAddressCheck [411]
Description	

– ConnectorRWROAddressesCheck [411]

Option	ConnectorRWROAddressesCheck [411]
Description	Ensure the RW and RO addresses are different

For environments where the connector has been configured to use different hosts and ports for RW and RO operations, ensure that the settings are in fact different.

– ConnectorSmartScaleAllowedCheck [411]

Option	ConnectorSmartScaleAllowedCheck [411]
Description	Confirms whether SmartScale is valid within the current configured parameters

Checks that both SmartScale and Read/Write splitting have been enabled.

– ConnectorUserCheck [411]

Option	ConnectorUserCheck [411]
Description	

– ConsistentReplicationCredentialsCheck [411]

Option	ConsistentReplicationCredentialsCheck [411]
Description	

– CurrentCommandCoordinatorCheck [412]

Option	CurrentCommandCoordinatorCheck [412]
Description	

– CurrentConnectorCheck [412]

Option	CurrentConnectorCheck [412]
Description	

– CurrentReleaseDirectoryIsSymlink [412]

Option	CurrentReleaseDirectoryIsSymlink [412]
Description	

– CurrentTopologyCheck [412]

Option	CurrentTopologyCheck [412]
Description	

– CurrentVersionCheck [412]

Option	CurrentVersionCheck [412]
Description	

– DatasourceBootScriptCheck [412]

Option	DatasourceBootScriptCheck [412]
Description	

– DifferentMasterSlaveCheck [412]

Option	DifferentMasterSlaveCheck [412]
Description	

– DirectOracleServiceSIDCheck [412]

Option	DirectOracleServiceSIDCheck [412]
Description	

– EncryptionCheck [412]

Option	EncryptionCheck [412]
Description	

– EncryptionKeystoreCheck [412]

Option	EncryptionKeystoreCheck [412]
Description	

– FileValidationCheck [412]

Option	FileValidationCheck [412]
Description	

– FirewallCheck [412]

Option	FirewallCheck [412]

Description	

– GlobalHostAddressesCheck [413]

Option	GlobalHostAddressesCheck [413]
Description	

– GlobalHostOracleLibrariesFoundCheck [413]

Option	GlobalHostOracleLibrariesFoundCheck [413]
Description	

– GlobalMatchingPingMethodCheck [413]

Option	GlobalMatchingPingMethodCheck [413]
Description	

– GlobalRestartComponentsCheck [413]

Option	GlobalRestartComponentsCheck [413]
Description	

– GroupValidationCheck [413]

Option	GroupValidationCheck [413]
Description	

– HdfsValidationCheck [413]

Option	HdfsValidationCheck [413]
Description	

– HostLicensesCheck [413]

Option	HostLicensesCheck [413]
Description	

– HostOracleLibrariesFoundCheck [413]

Option	HostOracleLibrariesFoundCheck [413]
Description	

– HostReplicatorServiceRunningCheck [413]

Option	HostReplicatorServiceRunningCheck [413]
Description	

– HostSkippedChecks [413]

Option	HostSkippedChecks [413]
Description	

– HostnameCheck [413]

Option	HostnameCheck [413]
Description	

– HostsFileCheck [413]

Option	HostsFileCheck [413]

Description	

– InstallServicesCheck [414]

Option	InstallServicesCheck [414]
Description	

– InstallationScriptCheck [414]

Option	InstallationScriptCheck [414]
Description	

– InstallerMasterSlaveCheck [414]

Option	InstallerMasterSlaveCheck [414]
Description	Checks whether a Primary host has been defined for the configured service.

– InstallingOverExistingInstallation [414]

Option	InstallingOverExistingInstallation [414]
Description	

– JavaUserTimezoneCheck [414]

Option	JavaUserTimezoneCheck [414]
Description	

– JavaVersionCheck [414]

Option	JavaVersionCheck [414]
Description	

– KeystoresCheck [414]

Option	KeystoresCheck [414]
Description	

– KeystoresToCommitCheck [414]

Option	KeystoresToCommitCheck [414]
Description	

– ManagerActiveWitnessConversionCheck [414]

Option	ManagerActiveWitnessConversionCheck [414]
Description	

– ManagerChecks [414]

Option	ManagerChecks [414]
Description	

– ManagerHeapThresholdCheck [414]

Option	ManagerHeapThresholdCheck [414]
Description	

– ManagerListenerAddressCheck [414]

Option	ManagerListenerAddressCheck [414]

Description	

– ManagerPingMethodCheck [415]

Option	ManagerPingMethodCheck [415]
Description	

– ManagerWitnessAvailableCheck [415]

Option	ManagerWitnessAvailableCheck [415]
Description	

– ManagerWitnessNeededCheck [415]

Option	ManagerWitnessNeededCheck [415]
Description	

– MatchingHomeDirectoryCheck [415]

Option	MatchingHomeDirectoryCheck [415]
Description	

– MissingReplicationServiceConfigurationCheck [415]

Option	MissingReplicationServiceConfigurationCheck [415]
Description	

– ModifiedConfigurationFilesCheck [415]

Option	ModifiedConfigurationFilesCheck [415]
Description	

– MySQLAllowIntensiveChecks [415]

Option	MySQLAllowIntensiveChecks [415]
Description	Enables searching MySQL INFORMATION_SCHEMA for validation checks

Enables tpm to make use of the MySQL INFORMATION_SCHEMA to perform various validation checks. These include, but are not limited to:

- Tables not configured to use transactional tables
- Unsupported datatypes in MySQL tables

– MySQLApplierLogsCheck [415]

Option	MySQLApplierLogsCheck [415]
Description	

– MySQLApplierPortCheck [415]

Option	MySQLApplierPortCheck [415]
Description	

– MySQLApplierServerIDCheck [415]

Option	MySQLApplierServerIDCheck [415]
Description	

– MySQLAvailableCheck [415]

Option	MySQLAvailableCheck [415]

Description	Checks if MySQL is installed

– MySQLBinaryLogsEnabledCheck [416]

Option	MySQLBinaryLogsEnabledCheck [416]
Description	Checks that binary logging has been enabled on MySQL

Examines the log_bin variable has been defined within the running MySQL server. Binary logging must be enabled for replication to work.

– MySQLBinlogDoDbCheck [416]

Option	MySQLBinlogDoDbCheck [416]
Description	

– MySQLClientCheck [416]

Option	MySQLClientCheck [416]
Description	Checks whether the MySQL client command tool is available

– MySQLConfigFileCheck [416]

Option	MySQLConfigFileCheck [416]
Description	Checks the existence of a MySQL configuration file

– MySQLConnectorBridgeModePermissionsCheck [416]

Option	MySQLConnectorBridgeModePermissionsCheck [416]
Description	

– MySQLConnectorPermissionsCheck [416]

Option	MySQLConnectorPermissionsCheck [416]
Description	

– MySQLDefaultTableTypeCheck [416]

Option	MySQLDefaultTableTypeCheck [416]
Description	Checks the default table type for MySQL

Checks that the default table type configured for MySQL is a compatible transactional storage engine such as InnoDB

– MySQLDumpCheck [416]

Option	MySQLDumpCheck [416]
Description	Checks that the mysqldump command version matches the installed MySQL

Checks whether the mysqldump command within the configured PATH matches the version of MySQL being configured as a source or target. A mismatch could indicate that multiple MySQL versions are installed.

A mismatch could create invalid or corrupt backups. Either correct your PATH or use --preferred-path [460] to point to the correct MySQL installation.

– MySQLGeneratedColumnCheck [416]

Option	MySQLGeneratedColumnCheck [416]
Description	Checks whether MySQL virtual/generated columns are defined

Checks, whether any tables contain generated or virtual columns. The test is only executed on MySQL 5.7 and only if --mysql-allow-intensive-checks [457] has been enabled.

– MySQLInnoDBEnabledCheck [416]

Option	MySQLInnoDBEnabledCheck [416]
Description	

– MySQLJsonDataTypeCheck [417]

Option	MySQLJsonDataTypeCheck [417]
Description	

Checks, whether any tables contain JSON columns. The test is only executed on MySQL 5.7 and only if --mysql-allow-intensive-checks [457] has been enabled.

– MySQLLoadDataInfilePermissionsCheck [417]

Option	MySQLLoadDataInfilePermissionsCheck [417]
Description	

– MySQLLoginCheck [417]

Option	MySQLLoginCheck [417]
Description	Checks whether Tungsten Cluster can connect to MySQL using the configured credentials

– MySQLMyISAMCheck [417]

Option	MySQLMyISAMCheck [417]
Description	Checks for the existence of MyISAM tables

Checks for the existence of MyISAM tables within the database. Use of MyISAM tables is not supported since MyISAM is not transactionally consistent. This can cause problems for both extraction and applying data.

In order to check for the existence of MyISAM tables, tpm uses two techniques:

- Looking for .MYD files within the MySQL directory, which are the files which contains MyISAM data. tpm must be able to read and see the contents of the MySQL data directory. If the configured user does not already have access, you can use the --root-command-prefix=true [449] option to grant root access to access the filesystem.
- Using the MySQL INFORMATION_SCHEMA to look for tables defined with the MyISAM engine. For this option to work, intensive checks must have been enabled using --mysql-allow-intensive-checks [457].

If neither of these methods is available, the check will fail and installation will stop.

– MySQLNoMySQLReplicationCheck [417]

Option	MySQLNoMySQLReplicationCheck [417]
Description	

– MySQLPasswordSettingCheck [417]

Option	MySQLPasswordSettingCheck [417]
Description	

– MySQLPermissionsCheck [417]

Option	MySQLPermissionsCheck [417]
Description	

– MySQLReadableLogsCheck [417]

Option	MySQLReadableLogsCheck [417]
Description	

– MySQLSettingsCheck [417]

Option	MySQLSettingsCheck [417]
Description	

– MySQLSuperReadOnlyCheck [418]

Option	MySQLSuperReadOnlyCheck [418]
Description	Checks whether super_read_only has been enabled on MySQL

Checks whether the super_read_only variable within MySQL has been enabled. If enabled, replication will not work. The check will test both the running server and the configuration file to determine whether the value has been enabled.

– MySQLTriggerCheck [418]

Option	MySQLTriggerCheck [418]
Description	

– MySQLUnsupportedDataTypesCheck [418]

Option	MySQLUnsupportedDataTypesCheck [418]
Description	

– MysqlConnectorCheck [418]

Option	MysqlConnectorCheck [418]
Description	

– MysqldumpAvailableCheck [418]

Option	MysqldumpAvailableCheck [418]
Description	

– MysqldumpSettingsCheck [418]

Option	MysqldumpSettingsCheck [418]
Description	

– NewDirectoryRequiredCheck [418]

Option	NewDirectoryRequiredCheck [418]
Description	

– NtpdRunningCheck [418]

Option	NtpdRunningCheck [418]
Description	

– OSCheck [418]

Option	OSCheck [418]
Description	

– OldServicesRunningCheck [418]

Option	OldServicesRunningCheck [418]
Description	

– OpenFilesLimitCheck [418]

Option	OpenFilesLimitCheck [418]

Description	

– OpensslLibraryCheck [419]

Option	OpensslLibraryCheck [419]
Description	

– OracleLoginCheck [419]

Option	OracleLoginCheck [419]
Description	

– OraclePermissionsCheck [419]

Option	OraclePermissionsCheck [419]
Description	

– OracleRedoReaderMinerDirectoryCheck [419]

Option	OracleRedoReaderMinerDirectoryCheck [419]
Description	

– OracleServiceSIDCheck [419]

Option	OracleServiceSIDCheck [419]
Description	

– OracleVersionCheck [419]

Option	OracleVersionCheck [419]
Description	

– PGAvailableCheck [419]

Option	PGAvailableCheck [419]
Description	

– ParallelReplicationCheck [419]

Option	ParallelReplicationCheck [419]
Description	

– ParallelReplicationCountCheck [419]

Option	ParallelReplicationCountCheck [419]
Description	

– PgControlAvailableCheck [419]

Option	PgControlAvailableCheck [419]
Description	

– PgStandbyAvailableCheck [419]

Option	PgStandbyAvailableCheck [419]
Description	

– PgdumpAvailableCheck [419]

Option	PgdumpAvailableCheck [419]
Description	

– PgdumpallAvailableCheck [420]

Option	PgdumpallAvailableCheck [420]
Description	

– PingSyntaxCheck [420]

Option	PingSyntaxCheck [420]
Description	

– PortAvailabilityCheck [420]

Option	PortAvailabilityCheck [420]
Description	

– ProfileScriptCheck [420]

Option	ProfileScriptCheck [420]
Description	

– RMIListenerAddressCheck [420]

Option	RMIListenerAddressCheck [420]
Description	

– RelayDirectoryWriteableCheck [420]

Option	RelayDirectoryWriteableCheck [420]
Description	Checks that the relay log directory can be written to

Confirms that the directory defined in `--relay-log-dir` directory exists and can be written to.

– ReplicatorChecks [420]

Option	ReplicatorChecks [420]
Description	

– RestartComponentsCheck [420]

Option	RestartComponentsCheck [420]
Description	

– RouterAffinityCheck [420]

Option	RouterAffinityCheck [420]
Description	

– RouterBridgeModeDefaultCheck [420]

Option	RouterBridgeModeDefaultCheck [420]
Description	

– RouterDelayBeforeOfflineCheck [420]

Option	RouterDelayBeforeOfflineCheck [420]

Description	

– RouterKeepAliveTimeoutCheck [421]

Option	RouterKeepAliveTimeoutCheck [421]
Description	

– RowBasedBinaryLoggingCheck [421]

Option	RowBasedBinaryLoggingCheck [421]
Description	Checks that Row-based binary logging has been enabled for heterogeneous deployments

For heterogeneous deployments, row-based binary logging must have been enabled. For all services where heterogeneous support has been enabled, for example due to --enable-heterogeneous-service [447] or --enable-batch-service, row-based logging within MySQL must have been switched on. The test looks for the value of binlog_format=ROW.

– RsyncAvailableCheck [421]

Option	RsyncAvailableCheck [421]
Description	

– RubyVersionCheck [421]

Option	RubyVersionCheck [421]
Description	

– SSHLoginCheck [421]

Option	SSHLoginCheck [421]
Description	Checks connectivity to other hosts over SSH

Checks to confirm the SSH logins to other hosts in the cluster work, without requiring a password, and without returning additional rows of information when directly, remotely, running a command.

In the event of the check failing, the following items should be checked:

- Confirm that it is possible to SSH to the remote site using the username provided, and without requiring a password. For example:

```
host1-shell> ssh tungsten@host2
Last login: Wed Aug 9 09:55:23 2017 from fe80::1042:8aee:61da:a20%en0
host2-shell>
```

- Remove any remote messages returned when the user logs in. This includes the output from the *Banner* argument within /etc/ssh/sshd_config, or text or files output by the users shell login script or profile.
- Ensure that your remote shell has not been configured to output text or a message when a logout is attempted, for example by using:

```
shell> trap "echo logout" 0
```

– ServiceTransferredLogStorageCheck [421]

Option	ServiceTransferredLogStorageCheck [421]
Description	

– StartingStoppedServices [421]

Option	StartingStoppedServices [421]
Description	

– SudoCheck [421]

Option	SudoCheck [421]
Description	

– SwappinessCheck [422]

Option	SwappinessCheck [422]
Description	Checks the swappiness OS configuration is within a recommended range

Checks whether the Linux swappiness parameter has been set to a value of 10 or less, both in the current setting and when the system reboots. A value greater than 10 may allow for running programs to be swapped out, which will affect the performance of the Tungsten Cluster when running. Change the value in sysctl.conf.

– THLDirectoryWriteableCheck [422]

Option	THLDirectoryWriteableCheck [422]
Description	

– THLListenerAddressCheck [422]

Option	THLListenerAddressCheck [422]
Description	

– THLSchemaChangeCheck [422]

Option	THLSchemaChangeCheck [422]
Description	Ensures that the existing THL format is compatible with the new release

Checks that the format of the current THL is compatible with the schema and format of the new software. A difference may mean that the THL needs to be reset before installation can continue.

– THLStorageCheck [422]

Option	THLStorageCheck [422]
Description	Confirms the THL storage directory exists, is empty and writeable

Confirms that the directory configured for THL storage using --log-dir directory exists, is writeable, and is empty.

– THLStorageChecksum [422]

Option	THLStorageChecksum [422]
Description	

– TargetDirectoryDoesNotExist [422]

Option	TargetDirectoryDoesNotExist [422]
Description	

– TransferredLogStorageCheck [422]

Option	TransferredLogStorageCheck [422]
Description	

– UpgradeSameProductCheck [422]

Option	UpgradeSameProductCheck [422]
Description	Ensures that the same product is being updated

Updates must occur with the same product, for example, Tungsten Replicator to Tungsten Replicator. It is not possible to update replicator to cluster, or cluster to replicator.

– VIPEnabledHostAllowsRootCommands [422]

Option	VIPEnabledHostAllowsRootCommands [422]
Description	

– VIPEnabledHostArpPath [423]

Option	VIPEnabledHostArpPath [423]
Description	

– VIPEnabledHostIfconfigPath [423]

Option	VIPEnabledHostIfconfigPath [423]
Description	

– VerticaUserGroupsCheck [423]

Option	VerticaUserGroupsCheck [423]
Description	Checks that the Vertica user has the correct OS group membership

Checks whether the user running Vertica is a member of the tungsten user's primary group. Without this setting, the CSV files generated by the replicator would not be readable by Vertica when importing them into the database during batchloading.

– WhichAvailableCheck [423]

Option	WhichAvailableCheck [423]
Description	Checks the existence of a working which command

Checks the existence of a working which command.

– WriteableHomeDirectoryCheck [423]

Option	WriteableHomeDirectoryCheck [423]
Description	Ensures the home directory can be written to

Checks that the home directory for the configured user can be written to.

– WriteableTempDirectoryCheck [423]

Option	WriteableTempDirectoryCheck [423]
Description	Ensures the temporary directory can be written to

The temporary directory is used during installation to store a variety of information. This check ensures that the directory is writeable, and that files can be created and deleted correctly.

– XtrabackupAvailableCheck [423]

Option	XtrabackupAvailableCheck [423]
Description	

– XtrabackupDirectoryWriteableCheck [423]

Option	XtrabackupDirectoryWriteableCheck [423]
Description	

– XtrabackupSettingsCheck [423]

Option	XtrabackupSettingsCheck [423]
Description	

10.8. tpm Configuration Options

tpm supports a large range of configuration options, which can be specified either:

- On the command-line, using a double-dash prefix, i.e. --repl-thl-log-retention=3d [470]

- In an INI file, without the double-dash prefix, i.e. `repl-thl-log-retention=3d` [470]

A full list of all the available options supported is provided in Table 10.6, "tpm Configuration Options".

Table 10.6. tpm Configuration Options

CmdLine Option	INI File Option	Description
`--application-password` [432], `--connector-password` [432]	`application-password` [432], `connector-password` [432]	Database password for the connector
`--application-port` [432], `--connector-listen-port` [432]	`application-port` [432], `connector-listen-port` [432]	Port for the connector to listen on
`--application-readonly-port` [433], `--connector-readonly-listen-port` [433]	`application-readonly-port` [433], `connector-readonly-listen-port` [433]	Port for the connector to listen for read-only connections on
`--application-user` [433], `--connector-user` [433]	`application-user` [433], `connector-user` [433]	Database username for the connector
`--auto-enable` [433], `--repl-auto-enable` [433]	`auto-enable` [433], `repl-auto-enable` [433]	Auto-enable services after start-up
`--auto-recovery-delay-interval` [433], `--repl-auto-recovery-delay-interval` [433]	`auto-recovery-delay-interval` [433], `repl-auto-recovery-delay-interval` [433]	Delay (in seconds) between going OFFLINE and attempting to go ONLINE
`--auto-recovery-max-attempts` [433], `--repl-auto-recovery-max-attempts` [433]	`auto-recovery-max-attempts` [433], `repl-auto-recovery-max-attempts` [433]	Maximum number of attempts at automatic recovery
`--auto-recovery-reset-interval` [434], `--repl-auto-recovery-reset-interval` [434]	`auto-recovery-reset-interval` [434], `repl-auto-recovery-reset-interval` [434]	Delay (in seconds) before autorecovery is deemed to have succeeded
`--backup-directory` [434], `--repl-backup-directory` [434]	`backup-directory` [434], `repl-backup-directory` [434]	Permanent backup storage directory
`--backup-dump-directory` [434], `--repl-backup-dump-directory` [434]	`backup-dump-directory` [434], `repl-backup-dump-directory` [434]	Backup temporary dump directory
`--backup-method` [434], `--repl-backup-method` [434]	`backup-method` [434], `repl-backup-method` [434]	Database backup method
`--backup-online` [435], `--repl-backup-online` [435]	`backup-online` [435], `repl-backup-online` [435]	Does the backup script support backing up a datasource while it is ONLINE
`--backup-retention` [435], `--repl-backup-retention` [435]	`backup-retention` [435], `repl-backup-retention` [435]	Number of backups to retain
`--backup-script` [435], `--repl-backup-script` [435]	`backup-script` [435], `repl-backup-script` [435]	What is the path to the backup script
`--batch-enabled` [435]	`batch-enabled` [435]	Should the replicator service use a batch applier
`--batch-load-language` [435]	`batch-load-language` [435]	Which script language to use for batch loading
`--batch-load-template` [435]	`batch-load-template` [435]	Value for the loadBatchTemplate property
`--repl-buffer-size` [436]	`repl-buffer-size` [436]	Replicator queue size between stages (min 1)
`--channels` [436], `--repl-channels` [436]	`channels` [436], `repl-channels` [436]	Number of replication channels to use for parallel apply.
`--cluster-slave-auto-recovery-delay-interval` [436], `--cluster-slave-repl-auto-recovery-delay-interval` [436]	`cluster-slave-auto-recovery-delay-interval` [436], `cluster-slave-repl-auto-recovery-delay-interval` [436]	Default value for --auto-recovery-delay-interval when --topology=cluster-slave
`--cluster-slave-auto-recovery-max-attempts` [436], `--cluster-slave-repl-auto-recovery-max-attempts` [436]	`cluster-slave-auto-recovery-max-attempts` [436], `cluster-slave-repl-auto-recovery-max-attempts` [436]	Default value for --auto-recovery-max-attempts when --topology=cluster-slave
`--cluster-slave-auto-recovery-reset-interval` [436], `--cluster-slave-repl-auto-recovery-reset-interval` [436]	`cluster-slave-auto-recovery-reset-interval` [436], `cluster-slave-repl-auto-recovery-reset-interval` [436]	Default value for --auto-recovery-reset-interval when --topology=cluster-slave

CmdLine Option	INI File Option	Description
--composite-datasources [436], --dataservice-composite-data-sources [436]	composite-datasources [436], dataservice-composite-data-sources [436]	Data services that should be added to this composite data service
--config-file [436]	config-file [436]	Display help information for content of the config file
--conn-java-enable-concur-rent-gc [437]	conn-java-enable-concur-rent-gc [437]	Connector Java uses concurrent garbage collection
--conn-java-mem-size [437]	conn-java-mem-size [437]	Connector Java heap memory size used to buffer data between clients and databases
--conn-round-robin-include-mas-ter [437]	conn-round-robin-include-mas-ter [437]	Should the Connector include the Primary in round-robin load balancing
--connector-affinity [437]	connector-affinity [437]	The default affinity for all connections
--connector-autoreconnect [437]	connector-autoreconnect [437]	Enable auto-reconnect in the connector
--connector-autoreconnect-killed-con-nections [437]	connector-autoreconnect-killed-con-nections [437]	Enable autoreconnect for connections killed within the connector
--connector-bridge-mode [438], --enable-connector-bridge-mode [438]	connector-bridge-mode [438], en-able-connector-bridge-mode [438]	Enable the Tungsten Connector bridge mode
--connector-default-schema [438], --connector-forced-schema [438]	connector-default-schema [438], connector-forced-schema [438]	Default schema for the connector to use
--connector-delete-user-map [438]	connector-delete-user-map [438]	Overwrite an existing user.map file
--connector-disable-connection-warn-ings [438]	connector-disable-connection-warn-ings [438]	Hide Connector warnings in log files
--connector-disconnect-time-out [438]	connector-disconnect-timeout [438]	Time (in seconds) to wait for active connection to disconnect before forcing them closed [default: 5]
--connector-drop-after-max-connec-tions [439]	connector-drop-after-max-connec-tions [439]	Instantly drop connections that arrive after --connector-max-connec-tions has been reached
--connector-keepalive-time-out [439]	connector-keepalive-timeout [439]	Delay (in ms) after which a manager connection is considered bro-ken by the connector if no keep-alive command was received. Value must be positive and lower than 300000 (5 min) or the connector will refuse to start. Make sure the manager has mgr-monitor-interval val-ue set greater than this, it controls the frequency at which keep-alive commands are sent.
--connector-listen-interface [439]	connector-listen-interface [439]	Listen interface to use for the connector
--connector-max-connections [439]	connector-max-connections [439]	The maximum number of connections the connector should allow at any time
--connector-max-slave-laten-cy [439], --connector-max-ap-plied-latency [439]	connector-max-applied-laten-cy [439], connector-max-slave-la-tency [439]	The maximum applied latency for replica connections. Disabled by default.
--connector-readonly [439], --en-able-connector-readonly [439]	connector-readonly [439], en-able-connector-readonly [439]	Enable the Tungsten Connector read-only mode
--connector-ro-addresses [439]	connector-ro-addresses [439]	Connector addresses that should receive a r/o connection
--connector-rw-addresses [440]	connector-rw-addresses [440]	Connector addresses that should receive a r/w connection
--connector-rwsplitting [440]	connector-rwsplitting [440]	Enable DirectReads R/W splitting in the connector
--connector-smartscale [440]	connector-smartscale [440]	Enable SmartScale R/W splitting in the connector
--connector-smartscale-session-id [440]	connector-smartscale-session-id [440]	The default session ID to use with smart scale
--connector-ssl-capable [440]	connector-ssl-capable [440]	Defines whether connector ports are advertised as being capable of SSL
--connectors [440], --dataser-vice-connectors [440]	connectors [440], dataservice-con-nectors [440]	Hostnames for the dataservice connectors
--consistency-policy [441], --re-pl-consistency-policy [441]	consistency-policy [441], repl-con-sistency-policy [441]	Should the replicator stop or warn if a consistency check fails?

CmdLine Option	INI File Option	Description
--dataservice-name [441]	dataservice-name [441]	Limit the command to the hosts in this dataservice Multiple data services may be specified by providing a comma separated list
--dataservice-relay-enabled [441]	dataservice-relay-enabled [441]	Make this dataservice a replica of another
--dataservice-schema [441]	dataservice-schema [441]	The db schema to hold dataservice details
--dataservice-thl-port [441]	dataservice-thl-port [441]	Port to use for THL operations
--dataservice-use-relative-latency [441], --use-relative-latency [441]	dataservice-use-relative-latency [441], use-relative-latency [441]	Enable the cluster to operate on relative latency
--dataservice-vip-enabled [441]	dataservice-vip-enabled [441]	Is VIP management enabled?
--dataservice-vip-ipaddress [442]	dataservice-vip-ipaddress [442]	VIP IP address
--dataservice-vip-netmask [442]	dataservice-vip-netmask [442]	VIP netmask
--datasource-boot-script [442], --repl-datasource-boot-script [442]	datasource-boot-script [442], repl-datasource-boot-script [442]	Database start script
--datasource-enable-ssl [442], --repl-datasource-enable-ssl [442]	datasource-enable-ssl [442], repl-datasource-enable-ssl [442]	Enable SSL connection to DBMS server
--datasource-log-directory [442], --repl-datasource-log-directory [442]	datasource-log-directory [442], repl-datasource-log-directory [442]	Primary log directory
--datasource-log-pattern [442], --repl-datasource-log-pattern [442]	datasource-log-pattern [442], repl-datasource-log-pattern [442]	Primary log filename pattern
--datasource-mysql-conf [442], --repl-datasource-mysql-conf [442]	datasource-mysql-conf [442], repl-datasource-mysql-conf [442]	MySQL config file
--datasource-mysql-data-directory [443], --repl-datasource-mysql-data-directory [443]	datasource-mysql-data-directory [443], repl-datasource-mysql-data-directory [443]	MySQL data directory
--datasource-mysql-ibdata-directory [443], --repl-datasource-mysql-ibdata-directory [443]	datasource-mysql-ibdata-directory [443], repl-datasource-mysql-ibdata-directory [443]	MySQL InnoDB data directory
--datasource-mysql-iblog-directory [443], --repl-datasource-mysql-iblog-directory [443]	datasource-mysql-iblog-directory [443], repl-datasource-mysql-iblog-directory [443]	MySQL InnoDB log directory
--datasource-mysql-ssl-ca [443], --repl-datasource-mysql-ssl-ca [443]	datasource-mysql-ssl-ca [443], repl-datasource-mysql-ssl-ca [443]	MySQL SSL CA file
--datasource-mysql-ssl-cert [443], --repl-datasource-mysql-ssl-cert [443]	datasource-mysql-ssl-cert [443], repl-datasource-mysql-ssl-cert [443]	MySQL SSL certificate file
--datasource-mysql-ssl-key [443], --repl-datasource-mysql-ssl-key [443]	datasource-mysql-ssl-key [443], repl-datasource-mysql-ssl-key [443]	MySQL SSL key file
--datasource-systemctl-service [443], --repl-datasource-systemctl-service [443]	datasource-systemctl-service [443], repl-datasource-systemctl-service [443]	Database systemctl script
--datasource-type [444], --repl-datasource-type [444]	datasource-type [444], repl-datasource-type [444]	Database type
--delete [444]	delete [444]	Delete the named data service from the configuration Data Service options
--deploy-current-package [444]	deploy-current-package [444]	Deploy the current Tungsten package
--deploy-package-uri [444]	deploy-package-uri [444]	URL for the Tungsten package to deploy
--direct-datasource-log-directory [444], --repl-direct-datasource-log-directory [444]	direct-datasource-log-directory [444], repl-direct-datasource-log-directory [444]	Primary log directory

CmdLine Option	INI File Option	Description
--direct-datasource-log-pattern [445], --repl-direct-datasource-log-pattern [445]	direct-datasource-log-pattern [445], repl-direct-datasource-log-pattern [445]	Primary log filename pattern
--direct-datasource-type [445], --repl-direct-datasource-type [445]	direct-datasource-type [445], repl-direct-datasource-type [445]	Database type
--direct-replication-host [445], --direct-datasource-host [445], --repl-direct-datasource-host [445]	direct-datasource-host [445], direct-replication-host [445], repl-direct-datasource-host [445]	Database server hostname
--direct-replication-password [445], --direct-datasource-password [445], --repl-direct-datasource-password [445]	direct-datasource-password [445], direct-replication-password [445], repl-direct-datasource-password [445]	Password for datasource connection
--direct-replication-port [445], --direct-datasource-port [445], --repl-direct-datasource-port [445]	direct-datasource-port [445], direct-replication-port [445], repl-direct-datasource-port [445]	Database server port
--direct-replication-user [445], --direct-datasource-user [445], --repl-direct-datasource-user [445]	direct-datasource-user [445], direct-replication-user [445], repl-direct-datasource-user [445]	Database login for Tungsten
--directory [446]	directory [446]	Set the directory of an existing installation used during fetching an existing configuration
--disable-relay-logs [446], --repl-disable-relay-logs [446]	disable-relay-logs [446], repl-disable-relay-logs [446]	Disable the use of relay-logs?
--disable-security-controls [446]	disable-security-controls [446]	Disables all forms of security, including SSL, TLS and authentication
--disable-slave-extractor [446], --repl-disable-slave-extractor [446]	disable-slave-extractor [446], repl-disable-slave-extractor [446]	Should replica servers support the primary role?
--drop-static-columns-in-updates [446]	drop-static-columns-in-updates [446]	This will modify UPDATE transactions in row-based replication and eliminate any columns that were not modified.
--enable-active-witnesses [446], --active-witnesses [446]	active-witnesses [446], enable-active-witnesses [446]	Enable active witness hosts
--enable-connector-client-ssl [447], --connector-client-ssl [447]	connector-client-ssl [447], enable-connector-client-ssl [447]	Enable SSL encryption of traffic from the client to the connector
--enable-connector-server-ssl [447], --connector-server-ssl [447]	connector-server-ssl [447], enable-connector-server-ssl [447]	Enable SSL encryption of traffic from the connector to the database
--enable-connector-ssl [447], --connector-ssl [447]	connector-ssl [447], enable-connector-ssl [447]	Enable SSL encryption of connector traffic to the database
--enable-heterogeneous-master [447]	enable-heterogeneous-master [447]	Enable heterogeneous operation for the primary
--enable-heterogeneous-service [447]	enable-heterogeneous-service [447]	Enable heterogeneous operation
--enable-heterogeneous-slave [448]	enable-heterogeneous-slave [448]	Enable heterogeneous operation for the replica
--enable-jgroups-ssl [448], --jgroups-ssl [448]	enable-jgroups-ssl [448], jgroups-ssl [448]	Enable SSL encryption of JGroups communication on this host
--enable-rmi-authentication [448], --rmi-authentication [448]	enable-rmi-authentication [448], rmi-authentication [448]	Enable RMI authentication for the services running on this host
--enable-rmi-ssl [448], --rmi-ssl [448]	enable-rmi-ssl [448], rmi-ssl [448]	Enable SSL encryption of RMI communication on this host
--enable-slave-thl-listener [448], --repl-enable-slave-thl-listener [448]	enable-slave-thl-listener [448], repl-enable-slave-thl-listener [448]	Should this service allow THL connections?
--enable-sudo-access [449], --root-command-prefix [449]	enable-sudo-access [449], root-command-prefix [449]	Run root commands using sudo

CmdLine Option	INI File Option	Description
--enable-thl-ssl [449], --repl-enable-thl-ssl [449], --thl-ssl [449]	enable-thl-ssl [449], repl-enable-thl-ssl [449], thl-ssl [449]	Enable SSL encryption of THL communication for this service
--executable-prefix [449]	executable-prefix [449]	Adds a prefix to command aliases
--file-protection-level [449]	file-protection-level [449]	Protection level for Continuent files
--file-protection-umask [450]	file-protection-umask [450]	Protection umask for Continuent files
--host-name [450]	host-name [450]	DNS hostname
--hosts [450]	hosts [450]	Limit the command to the hosts listed You must use the hostname as it appears in the configuration.
--hub [450], --dataservice-hub-host [450]	dataservice-hub-host [450], hub [450]	What is the hub host for this all-masters dataservice?
--hub-service [450], --dataservice-hub-service [450]	dataservice-hub-service [450], hub-service [450]	The data service to use for the hub of a star topology
--install [450]	install [450]	Install service start scripts
--install-directory [450], --home-directory [450]	home-directory [450], install-directory [450]	Installation directory
--java-connector-keystore-password [451]	java-connector-keystore-password [451]	Set the password for unlocking the tungsten_connector_keystore.jks file in the security directory. Specific to connector<->mysql communication only.
--java-connector-keystore-path [451]	java-connector-keystore-path [451]	Local path to the Java Connector Keystore file. Specific to connector<->mysql communication only.
--java-connector-truststore-password [451]	java-connector-truststore-password [451]	Set the password for unlocking the tungsten_connector_truststore.jks file in the security directory. Specific to connector<->mysql communication only.
--java-connector-truststore-path [451]	java-connector-truststore-path [451]	Local path to the Java Connector Truststore file. Specific to connector<->mysql communication only.
--java-enable-concurrent-gc [451], --repl-java-enable-concurrent-gc [451]	java-enable-concurrent-gc [451], repl-java-enable-concurrent-gc [451]	Replicator Java uses concurrent garbage collection
--java-external-lib-dir [451], --repl-java-external-lib-dir [451]	java-external-lib-dir [451], repl-java-external-lib-dir [451]	Directory for 3rd party Jar files required by replicator
--java-file-encoding [452], --repl-java-file-encoding [452]	java-file-encoding [452], repl-java-file-encoding [452]	Java platform charset (esp. for heterogeneous replication)
--java-jgroups-key [452]	java-jgroups-key [452]	The alias to use for the JGroups TLS key in the keystore.
--java-jgroups-keystore-path [452]	java-jgroups-keystore-path [452]	Local path to the JGroups Java Keystore file.
--java-jmxremote-access-path [452]	java-jmxremote-access-path [452]	Local path to the Java JMX Remote Access file.
--java-keystore-password [452]	java-keystore-password [452]	Set the password for unlocking the tungsten_keystore.jks file in the security directory. Specific for intra cluster communication.
--java-keystore-path [452]	java-keystore-path [452]	Local path to the Java Keystore file. Specific for intra cluster communication. NOTE: When java-keystore-path is passed to tpm, the keystore must contain both tls and mysql certs when appropriate. tpm will NOT add mysql cert nor generate tls cert when this flag is found, so both certs must be manually imported already.
--java-mem-size [452], --repl-java-mem-size [452]	java-mem-size [452], repl-java-mem-size [452]	Replicator Java heap memory size in Mb (min 128)
--java-passwordstore-path [452]	java-passwordstore-path [452]	Local path to the Java Password Store file.
--java-tls-alias [453]	java-tls-alias [453]	The alias to use for the TLS key/certificate in the keystore and truststore.
--java-tls-key-lifetime [453]	java-tls-key-lifetime [453]	Lifetime for the Java TLS key
--java-tls-keystore-path [453]	java-tls-keystore-path [453]	The keystore holding a certificate to use for all Continuent TLS encryption.

CmdLine Option	INI File Option	Description
--java-truststore-password [453]	java-truststore-password [453]	The password for unlocking the tungsten_truststore.jks file in the security directory
--java-truststore-path [453]	java-truststore-path [453]	Local path to the Java Truststore file.
--java-user-timezone [453], --repl-java-user-timezone [453]	java-user-timezone [453], repl-java-user-timezone [453]	Java VM Timezone (esp. for cross-site replication)
--log [453]	log [453]	Write all messages, visible and hidden, to this file. You may specify a filename, 'pid' or 'timestamp'.
--log-slave-updates [454]	log-slave-updates [454]	Should replicas log updates to binlog
--master [454], --dataservice-master-host [454], --masters [454], --relay [454]	dataservice-master-host [454], master [454], masters [454], relay [454]	Hostname of the primary (or relay) host within this service
--master-preferred-role [454], --repl-master-preferred-role [454]	master-preferred-role [454], repl-master-preferred-role [454]	Preferred role for primary THL when connecting as a replica
--master-services [454], --dataservice-master-services [454]	dataservice-master-services [454], master-services [454]	Data service names that should be used on each Primary
--master-thl-host [454]	master-thl-host [454]	Primary THL Hostname
--master-thl-port [454]	master-thl-port [454]	Primary THL Port
--members [455], --dataservice-hosts [455]	dataservice-hosts [455], members [455]	Hostnames for the dataservice members
--metadata-directory [455], --repl-metadata-directory [455]	metadata-directory [455], repl-metadata-directory [455]	Replicator metadata directory
--mgr-api [455]	mgr-api [455]	Enable the Manager API
--mgr-api-address [455]	mgr-api-address [455]	Address for the Manager API
--mgr-api-full-access [455]	mgr-api-full-access [455]	Enable all Manager API commands. Only the status command will be enabled without it.
--mgr-api-port [455]	mgr-api-port [455]	Port for the Manager API
--mgr-group-communication-port [455]	mgr-group-communication-port [455]	Port to use for manager group communication
--mgr-heap-threshold [456]	mgr-heap-threshold [456]	Java memory usage (MB) that will force a Manager restart
--mgr-java-enable-concurrent-gc [456]	mgr-java-enable-concurrent-gc [456]	Manager Java uses concurrent garbage collection
--mgr-java-mem-size [456]	mgr-java-mem-size [456]	Manager Java heap memory size in Mb (min 128)
--mgr-listen-interface [456]	mgr-listen-interface [456]	Listen interface to use for the manager
--mgr-ping-method [456]	mgr-ping-method [456]	Mechanism to use when identifying the liveness of other data-sources (ping, echo)
--mgr-policy-mode [456]	mgr-policy-mode [456]	Manager policy mode
--mgr-rmi-port [456]	mgr-rmi-port [456]	Port to use for the manager RMI server
--mgr-rmi-remote-port [457]	mgr-rmi-remote-port [457]	Port to use for calling the remote manager RMI server
--mgr-ro-slave [457]	mgr-ro-slave [457]	Make replicas read-only
--mgr-vip-arp-path [457]	mgr-vip-arp-path [457]	Path to the arp binary
--mgr-vip-device [457]	mgr-vip-device [457]	VIP network device
--mgr-vip-ifconfig-path [457]	mgr-vip-ifconfig-path [457]	Path to the ifconfig binary
--mgr-wait-for-members [457]	mgr-wait-for-members [457]	Wait for all datasources to be available before completing installation
--mysql-allow-intensive-checks [457]	mysql-allow-intensive-checks [457]	For MySQL installation, enables detailed checks on the supported data types within the MySQL database to confirm compatibility.
--mysql-connectorj-path [458]	mysql-connectorj-path [458]	Path to MySQL Connector/J
--mysql-driver [458]	mysql-driver [458]	MySQL Driver Vendor
--mysql-enable-ansiquotes [458], --repl-mysql-enable-ansiquotes [458]	mysql-enable-ansiquotes [458], repl-mysql-enable-ansiquotes [458]	Enables ANSI_QUOTES mode for incoming events?

CmdLine Option	INI File Option	Description
--mysql-enable-enumtostring [458], --repl-mysql-enable-enum-tostring [458]	mysql-enable-enumtostring [458], repl-mysql-enable-enum-tostring [458]	Enable a filter to convert ENUM values to strings
--mysql-enable-noonlykey-words [458], --repl-mysql-en-able-noonlykeywords [458]	mysql-enable-noonlykeywords [458], repl-mysql-enable-noonlykey-words [458]	Enables a filter to translate DELETE FROM ONLY to DELETE FROM and UPDATE ON-LY to UPDATE.
--mysql-enable-settostring [458], --repl-mysql-enable-set-tostring [458]	mysql-enable-settostring [458], re-pl-mysql-enable-settostring [458]	Enable a filter to convert SET types to strings
--mysql-ro-slave [459], --re-pl-mysql-ro-slave [459]	mysql-ro-slave [459], repl-mysql-ro-slave [459]	Replicas are read-only?
--mysql-server-id [459], --re-pl-mysql-server-id [459]	mysql-server-id [459], repl-mysql-server-id [459]	Explicitly set the MySQL server ID
--mysql-use-bytes-for-string [459], --repl-mysql-use-bytes-for-string [459]	mysql-use-bytes-for-string [459], repl-mysql-use-bytes-for-string [459]	Transfer strings as their byte representation?
--mysql-xtrabackup-dir [459], --re-pl-mysql-xtrabackup-dir [459]	mysql-xtrabackup-dir [459], re-pl-mysql-xtrabackup-dir [459]	Directory to use for storing xtrabackup full & incremental backups
--native-slave-takeover [459], --repl-native-slave-takeover [459]	native-slave-takeover [459], re-pl-native-slave-takeover [459]	Takeover native replication
--no-connectors [459]	no-connectors [459]	When issued during an update, connectors will not be restarted. Restart of the connectors will then need to be performed mannually for updates to take affect.
--no-deployment [460]	no-deployment [460]	Skip deployment steps that create the install directory
--no-validation [460]	no-validation [460]	Skip validation checks that run on each host
--optimize-row-events [460]	optimize-row-events [460]	Enables or disables optimized row updates. Enabled by default.
--preferred-path [460]	preferred-path [460]	Additional command path
--prefetch-enabled [460]	prefetch-enabled [460]	Should the replicator service be setup as a prefetch applier
--prefetch-max-time-ahead [461]	prefetch-max-time-ahead [461]	Maximum number of seconds that the prefetch applier can get in front of the standard applier
--prefetch-min-time-ahead [461]	prefetch-min-time-ahead [461]	Minimum number of seconds that the prefetch applier must be in front of the standard applier
--prefetch-schema [461]	prefetch-schema [461]	Schema to watch for timing prefetch progress
--prefetch-sleep-time [461]	prefetch-sleep-time [461]	How long to wait when the prefetch applier gets too far ahead
--privileged-master [461]	privileged-master [461]	Does the login for the Primary database service have superuser privileges
--privileged-slave [461]	privileged-slave [461]	Does the login for the Replica database service have superuser privileges
--profile-script [461]	profile-script [461]	Append commands to include env.sh in this profile script
--protect-configura-tion-files [461]	protect-configuration-files [461]	When enabled, configuration files are protected to be only readable and updatable by the configured user
--redshift-dbname [462], --re-pl-redshift-dbname [462]	redshift-dbname [462], repl-red-shift-dbname [462]	Name of the Redshift database to replicate into
--relay-directory [462], --repl-re-lay-directory [462]	relay-directory [462], repl-re-lay-directory [462]	Directory for logs transferred from the Primary
--relay-enabled [462]	relay-enabled [462]	Should the replicator service be setup as a relay.
--relay-source [463], --dataser-vice-relay-source [463], --mas-ter-dataservice [463]	dataservice-relay-source [463], master-dataservice [463], re-lay-source [463]	Dataservice name to use as a relay source
--repl-allow-bidi-unsafe [463]	repl-allow-bidi-unsafe [463]	Allow unsafe SQL from remote service
--replace-tls-certificate [463]	replace-tls-certificate [463]	Replace the TLS certificate

CmdLine Option	INI File Option	Description
--replication-host [463], --datasource-host [463], --repl-datasource-host [463]	datasource-host [463], repl-datasource-host [463], replication-host [463]	Hostname of the datasource
--replication-password [463], --datasource-password [463], --repl-datasource-password [463]	datasource-password [463], repl-datasource-password [463], replication-password [463]	Database password
--replication-port [463], --datasource-port [463], --repl-datasource-port [463]	datasource-port [463], repl-datasource-port [463], replication-port [463]	Database network port
--replication-user [464], --datasource-user [464], --repl-datasource-user [464]	datasource-user [464], repl-datasource-user [464], replication-user [464]	User for database connection
--reset [464]	reset [464]	Clear the current configuration before processing any arguments
--rmi-port [464], --repl-rmi-port [464]	repl-rmi-port [464], rmi-port [464]	Replication RMI listen port
--rmi-user [464]	rmi-user [464]	The username for RMI authentication
--role [464], --repl-role [464]	repl-role [464], role [464]	What is the replication role for this service?
--router-gateway-port [465]	router-gateway-port [465]	The router gateway port
--router-jmx-port [465]	router-jmx-port [465]	The router jmx port
--security-directory [465]	security-directory [465]	Storage directory for the Java security/encryption files
--service-alias [465], --dataservice-service-alias [465]	dataservice-service-alias [465], service-alias [465]	Replication alias of this dataservice
--service-name [465]	service-name [465]	Set the service name
--service-type [465], --repl-service-type [465]	repl-service-type [465], service-type [465]	What is the replication service type?
--skip-statemap [466]	skip-statemap [466]	Do not copy the cluster-home/conf/statemap.properties from the previous install
--slaves [466], --dataservice-slaves [466], --members [455]	dataservice-slaves [466], members [455], slaves [466]	What are the Replicas for this dataservice?
--start [466]	start [466]	Start the services after configuration
--start-and-report [466]	start-and-report [466]	Start the services and report out the status after configuration
--svc-allow-any-remote-service [466], --repl-svc-allow-any-remote-service [466]	repl-svc-allow-any-remote-service [466], svc-allow-any-remote-service [466]	Replicate from any service
--svc-applier-block-commit-interval [466], --repl-svc-applier-block-commit-interval [466]	repl-svc-applier-block-commit-interval [466], svc-applier-block-commit-interval [466]	Minimum interval between commits
--svc-applier-block-commit-size [466], --repl-svc-applier-block-commit-size [466]	repl-svc-applier-block-commit-size [466], svc-applier-block-commit-size [466]	Applier block commit size (min 1)
--svc-applier-filters [467], --repl-svc-applier-filters [467]	repl-svc-applier-filters [467], svc-applier-filters [467]	Replication service applier filters
--svc-extractor-filters [467], --repl-svc-extractor-filters [467]	repl-svc-extractor-filters [467], svc-extractor-filters [467]	Replication service extractor filters
--svc-fail-on-zero-row-update [467], --repl-svc-fail-on-zero-row-update [467]	repl-svc-fail-on-zero-row-update [467], svc-fail-on-zero-row-update [467]	How should the replicator behave when a Row-Based Replication UPDATE or DELETE does not affect any rows.
--svc-parallelization-type [467], --repl-svc-parallelization-type [467]	repl-svc-parallelization-type [467], svc-parallelization-type [467]	Method for implementing parallel apply
--svc-remote-filters [467], --repl-svc-remote-filters [467]	repl-svc-remote-filters [467], svc-remote-filters [467]	Replication service remote download filters

CmdLine Option	INI File Option	Description
--svc-reposition-on-source-id-change [468], --repl-svc-reposition-on-source-id-change [468]	repl-svc-reposition-on-source-id-change [468], svc-reposition-on-source-id-change [468]	The Primary will come ONLINE from the current position if the stored source_id does not match the value in the static properties
--svc-shard-default-db [468], --repl-svc-shard-default-db [468]	repl-svc-shard-default-db [468], svc-shard-default-db [468]	Mode for setting the shard ID from the default db
--svc-table-engine [468], --repl-svc-table-engine [468]	repl-svc-table-engine [468], svc-table-engine [468]	Replication service table engine
--svc-thl-filters [468], --repl-svc-thl-filters [468]	repl-svc-thl-filters [468], svc-thl-filters [468]	Replication service THL filters
--target-dataservice [468], --slave-dataservice [468]	slave-dataservice [468], target-dataservice [468]	Dataservice to use to determine the value of host configuration
--temp-directory [468]	temp-directory [468]	Temporary Directory
--template-file [469]	template-file [469]	Display the keys that may be used in configuration template files
--template-search-path [469]	template-search-path [469]	Adds a new template search path for configuration file generation
--thl-directory [469], --repl-thl-directory [469]	repl-thl-directory [469], thl-directory [469]	Replicator log directory
--thl-do-checksum [469], --repl-thl-do-checksum [469]	repl-thl-do-checksum [469], thl-do-checksum [469]	Execute checksum operations on THL log files
--thl-interface [469], --repl-thl-interface [469]	repl-thl-interface [469], thl-interface [469]	Listen interface to use for THL operations
--thl-log-connection-timeout [469], --repl-thl-log-connection-timeout [469]	repl-thl-log-connection-timeout [469], thl-log-connection-timeout [469]	Number of seconds to wait for a connection to the THL log
--thl-log-file-size [469], --repl-thl-log-file-size [469]	repl-thl-log-file-size [469], thl-log-file-size [469]	File size in bytes for THL disk logs
--thl-log-fsync [470], --repl-thl-log-fsync [470]	repl-thl-log-fsync [470], thl-log-fsync [470]	Fsync THL records on commit. More reliable operation but adds latency to replication when using low-performance storage
--thl-log-retention [470], --repl-thl-log-retention [470]	repl-thl-log-retention [470], thl-log-retention [470]	How long do you want to keep THL files.
--thl-port [470], --repl-thl-port [470]	repl-thl-port [470], thl-port [470]	Port to use for THL Operations
--thl-protocol [470], --repl-thl-protocol [470]	repl-thl-protocol [470], thl-protocol [470]	Protocol to use for THL communication with this service
--topology [470], --dataservice-topology [470]	dataservice-topology [470], topology [470]	Replication topology for the dataservice.
--track-schema-changes [471]	track-schema-changes [471]	This will enable filters that track DDL statements and write the resulting change to files on Replica hosts. The feature is intended for use in some batch deployments.
--user [471]	user [471]	System User
--witnesses [471], --dataservice-witnesses [471]	dataservice-witnesses [471], witnesses [471]	Witness hosts for the dataservice

10.8.1. A tpm Options

--application-password

Option	--application-password [432]
Aliases	--connector-password [432]
Config File Options	application-password [432], connector-password [432]
Description	Database password for the connector
Value Type	string

--application-port

Option	--application-port [432]
Aliases	--connector-listen-port [432]
Config File Options	application-port [432], connector-listen-port [432]
Description	Port for the connector to listen on
Value Type	string
Default	9999

--application-readonly-port

Option	--application-readonly-port [433]
Aliases	--connector-readonly-listen-port [433]
Config File Options	application-readonly-port [433], connector-readonly-listen-port [433]
Description	Port for the connector to listen for read-only connections on
Value Type	string

--application-user

Option	--application-user [433]
Aliases	--connector-user [433]
Config File Options	application-user [433], connector-user [433]
Description	Database username for the connector
Value Type	string

--auto-enable

Option	--auto-enable [433]	
Aliases	--repl-auto-enable [433]	
Config File Options	auto-enable [433], repl-auto-enable [433]	
Description	Auto-enable services after start-up	
Value Type	boolean	
Valid Values	false	
	true	

--auto-recovery-delay-interval

Option	--auto-recovery-delay-interval [433]
Aliases	--repl-auto-recovery-delay-interval [433]
Config File Options	auto-recovery-delay-interval [433], repl-auto-recovery-delay-interval [433]
Description	Delay (in seconds) between going OFFLINE and attempting to go ONLINE
Value Type	numeric
Default	5

The delay between the replicator identifying that autorecovery is needed, and autorecovery being attempted. For busy MySQL installations, larger numbers may be needed to allow time for MySQL servers to restart or recover from their failure.

--auto-recovery-max-attempts

Option	--auto-recovery-max-attempts [433]
Aliases	--repl-auto-recovery-max-attempts [433]
Config File Options	auto-recovery-max-attempts [433], repl-auto-recovery-max-attempts [433]
Description	Maximum number of attempts at automatic recovery
Value Type	numeric
Default	0

Specifies the number of attempts the replicator will make to go back online. When the number of attempts has been reached, the replicator will remain in the OFFLINE state.

Autorecovery is not enabled until the value of this parameter is set to a non-zero value. The state of autorecovery can be determined using the *autoRecoveryEnabled* status parameter. The number of attempts made to autorecover can be tracked using the *autoRecoveryTotal* status parameter.

--auto-recovery-reset-interval

Option	--auto-recovery-reset-interval [434]
Aliases	--repl-auto-recovery-reset-interval [434]
Config File Options	auto-recovery-reset-interval [434], repl-auto-recovery-reset-interval [434]
Description	Delay (in seconds) before autorecovery is deemed to have succeeded
Value Type	numeric
Default	5

The time in ONLINE state that indicates to the replicator that the autorecovery procedure has succeeded. For servers with very large transactions, this value should be increased to allow the transaction to be successfully applied.

10.8.2. B tpm Options

--backup-directory

Option	--backup-directory [434]
Aliases	--repl-backup-directory [434]
Config File Options	backup-directory [434], repl-backup-directory [434]
Description	Permanent backup storage directory
Value Type	string
Default	{home directory}/backups

--backup-dump-directory

Option	--backup-dump-directory [434]
Aliases	--repl-backup-dump-directory [434]
Config File Options	backup-dump-directory [434], repl-backup-dump-directory [434]
Description	Backup temporary dump directory
Value Type	string

--backup-method

Option	--backup-method [434]	
Aliases	--repl-backup-method [434]	
Config File Options	backup-method [434], repl-backup-method [434]	
Description	Database backup method	
Value Type	string	
Valid Values	ebs-snapshot	
	file-copy-snapshot	
	mariabackup	Use mariabackup (Available from v7.0.0 only)
	mariabackup-incremental	Use mariabackup (Available from v7.0.0 only)
	mysqldump	Use mysqldump
	none	
	script	Use a custom script
	xtrabackup	Use Percona XtraBackup
	xtrabackup-full	Use Percona XtraBackup Full

	xtrabackup-incremental	Use Percona XtraBackup Incremental

The default, if not supplied, will be dependant on the enviroment. During installation tpm will detect which tools are available, favouring xtrabackup-full (or mariabackup-full). If not found, then mysqldump will be the default.

--backup-online

Option	`--backup-online` [435]	
Aliases	`--repl-backup-online` [435]	
Config File Options	`backup-online` [435], `repl-backup-online` [435]	
Description	Does the backup script support backing up a datasource while it is ONLINE	
Value Type	boolean	
Valid Values	false	
	true	

--backup-retention

Option	`--backup-retention` [435]
Aliases	`--repl-backup-retention` [435]
Config File Options	`backup-retention` [435], `repl-backup-retention` [435]
Description	Number of backups to retain
Value Type	numeric

--backup-script

Option	`--backup-script` [435]
Aliases	`--repl-backup-script` [435]
Config File Options	`backup-script` [435], `repl-backup-script` [435]
Description	What is the path to the backup script
Value Type	filename

--batch-enabled

Option	`--batch-enabled` [435]	
Config File Options	`batch-enabled` [435]	
Description	Should the replicator service use a batch applier	
Value Type	boolean	
Default	false	
Valid Values	true	

--batch-load-language

Option	`--batch-load-language` [435]	
Config File Options	`batch-load-language` [435]	
Description	Which script language to use for batch loading	
Value Type	string	
Valid Values	js	JavaScript
	sql	SQL

--batch-load-template

Option	`--batch-load-template` [435]
Config File Options	`batch-load-template` [435]
Description	Value for the loadBatchTemplate property

Value Type	string

--repl-buffer-size

Option	--repl-buffer-size [436]
Config File Options	repl-buffer-size [436]
Description	Replicator queue size between stages (min 1)
Value Type	numeric
Default	10

10.8.3. C tpm Options

--channels

Option	--channels [436]
Aliases	--repl-channels [436]
Config File Options	channels [436], repl-channels [436]
Description	Number of replication channels to use for parallel apply.
Value Type	numeric
Default	1

--cluster-slave-auto-recovery-delay-interval

Option	--cluster-slave-auto-recovery-delay-interval [436]
Aliases	--cluster-slave-repl-auto-recovery-delay-interval [436]
Config File Options	cluster-slave-auto-recovery-delay-interval [436], cluster-slave-repl-auto-recovery-delay-interval [436]
Description	Default value for --auto-recovery-delay-interval when --topology=cluster-slave
Value Type	string

--cluster-slave-auto-recovery-max-attempts

Option	--cluster-slave-auto-recovery-max-attempts [436]
Aliases	--cluster-slave-repl-auto-recovery-max-attempts [436]
Config File Options	cluster-slave-auto-recovery-max-attempts [436], cluster-slave-repl-auto-recovery-max-attempts [436]
Description	Default value for --auto-recovery-max-attempts when --topology=cluster-slave
Value Type	string

--cluster-slave-auto-recovery-reset-interval

Option	--cluster-slave-auto-recovery-reset-interval [436]
Aliases	--cluster-slave-repl-auto-recovery-reset-interval [436]
Config File Options	cluster-slave-auto-recovery-reset-interval [436], cluster-slave-repl-auto-recovery-reset-interval [436]
Description	Default value for --auto-recovery-reset-interval when --topology=cluster-slave
Value Type	string

--composite-datasources

Option	--composite-datasources [436]
Aliases	--dataservice-composite-datasources [436]
Config File Options	composite-datasources [436], dataservice-composite-datasources [436]
Description	Data services that should be added to this composite data service
Value Type	string

--config-file

Option	--config-file [436]
Config File Options	config-file [436]
Description	Display help information for content of the config file
Value Type	string

--conn-java-enable-concurrent-gc

Option	--conn-java-enable-concurrent-gc [437]
Config File Options	conn-java-enable-concurrent-gc [437]
Description	Connector Java uses concurrent garbage collection
Value Type	string

--conn-java-mem-size

Option	--conn-java-mem-size [437]	
Config File Options	conn-java-mem-size [437]	
Description	Connector Java heap memory size used to buffer data between clients and databases	
Value Type	numeric	
Valid Values	256	

The Connector allocates memory for each concurrent client connection, and may use up to the size of the configured MySQL max_allowed_packet. With multiple connections, the heap size should be configured to at least the combination of the number of concurrent connections multiplied by the maximum packet size.

--conn-round-robin-include-master

Option	--conn-round-robin-include-master [437]	
Config File Options	conn-round-robin-include-master [437]	
Description	Should the Connector include the Primary in round-robin load balancing	
Value Type	boolean	
Default	false	
Valid Values	false	
	true	

--connector-affinity

Option	--connector-affinity [437]
Config File Options	connector-affinity [437]
Description	The default affinity for all connections
Value Type	string

--connector-autoreconnect

Option	--connector-autoreconnect [437]	
Config File Options	connector-autoreconnect [437]	
Description	Enable auto-reconnect in the connector	
Value Type	boolean	
Default	true	
Valid Values	false	
	true	

--connector-autoreconnect-killed-connections

Option	--connector-autoreconnect-killed-connections [437]
Config File Options	connector-autoreconnect-killed-connections [437]

Description	Enable autoreconnect for connections killed within the connector	
Value Type	boolean	
Default	true	
Valid Values	false	
	true	

By default, the connector operates as follows:

- Reconnect closed connections
- Retry autocommitted reads

The behavior can be modified by using the `--connector-autoreconnect-killed-connections` [437]. Setting to `false` disables the reconnection or retry of a connection outside of a planned switch or automatic failover. The default is `true`, reconnecting and retrying all connections.

--connector-bridge-mode

Option	`--connector-bridge-mode` [438]	
Aliases	`--enable-connector-bridge-mode` [438]	
Config File Options	`connector-bridge-mode` [438], `enable-connector-bridge-mode` [438]	
Description	Enable the Tungsten Connector bridge mode	
Value Type	boolean	
Default	true	
Valid Values	false	
	true	

--connector-default-schema

Option	`--connector-default-schema` [438]
Aliases	`--connector-forced-schema` [438]
Config File Options	`connector-default-schema` [438], `connector-forced-schema` [438]
Description	Default schema for the connector to use
Value Type	string

--connector-delete-user-map

Option	`--connector-delete-user-map` [438]
Config File Options	`connector-delete-user-map` [438]
Description	Overwrite an existing user.map file
Value Type	boolean

--connector-disable-connection-warnings

Option	`--connector-disable-connection-warnings` [438]
Config File Options	`connector-disable-connection-warnings` [438]
Description	Hide Connector warnings in log files
Value Type	boolean

--connector-disconnect-timeout

Option	`--connector-disconnect-timeout` [438]
Config File Options	`connector-disconnect-timeout` [438]
Description	Time (in seconds) to wait for active connection to disconnect before forcing them closed [default: 5]
Value Type	numeric
Default	5

--connector-drop-after-max-connections

Option	--connector-drop-after-max-connections [439]
Config File Options	connector-drop-after-max-connections [439]
Description	Instantly drop connections that arrive after --connector-max-connections has been reached
Value Type	boolean

--connector-keepalive-timeout

Option	--connector-keepalive-timeout [439]
Config File Options	connector-keepalive-timeout [439]
Description	Delay (in ms) after which a manager connection is considered broken by the connector if no keep-alive command was received. Value must be positive and lower than 300000 (5 min) or the connector will refuse to start. Make sure the manager has mgr-monitor-interval value set greater than this, it controls the frequency at which keep-alive commands are sent.
Value Type	numeric
Default	30000

--connector-listen-interface

Option	--connector-listen-interface [439]
Config File Options	connector-listen-interface [439]
Description	Listen interface to use for the connector
Value Type	string

--connector-max-connections

Option	--connector-max-connections [439]
Config File Options	connector-max-connections [439]
Description	The maximum number of connections the connector should allow at any time
Value Type	numeric

--connector-max-slave-latency

Option	--connector-max-slave-latency [439]
Aliases	--connector-max-applied-latency [439]
Config File Options	connector-max-applied-latency [439], connector-max-slave-latency [439]
Description	The maximum applied latency for replica connections. Disabled by default.
Value Type	numeric
Default	-1

--connector-readonly

Option	--connector-readonly [439]
Aliases	--enable-connector-readonly [439]
Config File Options	connector-readonly [439], enable-connector-readonly [439]
Description	Enable the Tungsten Connector read-only mode
Value Type	boolean

--connector-ro-addresses

Option	--connector-ro-addresses [439]
Config File Options	connector-ro-addresses [439]
Description	Connector addresses that should receive a r/o connection
Value Type	string

--connector-rw-addresses

Option	--connector-rw-addresses [440]
Config File Options	connector-rw-addresses [440]
Description	Connector addresses that should receive a r/w connection
Value Type	string

--connector-rwsplitting

Option	--connector-rwsplitting [440]
Config File Options	connector-rwsplitting [440]
Description	Enable DirectReads R/W splitting in the connector
Value Type	string

--connector-smartscale

Option	--connector-smartscale [440]	
Config File Options	connector-smartscale [440]	
Description	Enable SmartScale R/W splitting in the connector	
Value Type	boolean	
Default	false	
Valid Values	false	
	true	

--connector-smartscale-sessionid

Option	--connector-smartscale-sessionid [440]	
Config File Options	connector-smartscale-sessionid [440]	
Description	The default session ID to use with smart scale	
Value Type	string	
Default	DATABASE	
Valid Values	CONNECTION	
	DATABASE	
	PROVIDED_IN_DBNAME	
	USER	

--connector-ssl-capable

Option	--connector-ssl-capable [440]	
Config File Options	connector-ssl-capable [440]	
Description	Defines whether connector ports are advertised as being capable of SSL	
Value Type	boolean	
Default	true	
Valid Values	false	Do not advertise connector ports as SSL capable
	true	Advertise connector ports as SSL capable

When SSL is enabled, the Connector automatically advertises the ports and itself as SSL capable. With some clients, this triggers them to use SSL even if SSL has not been configured. This causes the connections to fail and not operate correctly.

--connectors

Option	--connectors [440]
Aliases	--dataservice-connectors [440]
Config File Options	connectors [440], dataservice-connectors [440]

Description	Hostnames for the dataservice connectors
Value Type	string

--consistency-policy

Option	`--consistency-policy` [441]
Aliases	`--repl-consistency-policy` [441]
Config File Options	`consistency-policy` [441], `repl-consistency-policy` [441]
Description	Should the replicator stop or warn if a consistency check fails?
Value Type	string

10.8.4. D tpm Options

--dataservice-name

Option	`--dataservice-name` [441]
Config File Options	`dataservice-name` [441]
Description	Limit the command to the hosts in this dataservice Multiple data services may be specified by providing a comma separated list
Value Type	string

--dataservice-relay-enabled

Option	`--dataservice-relay-enabled` [441]
Config File Options	`dataservice-relay-enabled` [441]
Description	Make this dataservice a replica of another
Value Type	string

--dataservice-schema

Option	`--dataservice-schema` [441]
Config File Options	`dataservice-schema` [441]
Description	The db schema to hold dataservice details
Value Type	string

--dataservice-thl-port

Option	`--dataservice-thl-port` [441]
Config File Options	`dataservice-thl-port` [441]
Description	Port to use for THL operations
Value Type	numeric
Default	2112

--dataservice-use-relative-latency

Option	`--dataservice-use-relative-latency` [441]
Aliases	`--use-relative-latency` [441]
Config File Options	`dataservice-use-relative-latency` [441], `use-relative-latency` [441]
Description	Enable the cluster to operate on relative latency
Value Type	boolean

--dataservice-vip-enabled

Option	`--dataservice-vip-enabled` [441]
Config File Options	`dataservice-vip-enabled` [441]

Description	Is VIP management enabled?
Value Type	boolean

--dataservice-vip-ipaddress

Option	--dataservice-vip-ipaddress [442]
Config File Options	dataservice-vip-ipaddress [442]
Description	VIP IP address
Value Type	string

--dataservice-vip-netmask

Option	--dataservice-vip-netmask [442]
Config File Options	dataservice-vip-netmask [442]
Description	VIP netmask
Value Type	string

--datasource-boot-script

Option	--datasource-boot-script [442]
Aliases	--repl-datasource-boot-script [442]
Config File Options	datasource-boot-script [442], repl-datasource-boot-script [442]
Description	Database start script
Value Type	string

--datasource-enable-ssl

Option	--datasource-enable-ssl [442]
Aliases	--repl-datasource-enable-ssl [442]
Config File Options	datasource-enable-ssl [442], repl-datasource-enable-ssl [442]
Description	Enable SSL connection to DBMS server
Value Type	boolean

--datasource-log-directory

Option	--datasource-log-directory [442]
Aliases	--repl-datasource-log-directory [442]
Config File Options	datasource-log-directory [442], repl-datasource-log-directory [442]
Description	Primary log directory
Value Type	string

--datasource-log-pattern

Option	--datasource-log-pattern [442]
Aliases	--repl-datasource-log-pattern [442]
Config File Options	datasource-log-pattern [442], repl-datasource-log-pattern [442]
Description	Primary log filename pattern
Value Type	string

--datasource-mysql-conf

Option	--datasource-mysql-conf [442]
Aliases	--repl-datasource-mysql-conf [442]
Config File Options	datasource-mysql-conf [442], repl-datasource-mysql-conf [442]

Description	MySQL config file
Value Type	string

--datasource-mysql-data-directory

Option	`--datasource-mysql-data-directory` [443]
Aliases	`--repl-datasource-mysql-data-directory` [443]
Config File Options	`datasource-mysql-data-directory` [443], `repl-datasource-mysql-data-directory` [443]
Description	MySQL data directory
Value Type	string

--datasource-mysql-ibdata-directory

Option	`--datasource-mysql-ibdata-directory` [443]
Aliases	`--repl-datasource-mysql-ibdata-directory` [443]
Config File Options	`datasource-mysql-ibdata-directory` [443], `repl-datasource-mysql-ibdata-directory` [443]
Description	MySQL InnoDB data directory
Value Type	string

--datasource-mysql-iblog-directory

Option	`--datasource-mysql-iblog-directory` [443]
Aliases	`--repl-datasource-mysql-iblog-directory` [443]
Config File Options	`datasource-mysql-iblog-directory` [443], `repl-datasource-mysql-iblog-directory` [443]
Description	MySQL InnoDB log directory
Value Type	string

--datasource-mysql-ssl-ca

Option	`--datasource-mysql-ssl-ca` [443]
Aliases	`--repl-datasource-mysql-ssl-ca` [443]
Config File Options	`datasource-mysql-ssl-ca` [443], `repl-datasource-mysql-ssl-ca` [443]
Description	MySQL SSL CA file
Value Type	string

--datasource-mysql-ssl-cert

Option	`--datasource-mysql-ssl-cert` [443]
Aliases	`--repl-datasource-mysql-ssl-cert` [443]
Config File Options	`datasource-mysql-ssl-cert` [443], `repl-datasource-mysql-ssl-cert` [443]
Description	MySQL SSL certificate file
Value Type	string

--datasource-mysql-ssl-key

Option	`--datasource-mysql-ssl-key` [443]
Aliases	`--repl-datasource-mysql-ssl-key` [443]
Config File Options	`datasource-mysql-ssl-key` [443], `repl-datasource-mysql-ssl-key` [443]
Description	MySQL SSL key file
Value Type	string

--datasource-systemctl-service

Option	`--datasource-systemctl-service` [443]

Aliases	--repl-datasource-systemctl-service [443]
Config File Options	datasource-systemctl-service [443], repl-datasource-systemctl-service [443]
Description	Database systemctl script
Value Type	string

Specifies the command name or full path of the command that should be used to control the database service, including startup, shutdown and restart. This is used by the Tungsten to control the underlying database service. By default, this will be configured to the service according to your environment if it has been found during installation. For example, the services command, or /etc/init.d/mysql.

--datasource-type

Option	--datasource-type [444]	
Aliases	--repl-datasource-type [444]	
Config File Options	datasource-type [444], repl-datasource-type [444]	
Description	Database type	
Value Type	string	
Default	mysql	
Valid Values	file	File
	hdfs	HDFS (Hadoop)
	kafka	Kafka
	mongodb	MongoDB
	mysql	MySQL
	oracle	Oracle
	postgres	PostgreSQL
	vertica	Vertica

--delete

Option	--delete [444]
Config File Options	delete [444]
Description	Delete the named data service from the configuration Data Service options
Value Type	string

--deploy-current-package

Option	--deploy-current-package [444]
Config File Options	deploy-current-package [444]
Description	Deploy the current Tungsten package
Value Type	string

--deploy-package-uri

Option	--deploy-package-uri [444]
Config File Options	deploy-package-uri [444]
Description	URL for the Tungsten package to deploy
Value Type	string

--direct-datasource-log-directory

Option	--direct-datasource-log-directory [444]
Aliases	--repl-direct-datasource-log-directory [444]
Config File Options	direct-datasource-log-directory [444], repl-direct-datasource-log-directory [444]
Description	Primary log directory

Value Type	string

--direct-datasource-log-pattern

Option	`--direct-datasource-log-pattern` [445]
Aliases	`--repl-direct-datasource-log-pattern` [445]
Config File Options	`direct-datasource-log-pattern` [445], `repl-direct-datasource-log-pattern` [445]
Description	Primary log filename pattern
Value Type	string

--direct-datasource-type

Option	`--direct-datasource-type` [445]	
Aliases	`--repl-direct-datasource-type` [445]	
Config File Options	`direct-datasource-type` [445], `repl-direct-datasource-type` [445]	
Description	Database type	
Value Type	string	
Default	mysql	
Valid Values	file	File
	hdfs	HDFS (Hadoop)
	mongodb	MongoDB
	mysql	
	mysql	MySQL
	oracle	Oracle
	vertica	Vertica

--direct-replication-host

Option	`--direct-replication-host` [445]
Aliases	`--direct-datasource-host` [445], `--repl-direct-datasource-host` [445]
Config File Options	`direct-datasource-host` [445], `direct-replication-host` [445], `repl-direct-datasource-host` [445]
Description	Database server hostname
Value Type	string

--direct-replication-password

Option	`--direct-replication-password` [445]
Aliases	`--direct-datasource-password` [445], `--repl-direct-datasource-password` [445]
Config File Options	`direct-datasource-password` [445], `direct-replication-password` [445], `repl-direct-datasource-password` [445]
Description	Password for datasource connection
Value Type	string

--direct-replication-port

Option	`--direct-replication-port` [445]
Aliases	`--direct-datasource-port` [445], `--repl-direct-datasource-port` [445]
Config File Options	`direct-datasource-port` [445], `direct-replication-port` [445], `repl-direct-datasource-port` [445]
Description	Database server port
Value Type	string

--direct-replication-user

Option	`--direct-replication-user` [445]

Aliases	--direct-datasource-user [445], --repl-direct-datasource-user [445]
Config File Options	direct-datasource-user [445], direct-replication-user [445], repl-direct-datasource-user [445]
Description	Database login for Tungsten
Value Type	string

--directory

Option	--directory [446]
Config File Options	directory [446]
Description	Set the directory of an existing installation used during fetching an existing configuration

Set the directory of an existing installation used during fetching an existing configuration

--disable-relay-logs

Option	--disable-relay-logs [446]	
Aliases	--repl-disable-relay-logs [446]	
Config File Options	disable-relay-logs [446], repl-disable-relay-logs [446]	
Description	Disable the use of relay-logs?	
Value Type	boolean	
Default	true	
Valid Values	false	
	true	

--disable-security-controls

Option	--disable-security-controls [446]	
Config File Options	disable-security-controls [446]	
Description	Disables all forms of security, including SSL, TLS and authentication	
Value Type	string	
Valid Values	false	Default in version 7.x
	true	Default in version 5.x and 6.x

--disable-slave-extractor

Option	--disable-slave-extractor [446]
Aliases	--repl-disable-slave-extractor [446]
Config File Options	disable-slave-extractor [446], repl-disable-slave-extractor [446]
Description	Should replica servers support the primary role?
Value Type	string

--drop-static-columns-in-updates

Option	--drop-static-columns-in-updates [446]	
Config File Options	drop-static-columns-in-updates [446]	
Description	This will modify UPDATE transactions in row-based replication and eliminate any columns that were not modified.	
Value Type	boolean	
Default	false	
Valid Values	false	
	true	

10.8.5. E tpm Options

--enable-active-witnesses

Option	--enable-active-witnesses [446]	
Aliases	--active-witnesses [446]	
Config File Options	active-witnesses [446], enable-active-witnesses [446]	
Description	Enable active witness hosts	
Value Type	boolean	
Default	false	
Valid Values	false	
	true	

--enable-connector-client-ssl

Option	--enable-connector-client-ssl [447]
Aliases	--connector-client-ssl [447]
Config File Options	connector-client-ssl [447], enable-connector-client-ssl [447]
Description	Enable SSL encryption of traffic from the client to the connector
Value Type	boolean

--enable-connector-server-ssl

Option	--enable-connector-server-ssl [447]
Aliases	--connector-server-ssl [447]
Config File Options	connector-server-ssl [447], enable-connector-server-ssl [447]
Description	Enable SSL encryption of traffic from the connector to the database
Value Type	boolean

--enable-connector-ssl

Option	--enable-connector-ssl [447]
Aliases	--connector-ssl [447]
Config File Options	connector-ssl [447], enable-connector-ssl [447]
Description	Enable SSL encryption of connector traffic to the database
Value Type	boolean

--enable-heterogeneous-master

Option	--enable-heterogeneous-master [447]	
Config File Options	enable-heterogeneous-master [447]	
Description	Enable heterogeneous operation for the primary	
Value Type	boolean	
Default	false	
Valid Values	false	
	true	

--enable-heterogeneous-service

Option	--enable-heterogeneous-service [447]	
Config File Options	enable-heterogeneous-service [447]	
Description	Enable heterogeneous operation	
Value Type	boolean	
Default	false	
Valid Values	false	
	true	

- On a Primary
  - `--mysql-use-bytes-for-string` [459] is set to false.
  - `colnames` filter is enabled (in the `binlog-to-q` stage to add column names to the THL information.
  - `pkey` filter is enabled (in the `binlog-to-q` and `q-to-dbms` stage), with the *`addPkeyToInserts`* and *`addColumnsToDeletes`* filter options set to false.
  - `enumtostring` filter is enabled (in the `q-to-thl` stage), to translate `ENUM` values to their string equivalents.
  - `settostring` filter is enabled (in the `q-to-thl` stage), to translate `SET` values to their string equivalents.
- On a Replica
  - `--mysql-use-bytes-for-string` [459] is set to true.
  - `pkey` filter is enabled (`q-to-dbms` stage).

--enable-heterogeneous-slave

Option	`--enable-heterogeneous-slave` [448]	
Config File Options	`enable-heterogeneous-slave` [448]	
Description	Enable heterogeneous operation for the replica	
Value Type	boolean	
Default	false	
Valid Values	false	
	true	

--enable-jgroups-ssl

Option	`--enable-jgroups-ssl` [448]
Aliases	`--jgroups-ssl` [448]
Config File Options	`enable-jgroups-ssl` [448], `jgroups-ssl` [448]
Description	Enable SSL encryption of JGroups communication on this host
Value Type	boolean

--enable-rmi-authentication

Option	`--enable-rmi-authentication` [448]
Aliases	`--rmi-authentication` [448]
Config File Options	`enable-rmi-authentication` [448], `rmi-authentication` [448]
Description	Enable RMI authentication for the services running on this host
Value Type	boolean

--enable-rmi-ssl

Option	`--enable-rmi-ssl` [448]
Aliases	`--rmi-ssl` [448]
Config File Options	`enable-rmi-ssl` [448], `rmi-ssl` [448]
Description	Enable SSL encryption of RMI communication on this host
Value Type	boolean

--enable-slave-thl-listener

Option	`--enable-slave-thl-listener` [448]
Aliases	`--repl-enable-slave-thl-listener` [448]
Config File Options	`enable-slave-thl-listener` [448], `repl-enable-slave-thl-listener` [448]
Description	Should this service allow THL connections?

Value Type	boolean

--enable-sudo-access

Option	`--enable-sudo-access` [449]	
Aliases	`--root-command-prefix` [449]	
Config File Options	`enable-sudo-access` [449], `root-command-prefix` [449]	
Description	Run root commands using sudo	
Value Type	boolean	
Valid Values	false	
	true	

The default behavior of this property is different in certain installs.

For a cluster node install that INCLUDES the manager process, AND where the install OS user is NOT root, the default will be `true`

For a Replicator only or Connector only install, the default will be `false`

When set to true, the property has the following effect:

- During staging tpm installs, if the tungsten user is different from the ssh user on remote hosts
- All startup scripts when using systemctl: replicator, connector, manager will call systemctl prefixed with sudo: for example: `sudo -n systemctl start treplicator`
- tprovision script (tps.pl) requires sudo access for mysql and xtrabackup calls
- replicator backup script for xtrabackup and other backup utilities
- check_tungsten.sh utility to call xinetd
- tmonitor starts exporter service with sudo
- manager to restart mysql service when found stopped
- tpm diagnostic operation (tpm diag)

--enable-thl-ssl

Option	`--enable-thl-ssl` [449]
Aliases	`--repl-enable-thl-ssl` [449], `--thl-ssl` [449]
Config File Options	`enable-thl-ssl` [449], `repl-enable-thl-ssl` [449], `thl-ssl` [449]
Description	Enable SSL encryption of THL communication for this service
Value Type	boolean

--executable-prefix

Option	`--executable-prefix` [449]
Config File Options	`executable-prefix` [449]
Description	Adds a prefix to command aliases
Value Type	string

When enabled, the supplied prefix is added to each command alias that is generated for a given installation. This enables multiple installations to co-exist and and be accessible through a unique alias. For example, if the executable prefix is configured as `east`, then an alias for the installation to trepctl will be created as east_trepctl.

Alias information for executable prefix data is stored within the `$CONTINUENT_ROOT/share/aliases.sh` file for each installation.

10.8.6. F tpm Options

--file-protection-level

Option	`--file-protection-level` [449]

Config File Options	file-protection-level [449]
Description	Protection level for Continuent files
Value Type	string

--file-protection-umask

Option	--file-protection-umask [450]
Config File Options	file-protection-umask [450]
Description	Protection umask for Continuent files
Value Type	string

10.8.7. H tpm Options

--host-name

Option	--host-name [450]
Config File Options	host-name [450]
Description	DNS hostname
Value Type	string

--hosts

Option	--hosts [450]
Config File Options	hosts [450]
Description	Limit the command to the hosts listed You must use the hostname as it appears in the configuration.
Value Type	string

--hub

Option	--hub [450]
Aliases	--dataservice-hub-host [450]
Config File Options	dataservice-hub-host [450], hub [450]
Description	What is the hub host for this all-masters dataservice?
Value Type	string

--hub-service

Option	--hub-service [450]
Aliases	--dataservice-hub-service [450]
Config File Options	dataservice-hub-service [450], hub-service [450]
Description	The data service to use for the hub of a star topology
Value Type	string

10.8.8. I tpm Options

--install

Option	--install [450]
Config File Options	install [450]
Description	Install service start scripts
Value Type	string

--install-directory

Option	--install-directory [450]

Aliases	`--home-directory` [450]
Config File Options	`home-directory` [450], `install-directory` [450]
Description	Installation directory
Value Type	string

Path to the directory where the active deployment will be installed. The configured directory will contain the software, THL and relay log information unless configured otherwise.

10.8.9. J tpm Options

--java-connector-keystore-password

Option	`--java-connector-keystore-password` [451]
Config File Options	`java-connector-keystore-password` [451]
Description	Set the password for unlocking the tungsten_connector_keystore.jks file in the security directory. Specific to connector<->mysql communication only.
Value Type	string

--java-connector-keystore-path

Option	`--java-connector-keystore-path` [451]
Config File Options	`java-connector-keystore-path` [451]
Description	Local path to the Java Connector Keystore file. Specific to connector<->mysql communication only.
Value Type	filename

--java-connector-truststore-password

Option	`--java-connector-truststore-password` [451]
Config File Options	`java-connector-truststore-password` [451]
Description	Set the password for unlocking the tungsten_connector_truststore.jks file in the security directory. Specific to connector<->mysql communication only.
Value Type	string

--java-connector-truststore-path

Option	`--java-connector-truststore-path` [451]
Config File Options	`java-connector-truststore-path` [451]
Description	Local path to the Java Connector Truststore file. Specific to connector<->mysql communication only.
Value Type	filename

--java-enable-concurrent-gc

Option	`--java-enable-concurrent-gc` [451]
Aliases	`--repl-java-enable-concurrent-gc` [451]
Config File Options	`java-enable-concurrent-gc` [451], `repl-java-enable-concurrent-gc` [451]
Description	Replicator Java uses concurrent garbage collection
Value Type	boolean

--java-external-lib-dir

Option	`--java-external-lib-dir` [451]
Aliases	`--repl-java-external-lib-dir` [451]
Config File Options	`java-external-lib-dir` [451], `repl-java-external-lib-dir` [451]
Description	Directory for 3rd party Jar files required by replicator
Value Type	string

--java-file-encoding

Option	--java-file-encoding [452]
Aliases	--repl-java-file-encoding [452]
Config File Options	java-file-encoding [452], repl-java-file-encoding [452]
Description	Java platform charset (esp. for heterogeneous replication)
Value Type	string

--java-jgroups-key

Option	--java-jgroups-key [452]
Config File Options	java-jgroups-key [452]
Description	The alias to use for the JGroups TLS key in the keystore.
Value Type	string

--java-jgroups-keystore-path

Option	--java-jgroups-keystore-path [452]
Config File Options	java-jgroups-keystore-path [452]
Description	Local path to the JGroups Java Keystore file.
Value Type	filename

--java-jmxremote-access-path

Option	--java-jmxremote-access-path [452]
Config File Options	java-jmxremote-access-path [452]
Description	Local path to the Java JMX Remote Access file.
Value Type	filename

--java-keystore-password

Option	--java-keystore-password [452]
Config File Options	java-keystore-password [452]
Description	Set the password for unlocking the tungsten_keystore.jks file in the security directory. Specific for intra cluster communication.
Value Type	string

--java-keystore-path

Option	--java-keystore-path [452]
Config File Options	java-keystore-path [452]
Description	Local path to the Java Keystore file. Specific for intra cluster communication. NOTE: When java-keystore-path is passed to tpm, the keystore must contain both tls and mysql certs when appropriate. tpm will NOT add mysql cert nor generate tls cert when this flag is found, so both certs must be manually imported already.
Value Type	filename

--java-mem-size

Option	--java-mem-size [452]
Aliases	--repl-java-mem-size [452]
Config File Options	java-mem-size [452], repl-java-mem-size [452]
Description	Replicator Java heap memory size in Mb (min 128)
Value Type	numeric

--java-passwordstore-path

Option	--java-passwordstore-path [452]
Config File Options	java-passwordstore-path [452]
Description	Local path to the Java Password Store file.
Value Type	filename

--java-tls-alias

Option	--java-tls-alias [453]
Config File Options	java-tls-alias [453]
Description	The alias to use for the TLS key/certificate in the keystore and truststore.
Value Type	string

--java-tls-key-lifetime

Option	--java-tls-key-lifetime [453]
Config File Options	java-tls-key-lifetime [453]
Description	Lifetime for the Java TLS key
Value Type	numeric

--java-tls-keystore-path

Option	--java-tls-keystore-path [453]
Config File Options	java-tls-keystore-path [453]
Description	The keystore holding a certificate to use for all Continuent TLS encryption.
Value Type	string

--java-truststore-password

Option	--java-truststore-password [453]
Config File Options	java-truststore-password [453]
Description	The password for unlocking the tungsten_truststore.jks file in the security directory
Value Type	string

--java-truststore-path

Option	--java-truststore-path [453]
Config File Options	java-truststore-path [453]
Description	Local path to the Java Truststore file.
Value Type	filename

--java-user-timezone

Option	--java-user-timezone [453]
Aliases	--repl-java-user-timezone [453]
Config File Options	java-user-timezone [453], repl-java-user-timezone [453]
Description	Java VM Timezone (esp. for cross-site replication)
Value Type	numeric

10.8.10. L tpm Options

--log

Option	--log [453]
Config File Options	log [453]

Description	Write all messages, visible and hidden, to this file. You may specify a filename, 'pid' or 'timestamp'.
Value Type	numeric

--log-slave-updates

Option	`--log-slave-updates` [454]	
Config File Options	`log-slave-updates` [454]	
Description	Should replicas log updates to binlog	
Value Type	boolean	
Default	false	
Valid Values	false	
	true	

10.8.11. M tpm Options

--master

Option	`--master` [454]
Aliases	`--dataservice-master-host` [454], `--masters` [454], `--relay` [454]
Config File Options	`dataservice-master-host` [454], `master` [454], `masters` [454], `relay` [454]
Description	Hostname of the primary (or relay) host within this service
Value Type	string

The hostname of the primary (extractor) within the current service.

--master-preferred-role

Option	`--master-preferred-role` [454]	
Aliases	`--repl-master-preferred-role` [454]	
Config File Options	`master-preferred-role` [454], `repl-master-preferred-role` [454]	
Description	Preferred role for primary THL when connecting as a replica	
Value Type	string	
Valid Values	master	Primary role
	slave	Replica role

--master-services

Option	`--master-services` [454]
Aliases	`--dataservice-master-services` [454]
Config File Options	`dataservice-master-services` [454], `master-services` [454]
Description	Data service names that should be used on each Primary
Value Type	string

--master-thl-host

Option	`--master-thl-host` [454]
Config File Options	`master-thl-host` [454]
Description	Primary THL Hostname
Value Type	string

--master-thl-port

Option	`--master-thl-port` [454]
Config File Options	`master-thl-port` [454]

Description	Primary THL Port
Value Type	string

--members

Option	`--members` [455]
Aliases	`--dataservice-hosts` [455]
Config File Options	`dataservice-hosts` [455], `members` [455]
Description	Hostnames for the dataservice members
Value Type	string

--metadata-directory

Option	`--metadata-directory` [455]
Aliases	`--repl-metadata-directory` [455]
Config File Options	`metadata-directory` [455], `repl-metadata-directory` [455]
Description	Replicator metadata directory
Value Type	string

--mgr-api

Option	`--mgr-api` [455]
Config File Options	`mgr-api` [455]
Description	Enable the Manager API
Value Type	boolean

--mgr-api-address

Option	`--mgr-api-address` [455]
Config File Options	`mgr-api-address` [455]
Description	Address for the Manager API
Value Type	string

--mgr-api-full-access

Option	`--mgr-api-full-access` [455]
Config File Options	`mgr-api-full-access` [455]
Description	Enable all Manager API commands. Only the status command will be enabled without it.
Value Type	boolean

--mgr-api-port

Option	`--mgr-api-port` [455]
Config File Options	`mgr-api-port` [455]
Description	Port for the Manager API
Value Type	string

--mgr-group-communication-port

Option	`--mgr-group-communication-port` [455]
Config File Options	`mgr-group-communication-port` [455]
Description	Port to use for manager group communication
Value Type	numeric
Default	7800

--mgr-heap-threshold

Option	--mgr-heap-threshold [456]
Config File Options	mgr-heap-threshold [456]
Description	Java memory usage (MB) that will force a Manager restart
Value Type	numeric
Default	200

--mgr-java-enable-concurrent-gc

Option	--mgr-java-enable-concurrent-gc [456]
Config File Options	mgr-java-enable-concurrent-gc [456]
Description	Manager Java uses concurrent garbage collection
Value Type	string

--mgr-java-mem-size

Option	--mgr-java-mem-size [456]
Config File Options	mgr-java-mem-size [456]
Description	Manager Java heap memory size in Mb (min 128)
Value Type	numeric
Default	250

--mgr-listen-interface

Option	--mgr-listen-interface [456]
Config File Options	mgr-listen-interface [456]
Description	Listen interface to use for the manager
Value Type	string

--mgr-ping-method

Option	--mgr-ping-method [456]
Config File Options	mgr-ping-method [456]
Description	Mechanism to use when identifying the liveness of other datasources (ping, echo)
Value Type	string

--mgr-policy-mode

Option	--mgr-policy-mode [456]	
Config File Options	mgr-policy-mode [456]	
Description	Manager policy mode	
Value Type	string	
Valid Values	automatic	Automatic policy mode
	maintenance	Maintenance policy mode
	manual	Manual policy mode

--mgr-rmi-port

Option	--mgr-rmi-port [456]
Config File Options	mgr-rmi-port [456]
Description	Port to use for the manager RMI server
Value Type	string

--mgr-rmi-remote-port

Option	--mgr-rmi-remote-port [457]
Config File Options	mgr-rmi-remote-port [457]
Description	Port to use for calling the remote manager RMI server
Value Type	string

--mgr-ro-slave

Option	--mgr-ro-slave [457]
Config File Options	mgr-ro-slave [457]
Description	Make replicas read-only
Value Type	boolean

--mgr-vip-arp-path

Option	--mgr-vip-arp-path [457]
Config File Options	mgr-vip-arp-path [457]
Description	Path to the arp binary
Value Type	filename

--mgr-vip-device

Option	--mgr-vip-device [457]
Config File Options	mgr-vip-device [457]
Description	VIP network device
Value Type	string

--mgr-vip-ifconfig-path

Option	--mgr-vip-ifconfig-path [457]
Config File Options	mgr-vip-ifconfig-path [457]
Description	Path to the ifconfig binary
Value Type	filename

--mgr-wait-for-members

Option	--mgr-wait-for-members [457]
Config File Options	mgr-wait-for-members [457]
Description	Wait for all datasources to be available before completing installation
Value Type	boolean

--mysql-allow-intensive-checks

Option	--mysql-allow-intensive-checks [457]	
Config File Options	mysql-allow-intensive-checks [457]	
Description	For MySQL installation, enables detailed checks on the supported data types within the MySQL database to confirm compatibility.	
Value Type	boolean	
Default	false	
Valid Values	false	
	true	

For MySQL installation, enables detailed checks on the supported data types within the MySQL database to confirm compatibility. This includes checking each table definition individually for any unsupported data types.

--mysql-connectorj-path

Option	--mysql-connectorj-path [458]
Config File Options	mysql-connectorj-path [458]
Description	Path to MySQL Connector/J
Value Type	filename

Important

As of v4.0.0, the MySQL Connector/J prerequisite has been removed. The JDBC interface now uses the Drizzle driver by default.

Note

tpm reverse will display the parameter *--mysql-connectorj-path* as long as any mysql-connector-java* file remains in /opt/continuent/share/

Warning

Do not use path /opt/continuent/share/ inside the value for *--mysql-connectorj-path* or tpm will abort with an error.

--mysql-driver

Option	--mysql-driver [458]
Config File Options	mysql-driver [458]
Description	MySQL Driver Vendor
Value Type	string
Default	drizzle

--mysql-enable-ansiquotes

Option	--mysql-enable-ansiquotes [458]
Aliases	--repl-mysql-enable-ansiquotes [458]
Config File Options	mysql-enable-ansiquotes [458], repl-mysql-enable-ansiquotes [458]
Description	Enables ANSI_QUOTES mode for incoming events?
Value Type	boolean

--mysql-enable-enumtostring

Option	--mysql-enable-enumtostring [458]
Aliases	--repl-mysql-enable-enumtostring [458]
Config File Options	mysql-enable-enumtostring [458], repl-mysql-enable-enumtostring [458]
Description	Enable a filter to convert ENUM values to strings
Value Type	boolean

--mysql-enable-noonlykeywords

Option	--mysql-enable-noonlykeywords [458]
Aliases	--repl-mysql-enable-noonlykeywords [458]
Config File Options	mysql-enable-noonlykeywords [458], repl-mysql-enable-noonlykeywords [458]
Description	Enables a filter to translate DELETE FROM ONLY to DELETE FROM and UPDATE ONLY to UPDATE.
Value Type	boolean

--mysql-enable-settostring

Option	--mysql-enable-settostring [458]
Aliases	--repl-mysql-enable-settostring [458]

Config File Options	mysql-enable-settostring [458], repl-mysql-enable-settostring [458]
Description	Enable a filter to convert SET types to strings
Value Type	boolean

--mysql-ro-slave

Option	--mysql-ro-slave [459]
Aliases	--repl-mysql-ro-slave [459]
Config File Options	mysql-ro-slave [459], repl-mysql-ro-slave [459]
Description	Replicas are read-only?
Value Type	boolean

--mysql-server-id

Option	--mysql-server-id [459]
Aliases	--repl-mysql-server-id [459]
Config File Options	mysql-server-id [459], repl-mysql-server-id [459]
Description	Explicitly set the MySQL server ID
Value Type	numeric

Setting this option explicitly sets the server-id information normally located in the MySQL configuration (my.cnf). This is useful in situations where there may be multiple MySQL installations and the server ID needs to be identified to prevent collisions when reading from the same Primary.

--mysql-use-bytes-for-string

Option	--mysql-use-bytes-for-string [459]
Aliases	--repl-mysql-use-bytes-for-string [459]
Config File Options	mysql-use-bytes-for-string [459], repl-mysql-use-bytes-for-string [459]
Description	Transfer strings as their byte representation?
Value Type	boolean

--mysql-xtrabackup-dir

Option	--mysql-xtrabackup-dir [459]
Aliases	--repl-mysql-xtrabackup-dir [459]
Config File Options	mysql-xtrabackup-dir [459], repl-mysql-xtrabackup-dir [459]
Description	Directory to use for storing xtrabackup full & incremental backups
Value Type	string

10.8.12. N tpm Options

--native-slave-takeover

Option	--native-slave-takeover [459]
Aliases	--repl-native-slave-takeover [459]
Config File Options	native-slave-takeover [459], repl-native-slave-takeover [459]
Description	Takeover native replication
Value Type	boolean

--no-connectors

Option	--no-connectors [459]
Config File Options	no-connectors [459]

Description	When issued during an update, connectors will not be restarted. Restart of the connectors will then need to be performed mannually for updates to take affect.
Value Type	string

--no-deployment

Option	`--no-deployment` [460]
Config File Options	`no-deployment` [460]
Description	Skip deployment steps that create the install directory
Value Type	string

--no-validation

Option	`--no-validation` [460]
Config File Options	`no-validation` [460]
Description	Skip validation checks that run on each host
Value Type	string

10.8.13. O tpm Options

--optimize-row-events

Option	`--optimize-row-events` [460]	
Config File Options	`optimize-row-events` [460]	
Description	Enables or disables optimized row updates. Enabled by default.	
Value Type	boolean	
Default	true	
Valid Values	false	Disable

Bundles multiple row-based events into a single `INSERT` or `DELETE` statement. This increases the throughput of large batches of row-based events.

10.8.14. P tpm Options

--preferred-path

Option	`--preferred-path` [460]
Config File Options	`preferred-path` [460]
Description	Additional command path
Value Type	filename

Specifies one or more additional directories that will be added before the current `PATH` environment variable when external commands are run from within the backup environment. This affects all external tools used by Tungsten Cluster, including MySQL, Ruby, Java, and back-up/restore tools such as Percona Xtrabackup.

One or more paths can be specified by separating each directory with a colon. For example:

```
shell> tpm ... --preferred-path=/usr/local/bin:/opt/bin:/opt/percona/bin
```

The `--preferred-path` [460] information propagated to all remote servers within the tpm configuration. However, if the staging server is one of the servers to which you are deploying, the `PATH` must be manually updated.

--prefetch-enabled

Option	`--prefetch-enabled` [460]
Config File Options	`prefetch-enabled` [460]
Description	Should the replicator service be setup as a prefetch applier
Value Type	boolean

--prefetch-max-time-ahead

Option	--prefetch-max-time-ahead [461]
Config File Options	prefetch-max-time-ahead [461]
Description	Maximum number of seconds that the prefetch applier can get in front of the standard applier
Value Type	numeric

--prefetch-min-time-ahead

Option	--prefetch-min-time-ahead [461]
Config File Options	prefetch-min-time-ahead [461]
Description	Minimum number of seconds that the prefetch applier must be in front of the standard applier
Value Type	numeric

--prefetch-schema

Option	--prefetch-schema [461]
Config File Options	prefetch-schema [461]
Description	Schema to watch for timing prefetch progress
Value Type	string
Default	tungsten_

--prefetch-sleep-time

Option	--prefetch-sleep-time [461]
Config File Options	prefetch-sleep-time [461]
Description	How long to wait when the prefetch applier gets too far ahead
Value Type	string

--privileged-master

Option	--privileged-master [461]
Config File Options	privileged-master [461]
Description	Does the login for the Primary database service have superuser privileges
Value Type	boolean

--privileged-slave

Option	--privileged-slave [461]
Config File Options	privileged-slave [461]
Description	Does the login for the Replica database service have superuser privileges
Value Type	booleam

--profile-script

Option	--profile-script [461]
Config File Options	profile-script [461]
Description	Append commands to include env.sh in this profile script
Value Type	string

--protect-configuration-files

Option	--protect-configuration-files [461]
Config File Options	protect-configuration-files [461]

Description	When enabled, configuration files are protected to be only readable and updatable by the configured user	
Value Type	string	
Valid Values	false	Make configuration files readable by any user
	true	

When enabled (default), the configuration that contain user, password and other information are configured so that they are only readable by the configured user. For example:

```
shell> ls -al /opt/continuent/tungsten/tungsten-replicator/conf/
total 148
drwxr-xr-x 2 tungsten mysql 4096 May 14 14:32 ./
drwxr-xr-x 11 tungsten mysql 4096 May 14 14:32 ../
-rw-r--r-- 1 tungsten mysql 33 May 14 14:32 dynamic-alpha.role
-rw-r--r-- 1 tungsten mysql 5059 May 14 14:32 log4j.properties
-rw-r--r-- 1 tungsten mysql 3488 May 14 14:32 log4j-thl.properties
-rw-r--r-- 1 tungsten mysql 972 May 14 14:32 mysql-java-charsets.properties
-rw-r--r-- 1 tungsten mysql 420 May 14 14:32 replicator.service.properties
-rw-r----- 1 tungsten mysql 1590 May 14 14:35 services.properties
-rw-r----- 1 tungsten mysql 1590 May 14 14:35 .services.properties.orig
-rw-r--r-- 1 tungsten mysql 896 May 14 14:32 shard.list
-rw-r----- 1 tungsten mysql 43842 May 14 14:35 static-alpha.properties
-rw-r----- 1 tungsten mysql 43842 May 14 14:35 .static-alpha.properties.orig
-rw-r----- 1 tungsten mysql 5667 May 14 14:35 wrapper.conf
-rw-r----- 1 tungsten mysql 5667 May 14 14:35 .wrapper.conf.orig
```

When disabled, the files are readable by all users:

```
shell> ll /opt/continuent/tungsten/tungsten-replicator/conf/
total 148
drwxr-xr-x 2 tungsten mysql 4096 May 14 14:32 ./
drwxr-xr-x 11 tungsten mysql 4096 May 14 14:32 ../
-rw-r--r-- 1 tungsten mysql 33 May 14 14:32 dynamic-alpha.role
-rw-r--r-- 1 tungsten mysql 5059 May 14 14:32 log4j.properties
-rw-r--r-- 1 tungsten mysql 3488 May 14 14:32 log4j-thl.properties
-rw-r--r-- 1 tungsten mysql 972 May 14 14:32 mysql-java-charsets.properties
-rw-r--r-- 1 tungsten mysql 420 May 14 14:32 replicator.service.properties
-rw-r--r-- 1 tungsten mysql 1590 May 14 14:32 services.properties
-rw-r--r-- 1 tungsten mysql 1590 May 14 14:32 .services.properties.orig
-rw-r--r-- 1 tungsten mysql 896 May 14 14:32 shard.list
-rw-r--r-- 1 tungsten mysql 43842 May 14 14:32 static-alpha.properties
-rw-r--r-- 1 tungsten mysql 43842 May 14 14:32 .static-alpha.properties.orig
-rw-r--r-- 1 tungsten mysql 5667 May 14 14:32 wrapper.conf
-rw-r--r-- 1 tungsten mysql 5667 May 14 14:32 .wrapper.conf.orig
```

10.8.15. R tpm Options

--redshift-dbname

Option	`--redshift-dbname` [462]
Aliases	`--repl-redshift-dbname` [462]
Config File Options	`redshift-dbname` [462], `repl-redshift-dbname` [462]
Description	Name of the Redshift database to replicate into
Value Type	string

--relay-directory

Option	`--relay-directory` [462]
Aliases	`--repl-relay-directory` [462]
Config File Options	`relay-directory` [462], `repl-relay-directory` [462]
Description	Directory for logs transferred from the Primary
Value Type	string
Default	{home directory}/relay

--relay-enabled

Option	`--relay-enabled` [462]
Config File Options	`relay-enabled` [462]

Description	Should the replicator service be setup as a relay.
Value Type	boolean

--relay-source

Option	`--relay-source` [463]
Aliases	`--dataservice-relay-source` [463], `--master-dataservice` [463]
Config File Options	`dataservice-relay-source` [463], `master-dataservice` [463], `relay-source` [463]
Description	Dataservice name to use as a relay source
Value Type	string

--repl-allow-bidi-unsafe

Option	`--repl-allow-bidi-unsafe` [463]	
Config File Options	`repl-allow-bidi-unsafe` [463]	
Description	Allow unsafe SQL from remote service	
Value Type	boolean	
Default	false	
Valid Values	false	
	true	

--replace-tls-certificate

Option	`--replace-tls-certificate` [463]
Config File Options	`replace-tls-certificate` [463]
Description	Replace the TLS certificate

Replace the TLS certificate

--replication-host

Option	`--replication-host` [463]
Aliases	`--datasource-host` [463], `--repl-datasource-host` [463]
Config File Options	`datasource-host` [463], `repl-datasource-host` [463], `replication-host` [463]
Description	Hostname of the datasource
Value Type	string

Hostname of the datasource where the database is located. If the specified hostname matches the current host or member name, the database is assumed to be local. If the hostnames do not match, extraction is assumed to be via remote access. For MySQL hosts, this configures a remote replication Replica (relay) connection.

--replication-password

Option	`--replication-password` [463]
Aliases	`--datasource-password` [463], `--repl-datasource-password` [463]
Config File Options	`datasource-password` [463], `repl-datasource-password` [463], `replication-password` [463]
Description	Database password
Value Type	string

The password to be used when connecting to the database using the corresponding `--replication-user` [464].

--replication-port

Option	`--replication-port` [463]
Aliases	`--datasource-port` [463], `--repl-datasource-port` [463]
Config File Options	`datasource-port` [463], `repl-datasource-port` [463], `replication-port` [463]

Description	Database network port	
Value Type	string	
Valid Values	1521	Oracle Default
	27017	Kafka Default
	27017	MongoDB Default
	3306	MySQL Default
	5432	PostgreSQL Default
	5433	Vertica Default
	5439	Redshift Default
	8020	HDFS Default

The network port used to connect to the database server. The default port used depends on the database being configured.

--replication-user

Option	`--replication-user` [464]
Aliases	`--datasource-user` [464], `--repl-datasource-user` [464]
Config File Options	`datasource-user` [464], `repl-datasource-user` [464], `replication-user` [464]
Description	User for database connection
Value Type	string

For databases that required authentication, the username to use when connecting to the database using the corresponding connection method (native, JDBC, etc.).

--reset

Option	`--reset` [464]
Config File Options	`reset` [464]
Description	Clear the current configuration before processing any arguments
Value Type	string

For staging configurations, deletes all pre-existing configuration information between updating with the new configuration values.

--rmi-port

Option	`--rmi-port` [464]
Aliases	`--repl-rmi-port` [464]
Config File Options	`repl-rmi-port` [464], `rmi-port` [464]
Description	Replication RMI listen port
Value Type	string
Default	10001

--rmi-user

Option	`--rmi-user` [464]
Config File Options	`rmi-user` [464]
Description	The username for RMI authentication
Value Type	string

--role

Option	`--role` [464]
Aliases	`--repl-role` [464]
Config File Options	`repl-role` [464], `role` [464]

Description	What is the replication role for this service?	
Value Type	string	
Valid Values	master	
	relay	
	slave	

--router-gateway-port

Option	`--router-gateway-port` [465]
Config File Options	`router-gateway-port` [465]
Description	The router gateway port
Value Type	string

--router-jmx-port

Option	`--router-jmx-port` [465]
Config File Options	`router-jmx-port` [465]
Description	The router jmx port
Value Type	string

10.8.16. S tpm Options

--security-directory

Option	`--security-directory` [465]
Config File Options	`security-directory` [465]
Description	Storage directory for the Java security/encryption files
Value Type	string

--service-alias

Option	`--service-alias` [465]
Aliases	`--dataservice-service-alias` [465]
Config File Options	`dataservice-service-alias` [465], `service-alias` [465]
Description	Replication alias of this dataservice
Value Type	string

--service-name

Option	`--service-name` [465]
Config File Options	`service-name` [465]
Description	Set the service name

Set the service name

--service-type

Option	`--service-type` [465]	
Aliases	`--repl-service-type` [465]	
Config File Options	`repl-service-type` [465], `service-type` [465]	
Description	What is the replication service type?	
Value Type	string	
Valid Values	local	
	remote	

--skip-statemap

Option	--skip-statemap [466]
Config File Options	skip-statemap [466]
Description	Do not copy the cluster-home/conf/statemap.properties from the previous install
Value Type	boolean

--slaves

Option	--slaves [466]
Aliases	--dataservice-slaves [466], --members [455]
Config File Options	dataservice-slaves [466], members [455], slaves [466]
Description	What are the Replicas for this dataservice?
Value Type	string

--start

Option	--start [466]
Config File Options	start [466]
Description	Start the services after configuration
Value Type	string

--start-and-report

Option	--start-and-report [466]
Config File Options	start-and-report [466]
Description	Start the services and report out the status after configuration
Value Type	string

--svc-allow-any-remote-service

Option	--svc-allow-any-remote-service [466]	
Aliases	--repl-svc-allow-any-remote-service [466]	
Config File Options	repl-svc-allow-any-remote-service [466], svc-allow-any-remote-service [466]	
Description	Replicate from any service	
Value Type	boolean	
Default	false	
Valid Values	true	

--svc-applier-block-commit-interval

Option	--svc-applier-block-commit-interval [466]	
Aliases	--repl-svc-applier-block-commit-interval [466]	
Config File Options	repl-svc-applier-block-commit-interval [466], svc-applier-block-commit-interval [466]	
Description	Minimum interval between commits	
Value Type	string	
Valid Values	0	When batch service is not enabled
	#d	Number of days
	#h	Number of hours
	#m	Number of minutes
	#s	Number of seconds

--svc-applier-block-commit-size

Option	--svc-applier-block-commit-size [466]
Aliases	--repl-svc-applier-block-commit-size [466]
Config File Options	repl-svc-applier-block-commit-size [466], svc-applier-block-commit-size [466]
Description	Applier block commit size (min 1)
Value Type	numeric

--svc-applier-filters

Option	--svc-applier-filters [467]
Aliases	--repl-svc-applier-filters [467]
Config File Options	repl-svc-applier-filters [467], svc-applier-filters [467]
Description	Replication service applier filters
Value Type	string

--svc-extractor-filters

Option	--svc-extractor-filters [467]
Aliases	--repl-svc-extractor-filters [467]
Config File Options	repl-svc-extractor-filters [467], svc-extractor-filters [467]
Description	Replication service extractor filters
Value Type	string

--svc-fail-on-zero-row-update

Option	--svc-fail-on-zero-row-update [467]	
Aliases	--repl-svc-fail-on-zero-row-update [467]	
Config File Options	repl-svc-fail-on-zero-row-update [467], svc-fail-on-zero-row-update [467]	
Description	How should the replicator behave when a Row-Based Replication UPDATE or DELETE does not affect any rows.	
Value Type	string	
Default	stop	
Valid Values	ignore	No warnings in the log file, and replication continues
	warn	Log a Warning in the log file, but continue anyway

Warning

From release 7.0.1 the default for this property was changed to stop, previously, the default was warn.

The change in the default value may cause unexpected behavior in Active/Active topologies due to the Asynchronous nature of replication, however care should be taken if changing back to the original default of warn.

If you notice many entries in your replicator logs indicating zero row updates, and these warnings are being ignored, you may encounter data drift.

--svc-parallelization-type

Option	--svc-parallelization-type [467]	
Aliases	--repl-svc-parallelization-type [467]	
Config File Options	repl-svc-parallelization-type [467], svc-parallelization-type [467]	
Description	Method for implementing parallel apply	
Value Type	string	
Valid Values	disk	
	memory	
	none	

--svc-remote-filters

Option	--svc-remote-filters [467]
Aliases	--repl-svc-remote-filters [467]
Config File Options	repl-svc-remote-filters [467], svc-remote-filters [467]
Description	Replication service remote download filters
Value Type	string

--svc-reposition-on-source-id-change

Option	--svc-reposition-on-source-id-change [468]
Aliases	--repl-svc-reposition-on-source-id-change [468]
Config File Options	repl-svc-reposition-on-source-id-change [468], svc-reposition-on-source-id-change [468]
Description	The Primary will come ONLINE from the current position if the stored source_id does not match the value in the static properties
Value Type	string

--svc-shard-default-db

Option	--svc-shard-default-db [468]	
Aliases	--repl-svc-shard-default-db [468]	
Config File Options	repl-svc-shard-default-db [468], svc-shard-default-db [468]	
Description	Mode for setting the shard ID from the default db	
Value Type	string	
Valid Values	relaxed	
	stringent	

--svc-table-engine

Option	--svc-table-engine [468]
Aliases	--repl-svc-table-engine [468]
Config File Options	repl-svc-table-engine [468], svc-table-engine [468]
Description	Replication service table engine
Value Type	string
Default	innodb

--svc-thl-filters

Option	--svc-thl-filters [468]
Aliases	--repl-svc-thl-filters [468]
Config File Options	repl-svc-thl-filters [468], svc-thl-filters [468]
Description	Replication service THL filters
Value Type	string

10.8.17. T tpm Options

--target-dataservice

Option	--target-dataservice [468]
Aliases	--slave-dataservice [468]
Config File Options	slave-dataservice [468], target-dataservice [468]
Description	Dataservice to use to determine the value of host configuration
Value Type	string

--temp-directory

Option	--temp-directory [468]
Config File Options	temp-directory [468]
Description	Temporary Directory
Value Type	string

--template-file

Option	--template-file [469]
Config File Options	template-file [469]
Description	Display the keys that may be used in configuration template files
Value Type	string

--template-search-path

Option	--template-search-path [469]
Config File Options	template-search-path [469]
Description	Adds a new template search path for configuration file generation
Value Type	filename

--thl-directory

Option	--thl-directory [469]
Aliases	--repl-thl-directory [469]
Config File Options	repl-thl-directory [469], thl-directory [469]
Description	Replicator log directory
Value Type	string
Default	{home directory}/thl
Valid Values	{home directory}/thl

--thl-do-checksum

Option	--thl-do-checksum [469]
Aliases	--repl-thl-do-checksum [469]
Config File Options	repl-thl-do-checksum [469], thl-do-checksum [469]
Description	Execute checksum operations on THL log files
Value Type	string

--thl-interface

Option	--thl-interface [469]
Aliases	--repl-thl-interface [469]
Config File Options	repl-thl-interface [469], thl-interface [469]
Description	Listen interface to use for THL operations
Value Type	string

--thl-log-connection-timeout

Option	--thl-log-connection-timeout [469]
Aliases	--repl-thl-log-connection-timeout [469]
Config File Options	repl-thl-log-connection-timeout [469], thl-log-connection-timeout [469]
Description	Number of seconds to wait for a connection to the THL log
Value Type	numeric

--thl-log-file-size

Option	--thl-log-file-size [469]
Aliases	--repl-thl-log-file-size [469]
Config File Options	repl-thl-log-file-size [469], thl-log-file-size [469]
Description	File size in bytes for THL disk logs
Value Type	numeric

--thl-log-fsync

Option	--thl-log-fsync [470]
Aliases	--repl-thl-log-fsync [470]
Config File Options	repl-thl-log-fsync [470], thl-log-fsync [470]
Description	Fsync THL records on commit. More reliable operation but adds latency to replication when using low-performance storage
Value Type	string

--thl-log-retention

Option	--thl-log-retention [470]	
Aliases	--repl-thl-log-retention [470]	
Config File Options	repl-thl-log-retention [470], thl-log-retention [470]	
Description	How long do you want to keep THL files.	
Value Type	string	
Default	7d	
Valid Values	#d	Number of days
	#h	Number of hours
	#m	Number of minutes
	#s	Number of seconds

--thl-port

Option	--thl-port [470]
Aliases	--repl-thl-port [470]
Config File Options	repl-thl-port [470], thl-port [470]
Description	Port to use for THL Operations
Value Type	numeric
Default	2112

--thl-protocol

Option	--thl-protocol [470]
Aliases	--repl-thl-protocol [470]
Config File Options	repl-thl-protocol [470], thl-protocol [470]
Description	Protocol to use for THL communication with this service
Value Type	string

--topology

Option	--topology [470]
Aliases	--dataservice-topology [470]
Config File Options	dataservice-topology [470], topology [470]
Description	Replication topology for the dataservice.
Value Type	string

Valid Values	all-masters	
	cluster-alias	
	cluster-slave	
	clustered	
	direct	
	fan-in	
	master-slave	
	star	

--track-schema-changes

Option	`--track-schema-changes` [471]
Config File Options	`track-schema-changes` [471]
Description	This will enable filters that track DDL statements and write the resulting change to files on Replica hosts. The feature is intended for use in some batch deployments.
Value Type	string

10.8.18. U tpm Options

--user

Option	`--user` [471]
Config File Options	`user` [471]
Description	System User
Value Type	string

10.8.19. W tpm Options

--witnesses

Option	`--witnesses` [471]
Aliases	`--dataservice-witnesses` [471]
Config File Options	`dataservice-witnesses` [471], `witnesses` [471]
Description	Witness hosts for the dataservice
Value Type	string

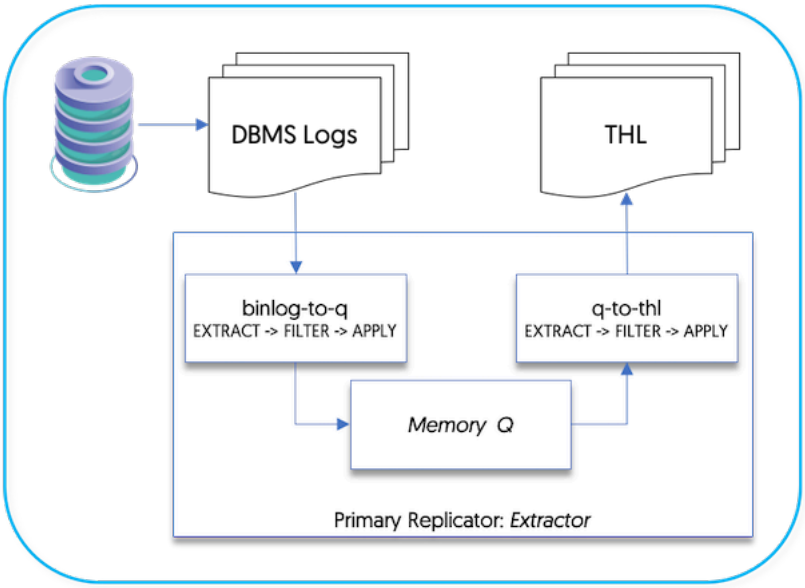
Chapter 11. Replication Filters

Filtering operates by applying the filter within one, or more, of the stages configured within the replicator. Stages are the individual steps that occur within a pipeline, that take information from a source (such as MySQL binary log) and write that information to an internal queue, the transaction history log, or apply it to a database. Where the filters are applied ultimately affect how the information is stored, used, or represented to the next stage or pipeline in the system.

For example, a filter that removed out all the tables from a specific database would have different effects depending on the stage it was applied. If the filter was applied on the Extractor before writing the information into the THL, then no Applier could ever access the table data, because the information would never be stored into the THL to be transferred to the Targets. However, if the filter was applied on the Applier, then some Appliers could replicate the table and database information, while other Appliers could choose to ignore them. The filtering process also has an impact on other elements of the system. For example, filtering on the Extractor may reduce network overhead, albeit at a reduction in the flexibility of the data transferred.

In a standard replicator configuration with MySQL, the following stages are configured in the Extractor, as shown in Figure 11.1, "Filters: Pipeline Stages on Extractors".

Figure 11.1. Filters: Pipeline Stages on Extractors



Where:

- `binlog-to-q` Stage

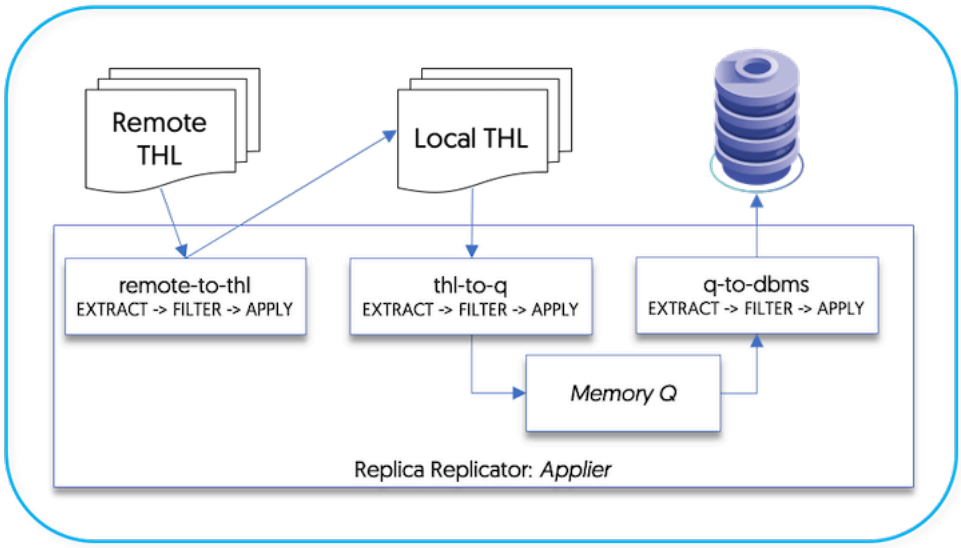
  The `binlog-to-q` stage reads information from the MySQL binary log and stores the information within an in-memory queue.

- `q-to-thl` Stage

  The in-memory queue is written out to the THL file on disk.

Within the Applier, the stages configured by default are shown in Figure 11.2, "Filters: Pipeline Stages on Appliers".

Figure 11.2. Filters: Pipeline Stages on Appliers



- `remote-to-thl` Stage

  Remote THL information is read from an trext; datasource and written to a local file on disk.

- `thl-to-q` Stage

  The THL information is read from the file on disk and stored in an in-memory queue.

- `q-to-dbms` Stage

  The data from the in-memory queue is written to the target database.

Filters can be applied during any configured stage, and where the filter is applied, alters the content and availability of the information. The staging and filtering mechanism can also be used to apply multiple filters to the data, altering content when it is read and when it is applied.

Where more than one filter is configured for a pipeline, each filter is executed in the order it appears in the configuration. For example, within the following fragment:

```
...
replicator.stage.binlog-to-q.filters=settostring,enumtostring,pkey,colnames
...
```

`settostring` is executed first, followed by `enumtostring`, `pkey` and finally `colnames`.

For certain filter combinations this order can be significant. Some filters rely on the information provided by earlier filters.

11.1. Enabling/Disabling Filters

A number of standard filter configurations are created and defined by default within the static properties file for the Tungsten Replicator configuration.

Filters can be enabled through tpm to update the filter configuration

- `--repl-svc-extractor-filters` [467]

  Apply the filter during the extraction stage, i.e. when the information is extracted from the binary log and written to the internal queue (`binlog-to-q`).

- `--repl-svc-thl-filters` [468]

  Apply the filter between the internal queue and when the transactions are written to the THL on the Extractor. (`q-to-thl`).

- `--repl-svc-remote-filters` [467]

  Apply the filter between reading from the remote THL server and writing to the local THL files on the Applier (`remote-to-thl`).

- `--repl-svc-applier-filters` [467]

  Apply the filter between reading from the internal queue and applying to the destination database (`q-to-dbms`).

Properties and options for an individual filter can be specified by setting the corresponding property value on the tpm command-line.

For example, to ignore a database schema on a Applier, the `replicate` filter can be enabled, and the *`replicator.filter.replicate.ignore`* specifies the name of the schemas to be ignored. To ignore the schema `contacts`:

For staging edeployments:

```
shell> ./tools/tpm update alpha --hosts=host1,host2,host3 \
    --repl-svc-applier-filters=replicate \
    --property=replicator.filter.replicate.ignore=contacts
```

For ini deployments:

```
shell> vi /etc/tungsten/tungsten.ini

[servicename]
...
repl-svc-applier-filters=replicate
property=replicator.filter.replicate.ignore=contacts
...

shell> tpm update
```

A bad filter configuration will not stop the replicator from starting, but the replicator will be placed into the `OFFLINE` state.

To disable a previously enabled filter for staging deployments, empty the filter specification and (optionally) unset the corresponding property or properties. For example:

```
shell> ./tools/tpm update alpha --hosts=host1,host2,host3 \
    --repl-svc-applier-filters= \
    --remove-property=replicator.filter.replicate.ignore
```

To disable a previously enabled filter for ini deployments, remove the values from the `tungsten.ini` file, and issue tpm update

Multiple filters can be applied on any stage, and the filters will be processed and called within the order defined within the configuration. For example, the following configuration:

```
shell> ./tools/tpm update alpha --hosts=host1,host2,host3 \
    --repl-svc-applier-filters=enumtostring,settostring,pkey \
    --remove-property=replicator.filter.replicate.ignore
```

The filters are called in order:

1. `enumtostring`
2. `settostring`
3. `pkey`

The order and sequence can be important if operations are being performed on the data and they are relied on later in the stage. For example, if data is being filtered by a value that exists in a `SET` column within the source data, the `settostring` filter must be defined before the data is filtered, otherwise the actual string value will not be identified.

Warning

In some cases, the filter order and sequence can also introduce errors. For example, when using the `pkey` filter and the `optimizeupdates` filters together, `pkey` may remove KEY information from the THL before `optimizeupdates` attempts to optimize the ROW event, causing the filter to raise a failure condition.

The currently active filters can be determined by using the trepctl status -name stages command:

```
shell> trepctl status -name stages
Processing status command (stages)...
...
NAME                 VALUE
----                 -----
applier.class      : com.continuent.tungsten.replicator.applier.MySQLDrizzleApplier
applier.name       : dbms
blockCommitRowCount: 10
committedMinSeqno  : 3600
extractor.class    : com.continuent.tungsten.replicator.thl.THLParallelQueueExtractor
extractor.name     : parallel-q-extractor
```

```
filter.0.class     : com.continuent.tungsten.replicator.filter.MySQLSessionSupportFilter
filter.0.name      : mysqlsessions
filter.1.class     : com.continuent.tungsten.replicator.filter.PrimaryKeyFilter
filter.1.name      : pkey
filter.2.class     : com.continuent.tungsten.replicator.filter.BidiRemoteSlaveFilter
filter.2.name      : bidiSlave
name               : q-to-dbms
processedMinSeqno  : -1
taskCount          : 5
Finished status command (stages)...
```

The above output is from a standard Applier replication installation showing the default filters enabled. The filter order can be determined by the number against each filter definition.

11.2. Enabling Additional Filters

The Tungsten Replicator configuration includes a number of filter configurations by default. However, not all filters are given a default configuration, and for some filters, multiple configurations may be needed to achieve more complex filtering requirements. Internally, filter configuration is defined through a property file that defines the filter name and corresponding parameters.

For example, the `rename` configuration is defined as follows:

```
replicator.filter.rename=com.continuent.tungsten.replicator.filter.RenameFilter
replicator.filter.rename.definitionsFile=${replicator.home.dir}/samples/extensions/java/rename.csv
```

The first line creates a new filter configuration using the corresponding Java class. In this case, the filter is named `rename`, as defined by the string *`replicator.filter.rename`*.

Configuration parameters for the filter are defined as values after the filter name. In this example, *`definitionsFile`* is the name of the property examined by the class to set the CSV file where the rename definitions are located.

To create an entirely new filter based on an existing filter class, a new property should created with the new filter definition in the configuration file.

Additional properties from this base should then be used. For example, to create a second rename filter definition called `custom`:

```
replicator.filter.rename.custom=com.continuent.tungsten.replicator.filter.RenameFilter
replicator.filter.rename.custom.definitionsFile=${replicator.home.dir}/samples/extensions/java/renamecustom.csv
```

The filter can be enabled against the desired stage using the filter name `custom`:

```
shell> ./tools/tpm configure \
    --repl-svc-applier-filters=custom
```

11.3. Filter Status

To determine which filters are currently being applied within a replicator, use the trepctl status -name stages command. This outputs a list of the current stages and their configuration. For example:

```
shell> trepctl status -name stages
Processing status command (stages)...
NAME                 VALUE
----                 -----
applier.class      : com.continuent.tungsten.replicator.thl.THLStoreApplier
applier.name       : thl-applier
blockCommitRowCount: 1
committedMinSeqno  : 15
extractor.class    : com.continuent.tungsten.replicator.thl.RemoteTHLExtractor
extractor.name     : thl-remote
name               : remote-to-thl
processedMinSeqno  : -1
taskCount          : 1
NAME                 VALUE
----                 -----
applier.class      : com.continuent.tungsten.replicator.thl.THLParallelQueueApplier
applier.name       : parallel-q-applier
blockCommitRowCount: 10
committedMinSeqno  : 15
extractor.class    : com.continuent.tungsten.replicator.thl.THLStoreExtractor
extractor.name     : thl-extractor
name               : thl-to-q
processedMinSeqno  : -1
taskCount          : 1
NAME                 VALUE
----                 -----
applier.class      : com.continuent.tungsten.replicator.applier.MySQLDrizzleApplier
```

```
applier.name       : dbms
blockCommitRowCount: 10
committedMinSeqno  : 15
extractor.class    : com.continuent.tungsten.replicator.thl.THLParallelQueueExtractor
extractor.name     : parallel-q-extractor
filter.0.class     : com.continuent.tungsten.replicator.filter.TimeDelayFilter
filter.0.name      : delay
filter.1.class     : com.continuent.tungsten.replicator.filter.MySQLSessionSupportFilter
filter.1.name      : mysqlsessions
filter.2.class     : com.continuent.tungsten.replicator.filter.PrimaryKeyFilter
filter.2.name      : pkey
name               : q-to-dbms
processedMinSeqno  : -1
taskCount          : 5
Finished status command (stages)...
```

In the output, the filters applied to the applier stage are shown in the last block of output. Filters are listed in the order in which they appear within the configuration.

For information about the filter operation and any modifications or changes made, check the `trepsvc.log` log file.

11.4. Filter Reference

The different filter types configured and available within Tungsten Replicator are designed to provide a number of different functionality and operations. Since the information exchanged through the THL system contains a copy of the statement or the row data that is being updated, the filters allow schemas, table and column names, as well as actual data to be converted at the stage in which they are applied.

Filters are identified according to the underlying Java class that defines their operation. For different filters, further configuration and naming is applied according to the templates used when Tungsten Cluster is installed through tpm.

Tungsten Replicator also comes with a number of JavaScript filters that can either be used directly, or that can be modified and adapted to suit individual requirements. These filter scripts are located in `tungsten-replicator/support/filters-javascript`.

For the purposes of classification, the different filters have been categorised according to their main purpose:

- Auditing

  These filters provide methods for tracking database updates alongside the original table data. For example, in a financial database, the actual data has to be updated in the corresponding tables, but the individual changes that lead to that update must also be logged individually.

- Content

  Content filters modify or update the content of the transaction events. These may alter information, for the purposes of interoperability (such as updating enumerated or integer values to their string equivalents), or remove or filter columns, tables, and entire schemas.

- Logging

  Logging filters record information about the transactions into the standard replicator log, either for auditing or debugging purposes.

- Optimization

  The optimization filters are designed to simplify and optimize statements and row updates to improve the speed at which those updates can be applied to the destination dataserver.

- Transformation

  Transformation filters rename or reformat schemas and tables according to a set of rules. For example, multiple schemas can be merged to a single schema, or tables and column names can be updated

- Validation

  Provide validation or consistency checking of either the data or the replication process.

- Miscellaneous

  Other filters that cannot be allocated to one of the existing filter classes.

In the following reference sections:

- Pre-configured filter name is the filter name that can be used against a stage without additional configuration.
- Property prefix is the prefix string for the filter to be used when assigning property values.

- Classname is the Java class name of the filter.
- Parameter is the name of the filter parameter can be set as a property within the configuration.
- Data compatibility indicates whether the filter is compatible with row-based events, statement-based events, or both.

11.4.1. `ansiquotes.js` Filter

The `ansiquotes` filter operates by inserting an SQL mode change to `ANSI_QUOTES` into the replication stream before a statement is executed, and returning to an empty SQL mode.

Pre-configured filter name		`ansiquotes`	
JavaScript Filter File		`tungsten-replicator/support/filters-javascript/ansiquotes.js`	
Property prefix		*`replicator.filter.ansiquotes`*	
Stage compatibility		`binlog-to-q`	
tpm Option compatibility		`--svc-extractor-filters` [467]	
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description

This changes a statement such as:

```
INSERT INTO notepad VALUES ('message',0);
```

To:

```
SET sql_mode='ANSI_QUOTES';
INSERT INTO notepad VALUES ('message',0);
SET sql_mode='';
```

This is achieved within the JavaScript by processing the incoming events and adding a new statement before the first `DBMSData` object in each event:

```
query = "SET sql_mode='ANSI_QUOTES'";
newStatement = new com.continuent.tungsten.replicator.dbms.StatementData(
    query,
    null,
    null
    );
data.add(0, newStatement);
```

A corresponding statement is appended to the end of the event:

```
query = "SET sql_mode=''";
newStatement = new com.continuent.tungsten.replicator.dbms.StatementData(
    query,
    null,
    null
    );
data.add(data.size(), newStatement);
```

11.4.2. BidiRemoteSlave (BidiSlave) Filter

The BidiRemoteSlaveFilter is used by Tungsten Replicator to prevent statements that originated from this service (i.e. where data was extracted), being re-applied to the database. This is a requirement for replication to prevent data that may be transferred between hosts being re-applied, particularly in Active/Active and other bi-directional replication deployments.

Pre-configured filter name	`bidiSlave`
Classname	`com.continuent.tungsten.replicator.filter.BidiRemoteSlaveFilter`
Property prefix	*`replicator.filter.bidiSlave`*
Stage compatibility	
tpm Option compatibility	
Data compatibility	Any event
Parameters	

Parameter	Type	Default	Description
localServiceName	string	*${local.service.name}*	Local service name of the service that reads the binary log
allowBidiUnsafe	boolean	false	If true, allows statements that may be unsafe for bi-directional replication
allowAnyRemoteService	boolean	false	If true, allows statements from any remote service, not just the current service

The filter works by comparing the server ID of the THL event that was created when the data was extracted against the server ID of the current server.

When deploying through the tpm service the filter is automatically enabled for remote Appliers. For complex deployments, particularly those with bi-directional replication (including active/active), the *allowBidiUnsafe* parameter may need to be enabled to allow certain statements to be re-executed.

11.4.3. breadcrumbs.js Filter

The breadcrumbs filter records regular 'breadcrumb' points into a MySQL table for systems that do not have global transaction IDs. This can be useful if recovery needs to be made to a specific point. The example also shows how metadata information for a given event can be updated based on the information from a table.

Pre-configured filter name		ansiquotes	
JavaScript Filter File		tungsten-replicator/support/filters-javascript/breadcrumbs.js	
Property prefix		*replicator.filter.breadcrumbs*	
Stage compatibility		binlog-to-q	
tpm Option compatibility		--svc-extractor-filters [467]	
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description
server_id	numeric	(none)	MySQL server ID of the current host

To use the filter:

1. A table is created and populated with one more rows on the Target server. For example:

```
CREATE TABLE `tungsten_svc1`.`breadcrumbs` (
 `id` int(11) NOT NULL PRIMARY KEY,
 `counter` int(11) DEFAULT NULL,
 `last_update` timestamp NOT NULL DEFAULT CURRENT_TIMESTAMP ON UPDATE CURRENT_TIMESTAMP) ENGINE=InnoDB;
INSERT INTO tungsten_svc1.breadcrumbs(id, counter) values(@@server_id, 1);
```

2. Now set an event to update the table regularly. For example, within MySQL an event can be created for this purpose:

```
CREATE EVENT breadcrumbs_refresh
  ON SCHEDULE EVERY 5 SECOND
  DO
    UPDATE tungsten_svc1.breadcrumbs SET counter=counter+1;
SET GLOBAL event_scheduler = ON;
```

The filter will extract the value of the counter each time it sees to the table, and then mark each transaction with a particular server ID with the counter value plus an offset. For convenience we assume row replication is enabled.

If you need to failover to another server that has different logs, you can figure out the restart point by looking in the THL for the breadcrumb metadata on the last transaction. Use this to search the binary logs on the new server for the correct restart point.

The filter itself work in two stages, and operates because the JavaScript instance is persistent as long as the Replicator is running. This means that data extracted during replication stays in memory and can be applied to later transactions. Hence the breadcrumb ID and offset information can be identified and used on each call to the filter function.

The first part of the filter event identifies the breadcrumb table and extracts the identified breadcrumb counter:

```
if (table.compareToIgnoreCase("breadcrumbs") == 0)
{
  columnValues = oneRowChange.getColumnValues();
  for (row = 0; row < columnValues.size(); row++)
```

```
  {
    values = columnValues.get(row);
    server_id_value = values.get(0);
    if (server_id == null || server_id == server_id_value.getValue())
    {
      counter_value = values.get(1);
      breadcrumb_counter = counter_value.getValue();
      breadcrumb_offset = 0;
    }
  }
}
```

The second part updates the event metadata using the extracted breadcrumb information:

```
topLevelEvent = event.getDBMSEvent();
if (topLevelEvent != null)
{
  xact_server_id = topLevelEvent.getMetadataOptionValue("mysql_server_id");
  if (server_id == xact_server_id)
  {
    topLevelEvent.setMetaDataOption("breadcrumb_counter", breadcrumb_counter);
    topLevelEvent.setMetaDataOption("breadcrumb_offset", breadcrumb_offset);
  }
}
```

To calculate the offset (i.e. the number of events since the last breadcrumb value was extracted), the filter determines if the event was the last fragment processed, and updates the offset counter:

```
if (event.getLastFrag())
{
  breadcrumb_offset = breadcrumb_offset + 1;
}
```

11.4.4. CaseTransform Filter

The `CaseTransform` filter can be used to force convert Schema, Table and Column names to either upper or lower case.

Pre-configured filter name		`casetransform`	
Classname		`com.continuent.tungsten.replicator.filter.CaseMappingFilter`	
Property prefix		*`replicator.filter.casetransform`*	
Stage compatibility			
tpm Option compatibility			
Data compatibility		Any Event	
Parameters			
Parameter	Type	Default	Description
`to_upper_case`	`boolean`	`true`	If true, converts object names to upper case; if false converts them to lower case

This filter can be useful when replicating between environments that have different case sensitivity settings in place.

Uage Example

To force Upper Case on extractor:

```
svc-extractor-filters=casetransform
property=replicator.filter.casetransform.to_upper_case=true
```

To force Lower Case on applier:

```
svc-applier-filters=casetransform
property=replicator.filter.casetransform.to_upper_case=false
```

11.4.5. ColumnName Filter

The `ColumnNameFilter` loads the table specification information for tables and adds this information to the THL data for information extracted using row-base replication.

Pre-configured filter name	`colnames`

Classname	com.continuent.tungsten.replicator.filter.ColumnNameFilter
Property prefix	*replicator.filter.colnames*
Stage compatibility	binlog-to-q
tpm Option compatibility	--svc-extractor-filters [467]
Data compatibility	Row events
Keeps Cached Data	Yes
Cached Refreshed When?	Emptied when going OFFLINE; Updated when ALTER statement seen
Metadata Updated	Yes; tungsten_filter_columnname=true

Parameters

Parameter	Type	Default	Description
user	string	*${replicator.global.extract.db.user}*	The username for the connection to the database for looking up column definitions
password	string	*${replicator.global.extract.db.password}*	The password for the connection to the database for looking up column definitions
url	string	jdbc:mysql:thin://${replicator.global.extract.db.host}: » ${replicator.global.extract.db.port}/${replicator.schema}?createDB=true	JDBC URL of the database connection to use for looking up column definitions
addSignedFlag	boolean	true	Determines whether the signed flag information for columns should be added to the metadata for each column.
ignoreMissingTables	boolean	true	When true, tables that do not exist will not trigger metadata and column names to be added to the THL data.

Note

This filter is designed to be used for testing and with heterogeneous replication where the field name information can be used to construct and build target data structures.

The filter is required for the correct operation of heterogeneous replication, for example when replicating to MongoDB. The filter works by using the replicator username and password to access the underlying database and obtain the table definitions. The table definition information is cached within the replication during operation to improve performance.

When extracting data from thew binary log using row-based replication, the column names for each row of changed data are added to the THL.

Enabling this filter changes the THL data from the following example, shown without the column names:

```
SEQ# = 27 / FRAG# = 0 (last frag)
- TIME = 2013-08-01 18:29:38.0
- EPOCH# = 11
- EVENTID = mysql-bin.000012:0000000000004369;0
- SOURCEID = host31
- METADATA = [mysql_server_id=1;dbms_type=mysql;service=alpha;shard=test]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
- OPTIONS = [foreign_key_checks = 1, unique_checks = 1]
- SQL(0) =
 - ACTION = INSERT
 - SCHEMA = test
 - TABLE = sales
 - ROW# = 0
  - COL(1: ) = 1
  - COL(2: ) = 23
  - COL(3: ) = 45
  - COL(4: ) = 45000.00
```

To a version where the column names are included as part of the THL record:

```
SEQ# = 43 / FRAG# = 0 (last frag)
- TIME = 2013-08-01 18:34:18.0
- EPOCH# = 28
- EVENTID = mysql-bin.000012:0000000000006814;0
- SOURCEID = host31
- METADATA = [mysql_server_id=1;dbms_type=mysql;service=alpha;shard=test]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
```

```
- OPTIONS = [foreign_key_checks = 1, unique_checks = 1]
- SQL(0) =
 - ACTION = INSERT
 - SCHEMA = test
 - TABLE = sales
 - ROW# = 0
  - COL(1: id) = 2
  - COL(2: country) = 23
  - COL(3: city) = 45
  - COL(4: value) = 45000.00
```

When the row-based data is applied to a non-MySQL database the column name information is used by the applier to specify the column, or they key when the column and value is used as a key/value pair in a document-based store.

11.4.6. ConvertStringFromMySQL Filter

The `ConvertStringFromMySQLFilter` is designed to be used in replicators that are used in conjunction either with existing native MySQL to MySQL replication deployments, or clustering deployments where the replication has been configured to use native MySQL byte storage for strings. These are incompatible with heterogeneous deployments as the string is stored internally and in the THL in a format that is useful only within similarly configured replicators.

Conversion can be selected to happen for all valid columns (`VARCHAR` or `CHAR` column types only), or for selected columns within specific tables and schemas. All conversions are made with the relevant character set for the table and THL event.

Note

Conversion will not occur on incompatible columns. For example, conversion will not be applied to `INT` columns. This is the case even if the column has been explicitly set to convert the column.

Pre-configured filter name		*convertstringfrommysql*	
Classname		`com.continuent.tungsten.replicator.ConvertStringFromMySQLFilter`	
Property prefix		*Not defined*	
Stage compatibility		any	
tpm Option compatibility			
Data compatibility		Row events only	
Parameters			
definitionsFile	string	`support/filters-config/convertstringfrom-mysql.json`	JSON file containing the definition of which events and which tables to skip

Configuration of the filter is made using the generic JSON file, which supports both default options to happen for all tables not otherwise explicitly specified. The default JSON file converts all valid (`VARCHAR` or `CHAR`) column types only:

```
{
    "__default": {
        "*" : "true",
    },
    "SCHEMA" : {
        "TABLE" : {
            "COLUMN" : "true",
        },
    }
}
```

Warning

For column specific selection to work, the column names must be included within the THL. The `colnames` filter must have been enabled either before this filter, or on the extractor where the data was originally extracted.

The default section handles the default response when an explicit schema or table name does not appear. Further sections are then organised by schema, table and column name. Where the setting is `true`, conversion will take place. A `false` disables conversion.

To enable conversion on a single column `DESCRIPTION` within the SALES.INVOICE schema/table while disabling conversion on all other columns:

```
{
    "__default": {
        "*" : "false",
    },
    "SALES" : {
        "INVOICE" : {
```

```
            "DESCRIPTION" : "true",
        },
    }
}
```

To convert all compatible columns in all tables within a schema:

```
{
    "__default": {
        "*" : "false",
    },
    "SALES" : {
        "*" : {
            "*" : "true",
        },
    }
}
```

A primary use case for this filter is for Cluster-Extractor replication from a cluster to a datawarehouse. For more details, please see Section 3.8, "Replicating from a Cluster to a Datawarehouse".

Source Cluster Example

For Cluster-Extractor replication to a datawarehouse, the source cluster nodes must use ROW-based MySQL binary logging, and also must have two extractor filters enabled, `colnames` and `pkey`.

For example, on every cluster node the lines below would be added to the `/etc/tungsten/tungsten.ini` file in the service stanza, then tpm update would be executed:

```
repl-svc-extractor-filters=colnames,pkey
property=replicator.filter.pkey.addColumnsToDeletes=true
property=replicator.filter.pkey.addPkeyToInserts=true
```

For staging deployments, prepend two hyphens to each line and include on the command line.

For more details about configuring the source cluster, please see Section 3.7, "Replicating Data Out of a Cluster".

Target Cluster-Extractor Example

On the replication Applier node, copy the `convertstringfrommysql.json` filter configuration sample file into the `/opt/continuent/share` directory then edit it to suit:

```
shell> cp /opt/continuent/tungsten/tungsten-replicator/support/filters-config/convertstringfrommysql.json /opt/continuent/share/
shell> vi /opt/continuent/share/convertstringfrommysql.json
```

Once the `convertstringfrommysql` JSON configuration file has been edited, update the `/etc/tungsten/tungsten.ini` file to add and configure the convertstringfrommysql filter.

For example, comfigure a service named `omega` on `host6` to read from the cluster nodes defined by cluster-alias `alpha`.

```
[alpha]
topology=cluster-alias
master=host1
members=host1,host2,host3
thl-port=2112

[omega]
topology=cluster-slave
relay=host6
relay-source=alpha
repl-svc-remote-filters=convertstringfrommysql
property=replicator.filter.convertstringfrommysql.definitionsFile=/opt/replicator/share/convertstringfrommysql.json
```

For more details about configuring the target Cluster-Extractor node, please see Section 3.7, "Replicating Data Out of a Cluster".

11.4.7. DatabaseTransform (dbtransform) Filter

This filter can be used to rename databases (schemas) and/or tables between source and targets

Pre-configured filter name	`dbtransform`
Classname	`com.continuent.tungsten.replicator.filter.DatabaseTransformFilter`
Property prefix	*`replicator.filter.dbtransform`*
Stage compatibility	

tpm Option compatibility			
Data compatibility		ROW Events only	
Parameters			
Parameter	Type	Default	Description
transformTables	boolean	false	If set to true, forces the rename transformations to operate on tables, not databases
from_regex1	string	foo	The search regular expression to use when renaming databases or tables (group 1); corresponds to *to_regex1*
to_regex1	string	bar	The replace regular expression to use when renaming databases or tables (group 1); corresponds to *from_regex1*
from_regex2	string		The search regular expression to use when renaming databases or tables (group 2); corresponds to *to_regex2*
to_regex2	string		The replace regular expression to use when renaming databases or tables (group 2); corresponds to *from_regex2*
from_regex3	string		The search regular expression to use when renaming databases or tables (group 3); corresponds to *to_regex3*
to_regex3	string		The replace regular expression to use when renaming databases or tables (group 3); corresponds to *from_regex3*
from_regex4	string		The search regular expression to use when renaming databases or tables (group 4); corresponds to *to_regex4*
to_regex4	string		The replace regular expression to use when renaming databases or tables (group 4); corresponds to *from_regex4*

The dbtransoform filter can be used to apply standard Java Regex expressions to rename databases and/or tables between source and target.

Up to 4 from/to regex patterns can be provided. By default the transofrmation will be applied to Database Schema names. To use the transofrm for Table Names, specify the transformTables=true option.

The filter will only transform database or tables, not a mix of the two. For more advanced transofrmation you may want to consider the rename filter instead

The filter only wors with ROW events. Statement based transofrmation are not supported with this filter.

11.4.8. dbrename.js Filter

The dbrename JavaScript filter renames database (schemas) using two parameters from the properties file, the *dbsource* and *dbtarget*. Each event is then processed, and the statement or row based schema information is updated to *dbtarget* when the *dbsource* schema is identified.

Pre-configured filter name		dbrename	
JavaScript Filter File		tungsten-replicator/support/filters-javascript/dbrename.js	
Property prefix		*replicator.filter.dbrename*	
Stage compatibility		binlog-to-q	
tpm Option compatibility		--svc-extractor-filters [467]	
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description
dbsource	string	(none)	Source table name (database/table to be renamed)
dbtarget	string	(none)	New database/table name

To configure the filter you would add the following to your properties:

```
replicator.filter.dbrename=com.continuent.tungsten.replicator.filter.JavaScriptFilter
replicator.filter.dbrename.script=${replicator.home.dir}/samples/extensions/javascript/dbrename.js
```

```
replicator.filter.dbrename.dbsource=SOURCE
replicator.filter.dbrename.dbtarget=TEST
```

The operation of the filter is straightforward, because the schema name is exposed and settable within the statement and row change objects:

```
function filter(event)
{
    sourceName = filterProperties.getString("dbsource");
    targetName = filterProperties.getString("dbtarget");

    data = event.getData();

    for(i=0;i<data.size();i++)
    {
        d = data.get(i);

        if(d instanceof
           com.continuent.tungsten.replicator.dbms.StatementData)
        {
            if(d.getDefaultSchema() != null &&
               d.getDefaultSchema().compareTo(sourceName)==0)
            {
                d.setDefaultSchema(targetName);
            }
        }
        else if(d instanceof
                com.continuent.tungsten.replicator.dbms.RowChangeData)
        {
            rowChanges = data.get(i).getRowChanges();

            for(j=0;j<rowChanges.size();j++)
            {
                oneRowChange = rowChanges.get(j);

                if(oneRowChange.getSchemaName().compareTo(sourceName)==0)
                {
                    oneRowChange.setSchemaName(targetName);
                }
            }
        }
    }
}
```

11.4.9. `dbselector.js` Filter

Filtering only a single database schema can be useful when you want to extract a single schema for external processing, or for sharding information across multiple replication targets. The `dbselector` filter deletes all statement and row changes, except those for the selected table. To configure, the *`db`* parameter to the filter configuration specifies the schema to be replicated.

Pre-configured filter name		`dbselector`	
JavaScript Filter File		`tungsten-replicator/support/filters-javascript/dbselector.js`	
Property prefix		*`replicator.filter.dbselector`*	
Stage compatibility		`binlog-to-q`, `q-to-thl`, `q-to-dbms`	
tpm Option compatibility		`--svc-extractor-filters` [467], `--svc-applier-filters` [467]	
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description
`db`	`string`	(none)	Database to be selected

Within the filter, statement changes look for the schema in the `StatementData` object and remove it from the array:

```
if (d instanceof com.continuent.tungsten.replicator.dbms.StatementData)
{
    if(d.getDefaultSchema().compareTo(db)!=0)
    {
        data.remove(i);
        i--;
    }
}
```

Because entries are being removed from the list of statements, the iterator used to process each item must be explicitly decremented by 1 to reset the counter back to the new position.

Similarly, when looking at row changes in the `RowChangeData`:

```
else if(d instanceof com.continuent.tungsten.replicator.dbms.RowChangeData)
{
    rowChanges = data.get(i).getRowChanges();

    for(j=0;j<rowChanges.size();j++)
    {
        oneRowChange = rowChanges.get(j);

        if(oneRowChange.getSchemaName().compareTo(db)!=0)
        {
            rowChanges.remove(j);
            j--;
        }
    }
}
```

11.4.10. `dbupper.js` Filter

The `dbupper` filter changes the case of the schema name for all schemas to uppercase. The schema information is easily identified in the statement and row based information, and therefore easy to update.

Pre-configured filter name		`dbupper`	
JavaScript Filter File		`tungsten-replicator/support/filters-javascript/dbupper.js`	
Property prefix		*`replicator.filter.dbupper`*	
Stage compatibility		`binlog-to-q`	
tpm Option compatibility		`--svc-extractor-filters` [467], `--svc-applier-filters` [467]	
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description
`from`	`string`	(none)	Database name to be converted to uppercase

For example, within statement data:

```
from = d.getDefaultSchema();
if (from != null)
{
    to   = from.toUpperCase();
    d.setDefaultSchema(to);
}
```

11.4.11. `dropcolumn.js` Filter

The `dropcolumn` filter enables columns in the THL to be dropped. This can be useful when replicating Personal Identification Information, such as email addresses, phone number, personal identification numbers and others are within the THL but need to be filtered out on the Target.

Pre-configured filter name		`dropcolumn`	
JavaScript Filter File		`tungsten-replicator/support/filters-javascript/dropcolumn.js`	
Property prefix		*`replicator.filter.dropcolumn`*	
Stage compatibility		`binlog-to-q`, `q-to-dbms`	
tpm Option compatibility		`--svc-extractor-filters` [467], `--svc-applier-filters` [467]	
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description
`definitionsFile`	Filename	`~/dropcolumn.json`	Location of the definitions file for dropping columns

The filter is available by default as `dropcolumn`, and the filter is configured through a JSON file that defines the list of columns to be dropped. The filter relies on the colnames filter being enabled.

To enable the filter:

```
shell> tpm update --svc-extractor-filters=colnames,dropcolumn \
```

```
    --property=replicator.filter.dropcolumn.definitionsFile=/opt/continuent/share/dropcolumn.json
```

A sample configuration file is provided in `tungsten-replicator/support/filters-config/dropcolumn.json`. The format of the file is a JSON array of schema/table/column specifications:

```
[
   {
       "schema": "vip",
       "table": "clients",
       "columns": [
           "personal_code",
           "birth_date",
           "email"
       ]
   },
   ...
]
```

Where:

- `schema` specifies the name of the schema on which to apply the filtering. If `*` is given, all schemas are matched.
- `table` specifies the name of the table on which to apply the filtering. If `*` is given, all tables are matched.
- `columns` is an array of column names to be matched.

For example:

```
[
   {
       "schema": "vip",
       "table": "clients",
       "columns": [
           "personal_code",
           "birth_date",
           "email"
       ]
   },
   ...
]
```

Filters the columns `email`, `birth_date`, and `personal_code` within the `clients` table in the `vip` schema.

To filter the `telephone` column in any table and any schema:

```
[
   {
       "schema": "*",
       "table": "*",
       "columns": [
           "telephone"
       ]
   }
]
```

Care should be taken when dropping columns on the Target and Source when the column order is different or when the names of the column differ:

- If the column order is same, even if dropcolumn.js is used, leave the default setting for the property *`replicator.applier.dbms.getColumnMetaDataFromDB=true`*.
- If the column order is different on the Source and Target, set *`replicator.applier.dbms.getColumnMetadataFromDB=false`*
- If slave's column names are different, regardless of differences in the order, use the default property setting *`replicator.applier.dbms.getColumnMetadataFromDB=true`*

11.4.12. `dropcomments.js` Filter

The `dropcomments` filter removes comments from statements within the event data.

Pre-configured filter name	`dropcomments`
JavaScript Filter File	`tungsten-replicator/support/filters-javascript/dropcomments.js`
Property prefix	*`replicator.filter.dropcomments`*

Stage compatibility		binlog-to-q, q-to-dbms	
tpm Option compatibility		--svc-extractor-filters [467], --svc-applier-filters [467]	
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description

Row changes do not have comments, so the filter only has to change the statement information, which is achieved by using a regular expression:

```
sqlOriginal = d.getQuery();
sqlNew = sqlOriginal.replaceAll("/\\*(?:.|[\\n\\r])*?\\*/","");
d.setQuery(sqlNew);
```

To handle the case where the statement could only be a comment, the statement is removed:

```
if(sqlNew.trim().length()==0)
{
    data.remove(i);
    i--;
}
```

11.4.13. dropmetadata.js Filter

All events within the replication stream contain metadata about each event. This information can be individually processed and manipulated. The dropmetadata filter removes specific metadata from each event, configured through the *option* parameter to the filter.

Pre-configured filter name		dropmetadata	
JavaScript Filter File		tungsten-replicator/support/filters-javascript/dropmetadata.js	
Property prefix		*replicator.filter.ansiquotes*	
Stage compatibility		binlog-to-q, q-to-dbms	
tpm Option compatibility		--svc-extractor-filters [467], --svc-applier-filters [467]	
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description
option	string	(none)	Name of the metadata field to be dropped

Metadata information can be processed at the event top-level:

```
metaData = event.getDBMSEvent().getMetadata();
for(m = 0; m < metaData.size(); m++)
{
    option = metaData.get(m);
    if(option.getOptionName().compareTo(optionName)==0)
    {
        metaData.remove(m);
        break;
    }
}
```

11.4.14. dropstatementdata.js Filter

Within certain replication deployments, enforcing that only row-based information is replicated is important to ensure that the row data is replicated properly. For example, when replicating to databases that do not accept statements, these events must be filtered out.

Pre-configured filter name		dropstatementdata	
JavaScript Filter File		tungsten-replicator/support/filters-javascript/dropstatementdata.js	
Property prefix		*replicator.filter.dropstatementdata*	
Stage compatibility		binlog-to-q, q-to-dbms	
tpm Option compatibility		--svc-extractor-filters [467], --svc-applier-filters [467]	
Data compatibility		Any event	
Parameters			

Parameter	Type	Default	Description

This is achieved by checking for statements, and then removing them from the event:

```
data = event.getData();

for(i = 0; i < data.size(); i++)
{
    d = data.get(i);

    if(d instanceof com.continuent.tungsten.replicator.dbms.StatementData)
    {
        data.remove(i);
        i--;
    }
}
```

11.4.15. `dropsqlmode.js` Filter

Different releases of MySQL occasionally add/remove various sql_modes, and in doing so if replicating between different versions, you may receive errors during replication as MySQL will reject unknown sql_modes.

This filter was specifically added to handle replication between MySQL 5.7 and MySQL 8 where a number of sql_modes where removed.

Pre-configured filter name		`dropsqlmode`	
JavaScript Filter File		`tungsten-replicator/support/filters-javascript/dropsqlmode.js`	
Property prefix		*`replicator.filter.dropsqlmode`*	
Stage compatibility		`q-to-dbms`	
tpm Option compatibility		`--svc-applier-filters` [467]	
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description
modes	string	See below	| separated string of sql_modes to drop

By default, the filter is configured to drop the following sql_modes: `NO_AUTO_CREATE_USER,NO_FIELD_OPTIONS,NO_KEY_OPTIONS,NO_TABLE_OPTIONS`

If you wish to add/remove sql_modes from this list, you will need to override the property as follows:

```
property=replicator.filter.dropsqlmode.modes=NO_AUTO_CREATE_USER|NO_FIELD_OPTIONS|NO_KEY_OPTIONS|NO_TABLE_OPTIONS| TIME_TRUNCATE_FRACTIONAL
```

11.4.16. `dropxa.js` Filter

The `dropxa` filter removes XA Transaction Events within the event data.

Pre-configured filter name		`dropxa`	
JavaScript Filter File		`tungsten-replicator/support/filters-javascript/dropxa.js`	
Property prefix		*`replicator.filter.dropxa`*	
Stage compatibility		`binlog-to-q`	
tpm Option compatibility		`--svc-extractor-filters` [467]	
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description

XA Transaction support was added into the replicator in version 6.1.14 however this filter can still be used if required to remove XA Transaction events if they are not required for replication

11.4.17. Dummy Filter

Pre-configured filter name	`dummy`

Classname	com.continuent.tungsten.replicator.filter.DummyFilter
Property prefix	*replicator.filter.dummy*
Stage compatibility	
tpm Option compatibility	
Data compatibility	Any event
Parameters	
(none)	

As the name suggests, the dummy filter does nothing, however it can be used as a simple mechanism to ensure that filters load correctly.

11.4.18. EnumToString Filter

The EnumToString filter translates ENUM datatypes within MySQL tables into their string equivalent within the THL.

Pre-configured filter name		enumtostring	
Classname		com.continuent.tungsten.replicator.filter.EnumToStringFilter	
Property prefix		*replicator.filter.enumtostring*	
Stage compatibility		binlog-to-q	
tpm Option compatibility		--repl-svc-extractor-filters [467]	
Data compatibility		Row events	
Metadata Updated		Yes; tungsten_filter_enumtostring=true	
Parameters			
Parameter	Type	Default	Description
user	string	*${replicator.global.extract.db.user}*	The username for the connection to the database for looking up column definitions
password	string	*${replicator.global.extract.db.password}*	The password for the connection to the database for looking up column definitions
url	string	jdbc:mysql:thin://${replicator.global.extract.db.host}: » ${replicator.global.extract.db.port}/${replicator.schema}?createDB=true	JDBC URL of the database connection to use for looking up column definitions

The EnumToString filter should be used with heterogeneous replication to ensure that the data is represented as the string value, not the internal numerical representation.

In the THL output below, the table has a ENUM column, country:

```
mysql> describe salesadv;
+----------+-------------------------------------+------+-----+---------+----------------+
| Field    | Type                                | Null | Key | Default | Extra          |
+----------+-------------------------------------+------+-----+---------+----------------+
| id       | int(11)                             | NO   | PRI | NULL    | auto_increment |
| country  | enum('US','UK','France','Australia') | YES  |     | NULL    |                |
| city     | int(11)                             | YES  |     | NULL    |                |
| salesman | set('Alan','Zachary')               | YES  |     | NULL    |                |
| value    | decimal(10,2)                       | YES  |     | NULL    |                |
+----------+-------------------------------------+------+-----+---------+----------------+
```

When extracted in the THL, the representation uses the internal value (for example, 1 for the first enumerated value). This can be seen in the THL output below.

```
SEQ# = 138 / FRAG# = 0 (last frag)
- TIME = 2013-08-01 19:09:35.0
- EPOCH# = 122
- EVENTID = mysql-bin.000012:0000000000021434;0
- SOURCEID = host31
- METADATA = [mysql_server_id=1;dbms_type=mysql;service=alpha;shard=test]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
- OPTIONS = [foreign_key_checks = 1, unique_checks = 1]
- SQL(0) =
 - ACTION = INSERT
 - SCHEMA = test
 - TABLE = salesadv
```

```
 - ROW# = 0
  - COL(1: id) = 2
  - COL(2: country) = 1
  - COL(3: city) = 8374
  - COL(4: salesman) = 1
  - COL(5: value) = 35000.00
```

For the `country` column, the corresponding value in the THL is `1`. With the `EnumToString` filter enabled, the value is expanded to the corresponding string value:

```
SEQ# = 121 / FRAG# = 0 (last frag)
- TIME = 2013-08-01 19:05:14.0
- EPOCH# = 102
- EVENTID = mysql-bin.000012:0000000000018866;0
- SOURCEID = host31
- METADATA = [mysql_server_id=1;dbms_type=mysql;service=alpha;shard=test]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
- OPTIONS = [foreign_key_checks = 1, unique_checks = 1]
- SQL(0) =
 - ACTION = INSERT
 - SCHEMA = test
 - TABLE = salesadv
 - ROW# = 0
  - COL(1: id) = 1
  - COL(2: country) = US
  - COL(3: city) = 8374
  - COL(4: salesman) = Alan
  - COL(5: value) = 35000.00
```

The information is critical when applying the data to a dataserver that is not aware of the table definition when replicating to non-MySQL target.

The examples here also show the Section 11.4.34, “SetToString Filter” and Section 11.4.5, “ColumnName Filter” filters.

11.4.19. EventMetadata Filter

Filters events based on metadata; used by default within sharding and Active/Active topologies

Pre-configured filter name	`eventmetadata`
Classname	`com.continuent.tungsten.replicator.filter.EventMetadataFilter`
Property prefix	*`replicator.filter.eventmetadata`*
Stage compatibility	
tpm Option compatibility	
Data compatibility	Row events
Metadata Updated	Yes; `tungsten_filter_settostring=true`
Parameters	
(none)	

11.4.20. `foreignkeychecks.js` Filter

The `foreignkeychecks` filter switches off foreign key checks for statements using the following statements:

```
CREATE TABLE
DROP TABLE
ALTER TABLE
RENAME TABLE
```

Pre-configured filter name	`foreignkeychecks`
JavaScript Filter File	`tungsten-replicator/support/filters-javascript/foreignkeychecks.js`
Property prefix	*`replicator.filter.foreignkeychecks`*
Stage compatibility	`binlog-to-q`, `q-to-dbms`
tpm Option compatibility	`--svc-extractor-filters` [467], `--svc-applier-filters` [467]
Data compatibility	Any event
Parameters	

Parameter	Type	Default	Description

The process checks the statement data and parses the content of the SQL statement by first trimming any extraneous space, and then converting the statement to upper case:

```
upCaseQuery = d.getQuery().trim().toUpperCase();
```

Then comparing the string for the corresponding statement types:

```
if(upCaseQuery.startsWith("CREATE TABLE") ||
    upCaseQuery.startsWith("DROP TABLE") ||
    upCaseQuery.startsWith("ALTER TABLE") ||
    upCaseQuery.startsWith("RENAME TABLE")
)
{
```

If they match, a new statement is inserted into the event that disables foreign key checks:

```
query = "SET foreign_key_checks=0";
newStatement = new com.continuent.tungsten.replicator.dbms.StatementData(
     d.getDefaultSchema(),
     null,
     query
     );
data.add(0, newStatement);
i++;
```

The use of `0` in the `add()` method inserts the new statement before the others within the current event.

11.4.21. Heartbeat Filter

The heartbeat file detects heartbeat events on Sources or Targets

Pre-configured filter name		[none]	
Classname		`com.continuent.tungsten.replicator.filter.HeartbeatFilter`	
Property prefix		[none]	
Stage compatibility			
tpm Option compatibility			
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description
heartbeatInterval	`numeric`	3000	Interval in milliseconds when a heartbeat event is inserted into the THL

11.4.22. `insertsonly.js` Filter

The `insertsonly` filter filters events to only include ROW-based events using `INSERT`.

Pre-configured filter name		`insertsonly`	
JavaScript Filter File		`tungsten-replicator/support/filters-javascript/insertonly.js`	
Property prefix		*replicator.filter.insertonly*	
Stage compatibility		`q-to-dbms`	
tpm Option compatibility		`--svc-applier-filters` [467]	
Data compatibility		Row events	
Parameters			
Parameter	Type	Default	Description

This is achieved by examining each row and removing row changes that do not match the `INSERT` action type:

```
if(oneRowChange.getAction()!="INSERT")
{
    rowChanges.remove(j);
```

```
    j--;
}
```

11.4.23. Logging Filter

Logs filtered events through the standard replicator logging mechanism

Pre-configured filter name	`logger`
Classname	`com.continuent.tungsten.replicator.filter.LoggingFilter`
Property prefix	*`replicator.filter.logger`*
Stage compatibility	
tpm Option compatibility	
Data compatibility	Any event
Parameters	
(none)	

11.4.24. MySQLSessionSupport (mysqlsessions) Filter

Filters transactions for session specific temporary tables and variables

Pre-configured filter name	`mysqlsessions`
Classname	`com.continuent.tungsten.replicator.filter.MySQLSessionSupportFilter`
Property prefix	*`replicator.filter.mysqlsession`*
Stage compatibility	
tpm Option compatibility	
Data compatibility	Any event
Parameters	
(none)	

11.4.25. NetworkClient Filter

The `NetworkClientFilter` processes data in selected columns

Pre-configured filter name		`networkclient`	
Classname		`com.continuent.tungsten.replicator.filter.NetworkClientFilter`	
Property prefix		*`replicator.filter.networkclient`*	
Stage compatibility		Any	
tpm Option compatibility		`--svc-extractor-filters` [467], `--svc-thl-filters` [468], `--svc-applier-filters` [467]	
Data compatibility		Row events	
Parameters			
Parameter	Type	Default	Description
`definitionsFile`	pathname	${replicator.home.dir}/samples/extensions/java/network-client.json	The name of a file containing the definitions for how columns should be processed by filters
`serverPort`	number	3112	The network port to use when communicating with the network client
`timeout`	number	10	Timeout in seconds before treating the network client as failed when waiting to send or receive content.

The network filter operates by sending field data, as defined in the corresponding filter configuration file, out to a network server that processes the information and sends it back to be re-introduced in place of the original field data. This can be used to translate and reformat information during the replication scheme.

The filter operation works as follows:

- All filtered data will be sent to a single network server, at the configured port.
- A single network server can be used to provide multiple transformations.
- The JSON configuration file for the filter supports multiple types and multiple column definitions.
- The protocol used by the network filter must be followed to effectively process the information. A failure in the network server or communication will cause the replicator to raise an error and replication to go `OFFLINE`.
- The network server must be running before the replicator is started. If the network server cannot be found, replication will go `OFFLINE`.

Correct operation requires building a suitable network filter using the defined protocol, and creating the JSON configuration file. A sample filter is provided for reference.

11.4.25.1. Network Client Configuration

The format of the configuration file defines the translation operation to be requested from the network client, in addition to the schema, table and column name. The format for the file is JSON, with the top-level hash defining the operation, and an array of field selections for each field that should be processed accordingly. For example:

```
{
   "String_to_HEX_v1" : [
      {
         "table" : "hextable",
         "schema" : "hexdb",
         "columns" : [
            "hexcol"
         ]
      }
   ]
}
```

The operation in this case is `String_to_HEX_v1`; this will be sent to the network server as part of the request. The column definition follows.

To send multiple columns from different tables to the same translation:

```
{
   "String_to_HEX_v1" : [
      {
         "table" : "hextable",
         "schema" : "hexdb",
         "columns" : [
            "hexcol"
         ]
      },
      {
         "table" : "hexagon",
         "schema" : "sourcetext",
         "columns" : [
            "itemtext"
         ]
      }
   ]
}
```

Alternatively, to configure different operations for the same two tables:

```
{
   "String_to_HEX_v1" : [
      {
         "table" : "hextable",
         "schema" : "hexdb",
         "columns" : [
            "hexcol"
         ]
      }
   ],
   "HEX_to_String_v1" : [
      {
         "table" : "hexagon",
         "schema" : "sourcetext",
         "columns" : [
            "itemtext"
         ]
      }
   ]
```

```
}
```

11.4.25.2. Network Filter Protocol

The network filter protocol has been designed to be both lightweight and binary data compatible, as it is designed to work with data that may be heavily encoded, binary, or compressed in nature.

The protocol operates through a combined JSON and optional binary payload structure that communicates the information. The JSON defines the communication type and metadata, while the binary payload contains the raw or translated information.

The filter communicates with the network server using the following packet types:

- prepare

  The `prepare` message is called when the filter goes online, and is designed to initialize the connection to the network server and confirm the supported filter types and operation. The format of the connection message is:

  ```
  {
     "payload" : -1,
     "type" : "prepare",
     "service" : "firstrep",
     "protocol" : "v0_9"
  }
  ```

  Where:

  - `protocol`

    The protocol version.

  - `service`

    The name of the replicator service that called the filter.

  - `type`

    The message type.

  - `payload`

    The size of the payload; a value of -1 indicates that there is no payload.

  The format of the response should be a JSON object and payload with the list of supported filter types in the payload section. The payload immediately follows the JSON, with the size of the list defined within the `payload` field of the returned JSON object:

  ```
  {
     "payload" : 22,
     "type" : "acknowledged",
     "protocol" : "v0_9",
     "service" : "firstrep",
     "return" : 0
  }Perl_BLOB_to_String_v1
  ```

  Where:

  - `protocol`

    The protocol version.

  - `service`

    The name of the replicator service that called the filter.

  - `type`

    The message type; when acknowledging the original prepare request it should be `acknowledge`.

  - `return`

    The return value. A value of 0 (zero) indicates no faults. Any true value indicates there was an issue.

  - `payload`

    The length of the appended payload information in bytes. This is used by the filter to identify how much additional data to read after the JSON object has been read.

The payload should be a comma-separated list of the supported transformation types within the network server.

- filter

  The `filter` message type is sent by Tungsten Replicator for each value from the replication stream that needs to be filtered and translated in some way. The format of the request is a JSON object with a trailing block of data, the payload, that contains the information to be filtered. For example:

```
{
   "schema" : "hexdb",
   "transformation" : "String_to_HEX_v1",
   "service" : "firstrep",
   "type" : "filter",
   "payload" : 22,
   "row" : 0,
   "column" : "hexcol",
   "table" : "hextable",
   "seqno" : 145196,
   "fragments" : 1,
   "protocol" : "v0_9",
   "fragment" : 1
}48656c6c6f20576f726c64
```

  Where:

  - `protocol`

    The protocol version.

  - `service`

    The service name the requested the filter.

  - `type`

    The message type, in this case, `filter`.

  - `row`

    The row of the source information from the THL that is being filtered.

  - `schema`

    The schema of the source information from the THL that is being filtered.

  - `table`

    The table of the source information from the THL that is being filtered.

  - `column`

    The column of the source information from the THL that is being filtered.

  - `seqno`

    The sequence number of the event from the THL that is being filtered.

  - `fragments`

    The number of fragments in the THL that is being filtered.

  - `fragment`

    The fragment number within the THL that is being filtered. The fragments may be sent individually and sequentially to the network server, so they may need to be retrieved, merged, and reconstituted depending on the nature of the source data and the filter being applied.

  - `transformation`

    The transformation to be performed on the supplied payload data. A single network server can support multiple transformations, so this information is provided to perform the corrupt operation. The actual transformation to be performed is taken from the JSON configuration file for the filter.

  - `payload`

The length, in bytes, of the payload data that will immediately follow the JSON filter request..

The payload that immediately follows the JSON block is the data from the column that should be processed by the network filter.

The response package should contain a copy of the supplied information from the requested filter, with the `payload` size updated to the size of the returned information, the message type changed to `filtered`, and the payload containing the translated data. For example:

```
{
   "transformation" : "String_to_HEX_v1",
   "fragments" : 1,
   "type" : "filtered",
   "fragment" : 1,
   "return" : 0,
   "seqno" : 145198,
   "table" : "hextable",
   "service" : "firstrep",
   "protocol" : "v0_9",
   "schema" : "hexdb",
   "payload" : 8,
   "column" : "hexcol",
   "row" : 0
}FILTERED
```

11.4.25.3. Sample Network Client

The following sample network server script is written in Perl, and is designed to translated packed hex strings (two-hex characters per byte) from their hex representation into their character representation.

```
#!/usr/bin/perl

use Switch;
use IO::Socket::INET;
use JSON qw( decode_json encode_json);
use Data::Dumper;

# auto-flush on socket
$| = 1;

my $serverName = "Perl_BLOB_to_String_v1";

while(1)
{
# creating a listening socket
my $socket = new IO::Socket::INET (
    LocalHost => '0.0.0.0',
    LocalPort => '3112',
    Proto => 'tcp',
    Listen => 5,
    Reuse => 1
);
die "Cannot create socket $!\n" unless $socket;
print "********\nServer waiting for client connection on port 3112\n******\n\n\n";

# Waiting for a new client connection
my $client_socket = $socket->accept();

# Fet information about a newly connected client
my $client_address = $client_socket->peerhost();
my $client_port = $client_socket->peerport();
print "Connection from $client_address:$client_port\n";

my $data = "";

while(    $data = $client_socket->getline())
{
    # Eead up to 1024 characters from the connected client
    chomp($data);

    print "\n\nReceived: <$data>\n";

    # Decode the JSON part
    my $msg = decode_json($data);

    # Extract payload
    my $payload = undef;

    if ($msg->{payload} > 0)
        {
            print STDERR "Reading $msg->{payload} bytes\n";
            $client_socket->read($payload,$msg->{payload});
            print "Payload: <$payload>\n";
```

```
         }

    switch( $msg->{'type'} )
    {
        case "prepare"
        {
              print STDERR "Received prepare request\n";

            # Send acknowledged message
            my $out = '{ "protocol": "v0_9", "type": "acknowledged", ' .
                      '"return": 0, "service": "' . $msg->{'service'} . '", "payload": ' .
                      length($serverName) . '}' . "\n" . $serverName;

            print $client_socket "$out";
            print "Sent: <$out>\n";
                print STDERR "Sent acknowledge request\n";
        }
        case "release"
        {
            # Send acknowledged message
            my $out = '{ "protocol": "v0_9", "type": "acknowledged", ' .
                      '"return": 0, "service": "' . $msg->{'service'} . '", "payload": 0}';

            print $client_socket "$out\n";
            print "Sent: <$out>\n";
        }
        case "filter"
        {
            # Send filtered message

                  print STDERR "Sending filtered payload\n";

            my $filtered = "FILTERED";
            my $out = <<END;
{
"protocol": "v0_9",
"type": "filtered",
"transformation": "$msg->{'transformation'}",
"return": 0,
"service": "$msg->{'service'}",
"seqno": $msg->{'seqno'},
"row": $msg->{'row'},
"schema": "$msg->{'schema'}",
"table": "$msg->{'table'}",
"column": "$msg->{'column'}",
"fragment": 1,
"fragments": 1,
"payload": @{[length($filtered)]}
}
END

$out =~ s/\n//g;
            print "About to send: <$out>\n";
            $client_socket->send("$out\n" . $filtered);
print("Response sent\n");
        }
    }

print("End of loop, hoping for next packet\n");
}

    # Notify client that we're done writing
    shutdown($client_socket, 1);

$socket->close();
}
```

11.4.26. `nocreatedbifnotexists.js` Filter

The `nocreatedbifnotexists` filter removes statements that start with:

```
CREATE DATABASE IF NOT EXISTS
```

Pre-configured filter name	`nocreatedbifnotexists`
JavaScript Filter File	`tungsten-replicator/support/filters-javascript/nocreatedbifnotexists.js`
Property prefix	*`replicator.filter.nocreatedbifnotexists`*
Stage compatibility	`q-to-dbms`
tpm Option compatibility	`--svc-applier-filters` [467]

Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description

This can be useful in heterogeneous replication where Tungsten Replicator specific databases need to be removed from the replication stream.

The filter works in two phases. The first phase creates a global variable within the `prepare()` [515] function that defines the string to be examined:

```
function prepare()
{
  beginning = "CREATE DATABASE IF NOT EXISTS";
}
```

Row based changes can be ignored, but for statement based events, the SQL is examine and the statement removed if the SQL starts with the text in the `beginning` variable:

```
sql = d.getQuery();
if(sql.startsWith(beginning))
{
    data.remove(i);
    i--;
}
```

11.4.27. OptimizeUpdates Filter

The `optimizeupdates` filter works with row-based events to simplify the update statement and remove columns/values that have not changed. This reduces the workload and row data exchanged between replicators.

Pre-configured filter name	`optimizeupdates`
Classname	`com.continuent.tungsten.replicator.filter.OptimizeUpdatesFilter`
Property prefix	*`replicator.filter.optimizeupdates`*
Stage compatibility	
tpm Option compatibility	
Data compatibility	Row events
Parameters	
(none)	

The filter operates by removing column values for keys in the update statement that do not change. For example, when replicating the row event from the statement:

```
mysql>  update testopt set msg = 'String1', string = 'String3' where id = 1;
```

Generates the following THL event data:

```
- SQL(0) =
 - ACTION = UPDATE
 - SCHEMA = test
 - TABLE = testopt
 - ROW# = 0
  - COL(1: id) = 1
  - COL(2: msg) = String1
  - COL(3: string) = String3
  - KEY(1: id) = 1
```

Column 1 [`id`] in this case is automatically implied by the KEY entry required for the update.

With the `optimizeupdates` filter enabled, the data in the THL is simplified to:

```
- SQL(0) =
 - ACTION = UPDATE
 - SCHEMA = test
 - TABLE = testopt
 - ROW# = 0
  - COL(2: msg) = String1
  - COL(3: string) = String4
  - KEY(1: id) = 1
```

In tables where there are multiple keys the stored THL information can be reduced further.

Warning

The filter works by comparing the value of each KEY and COL entry in the THL and determining whether the value has changed or not. If the number of keys and columns do not match then the filter will fail with the following error message:

```
Caused by: java.lang.Exception: Column and key count is different in this event! Cannot filter
```

This may be due to a filter earlier within the filter configuration that has optimized or simplified the data. For example, the `pkey` filter removes KEY entries from the THL that are not primary keys, or `dropcolumn` which drops column data.

The following error message may appear in the logs and in the output from trepctl status to indicate that this ordering issue may be the problem:

```
OptimizeUpdatesFilter cannot filter, because column and key count is different.
Make sure that it is defined before filters which remove keys (eg. PrimaryKeyFilter).
```

11.4.28. PrimaryKey Filter

The `PrimaryKey` filter adds primary key information to row-based replication data. This is required by heterogeneous environments to ensure that the primary key is identified when updating or deleting tables. Without this information, the primary key to use, for example as the document ID in a document store such as MongoDB, is generated dynamically. In addition, without this filter in place, when performing update or delete operations a full table scan is performed on the target dataserver to determine the record that must be updated.

Pre-configured filter name	`pkey`
Classname	`com.continuent.tungsten.replicator.filter.PrimaryKeyFilter`
Property prefix	*`replicator.filter.pkey`*
Stage compatibility	`binlog-to-q`
tpm Option compatibility	`--repl-svc-extractor-filters` [467]
Data compatibility	Row events
Keeps Cached Data	Yes
Cached Refreshed When?	Emptied when going `OFFLINE`; Updated when `ALTER` statement seen
Metadata Updated	Yes; `tungsten_filter_primarykey=true`

Parameters

Parameter	Type	Default	Description
`user`	string	*`${replicator.global.extract.db.user}`*	The username for the connection to the database for looking up column definitions
`password`	string	*`${replicator.global.extract.db.password}`*	The password for the connection to the database for looking up column definitions
`url`	string	*`jdbc:mysql:thin://${replicator.global.extract.db.host}:» ${replicator.global.extract.db.port}/${replicator.schema}?createDB=true`*	JDBC URL of the database connection to use for looking up column definitions
`addPkeyToInsert`	`boolean`	`false`	If set to true, primary keys are added to `INSERT` operations. This setting is required for batch loading
`addColumnsToDeletes`	`boolean`	`false`	If set to true, full column metadata is added to `DELETE` operations. This setting is required for batch loading

Note

This filter is designed to be used for testing and with heterogeneous replication where the field name information can be used to construct and build target data structures.

For example, in the following THL fragment, the key information includes data for all columns, which the is the default behavior for `UPDATE` and `DELETE` operations.

```
SEQ# = 142 / FRAG# = 0 (last frag)
- TIME = 2013-08-01 19:31:04.0
- EPOCH# = 122
- EVENTID = mysql-bin.000012:0000000000022187;0
- SOURCEID = host31
- METADATA = [mysql_server_id=1;dbms_type=mysql;service=alpha;shard=test]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
```

```
- OPTIONS = [foreign_key_checks = 1, unique_checks = 1]
- SQL(0) =
 - ACTION = UPDATE
 - SCHEMA = test
 - TABLE = salesadv
 - ROW# = 0
  - COL(1: id) = 2
  - COL(2: country) = 1
  - COL(3: city) = 8374
  - COL(4: salesman) = 1
  - COL(5: value) = 89000.00
  - KEY(1: id) = 2
  - KEY(2: country) = 1
  - KEY(3: city) = 8374
  - KEY(4: salesman) = 1
  - KEY(5: value) = 89000.00
```

When the `PrimaryKey` filter is enabled, the key information has been optimized to only contain the actual primary keys in the row-based THL record:

```
SEQ# = 142 / FRAG# = 0 (last frag)
- TIME = 2013-08-01 19:31:04.0
- EPOCH# = 122
- EVENTID = mysql-bin.000012:0000000000022187;0
- SOURCEID = host31
- METADATA = [mysql_server_id=1;dbms_type=mysql;service=alpha;shard=test]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
- OPTIONS = [foreign_key_checks = 1, unique_checks = 1]
- SQL(0) =
 - ACTION = UPDATE
 - SCHEMA = test
 - TABLE = salesadv
 - ROW# = 0
  - COL(1: id) = 2
  - COL(2: country) = 1
  - COL(3: city) = 8374
  - COL(4: salesman) = 1
  - COL(5: value) = 89000.00
  - KEY(1: id) = 2
```

The final line shows the addition of the primary key `id` added to THL event.

> **Important**
>
> The filter determines primary key information by examining the DDL for the table, and keeping that information in an internal cache. If the DDL for a table is not known, or an `ALTER TABLE` statement is identified, the cache information is updated before the THL is then modified with the primary key information.
>
> In the situation where you enable the filter, but have not create primary key information on the tables, it is possible that creating or adding other index types (such as `UNIQUE`) on a table, could lead to the incorrect primary key information being updated in the THL, particularly if there are active transactions taking place during and/or immediately after the `ALTER` statement.
>
> The safest way to perform an index update in case remains the same as for any safe DDL update:
>
> - Put the replicator offline
> - Change the DDL for the table or tables
> - Put the replicator online

The two options, *`addPkeyToInsert`* and *`addColumnsToDeletes`* add the primary key information to `INSERT` and `DELETE` operations respectively. In a heterogeneous environment, these options should be enabled to prevent full-table scans during update and deletes.

11.4.29. PrintEvent Filter

Outputs transaction event information to the replication logging system

Pre-configured filter name	`printevent`
Classname	`com.continuent.tungsten.replicator.filter.PrintEventFilter`
Property prefix	*`replicator.filter.printevent`*
Stage compatibility	
tpm Option compatibility	

Data compatibility	Any event
Parameters	
(none)	

11.4.30. Rename Filter

The `rename` filter enables schemas to be renamed at the database, table and column levels, and for complex combinations of these renaming operations. Configuration is through a CSV file that defines the rename parameters. A single CSV file can contain multiple rename definitions. The rename operations occur only on ROW based events.

The `rename` filter also performs schema renames on statement data.

Pre-configured filter name	`rename`		
Classname	`com.continuent.tungsten.replicator.filter.RenameFilter`		
Property prefix	*`replicator.filter.rename`*		
Stage compatibility			
tpm Option compatibility			
Data compatibility	Row events.		
Parameters			
Parameter	Type	Default	Description
`definitionsFile`	string	`{replicator.home.dir}/samples/extensions/java/rename.csv`	Location of the CSV file that contains the rename definitions.

The CSV file is only read when an explicit reconfigure operation is triggered. If the file is changed, a configure operation (using tpm update) must be initiated to force reconfiguration.

To enable using the default CSV file:

```
shell> ./tools/tpm update alpha --svc-applier-filters=rename
```

The CSV consists of multiple lines, one line for each rename specification. Comments are supposed using the `#` character.

The format of each line of the CSV is:

```
originalSchema,originalTable,originalColumn,newSchema,newTable,newColumn
```

Where:

- `originalSchema`, `originalTable`, `originalColumn` define the original schema, table and column.

  Definition can either be:

  - Explicit schema, table or column name
  - `*` character, which indicates that all entries should match.

- `newSchema`, `newTable`, `newColumn` define the new schema, table and column for the corresponding original specification.

  Definition can either be:

  - Explicit schema, table or column name
  - `-` character, which indicates that the corresponding object should not be updated.

For example, the specification:

```
*,chicago,*,-,newyork,-
```

Would rename the table `chicago` in every database schema to `newyork`. The schema and column names are not modified.

The specification:

```
*,chicago,destination,-,-,source
```

Would match all schemas, but update the column `destination` in the table `chicago` to the column name `source`, without changing the schema or table name.

Processing of the individual rules is executed in a specific order to allow for complex matching and application of the rename changes.

- Rules are case sensitive.
- Schema names are looked up in the following order:
  1. `schema.table` (explicit schema/table)
  2. `schema.*` (explicit schema, wildcard table)
- Table names are looked up in the following order:
  1. `schema.table` (explicit schema/table)
  2. `*.table` (wildcard schema, explicit table)
- Column names are looked up in the following order:
  1. `schema.table` (explicit schema/table)
  2. `schema.*` (explicit schema, wildcard table)
  3. `*.table` (wildcard schema, explicit table)
  4. `*.*` (wildcard schema, wildcard table)
- Rename operations match the first specification according to the above rules, and only one matching rule is executed.

11.4.30.1. Rename Filter Examples

When processing multiple entries that would match the same definition, the above ordering rules are applied. For example, the definition:

```
asia,*,*,america,-,-
asia,shanghai,*,europe,-,-
```

Would rename `asia.shanghai` to `europe.shanghai`, while renaming all other tables in the schema `asia` to the schema `america`. This is because the explicit `schema.table` rule is matched first and then executed.

Complex renames involving multiple schemas, tables and columns can be achieved by writing multiple rules into the same CSV file. For example given a schema where all the tables currently reside in a single schema, but must be renamed to specific continents, or to a 'miscellaneous' schema, while also updating the column names to be more neutral would require a detailed rename definition.

Existing tables are in the schema `sales`:

```
chicago
newyork
london
paris
munich
moscow
tokyo
shanghai
sydney
```

Need to be renamed to:

```
northamerica.chicago
northamerica.newyork
europe.london
europe.paris
europe.munich
misc.moscow
asiapac.tokyo
asiapac.shanghai
misc.sydney
```

Meanwhile, the table definition needs to be updated to support more complex structure:

```
id
area
country
city
value
type
```

The area is being updated to contain the region within the country, while the value should be renamed to the three-letter currency code, for example, the `london` table would rename the `value` column to `gbp`.

The definition can be divided up into simple definitions at each object level, relying on the processing order to handle the individual exceptions. Starting with the table renames for the continents:

```
sales,chicago,*,northamerica,-,-
sales,newyork,*,northamerica,-,-
sales,london,*,europe,-,-
sales,paris,*,europe,-,-
sales,munich,*,europe,-,-
sales,tokyo,*,asiapac,-,-
sales,shanghai,*,asiapac,-,-
```

A single rule to handle the renaming of any table not explicitly mentioned in the list above into the `misc` schema:

```
*,*,*,misc,-,-
```

Now a rule to change the `area` column for all tables to `region`. This requires a wildcard match against the schema and table names:

```
*,*,area,-,-,region
```

And finally the explicit changes for the value column to the corresponding currency:

```
*,chicago,value,-,-,usd
*,newyork,value,-,-,usd
*,london,value,-,-,gbp
*,paris,value,-,-,eur
*,munich,value,-,-,eur
*,moscow,value,-,-,rub
*,tokyo,value,-,-,jpy
*,shanghai,value,-,-,cny
*,sydney,value,-,-,aud
```

11.4.31. Replicate Filter

The `replicate` filter enables explicit inclusion or exclusion of tables and schemas. Each specification supports wildcards and multiple entries.

Pre-configured filter name		`replicate`	
Classname		`com.continuent.tungsten.replicator.filter.ReplicateFilter`	
Property prefix		*`replicator.filter.replicate`*	
Stage compatibility		Any	
tpm Option compatibility			
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description
`ignore`	string	empty	Comma separated list of database/tables to ignore during replication
`do`	string	empty	Comma separated list of database/tables to replicate

Rules using the supplied parameters are evaluated as follows:

- When both `do` and `ignore` are empty, updates are allowed to any table.
- When only `do` is specified, only the schemas (or schemas and tables) mentioned in the list are replicated.
- When only `ignore` is specified, all schemas/tables are replicated except those defined.

For each parameter, a comma-separated list of schema or schema and table definitions are supported, and wildcards using `*` (any number of characters) and `?` (single character) are also honored. For example:

- `do=sales`

  Replicates only the schema `sales`.

- `ignore=sales`

  Replicates everything, ignoring the schema `sales`.

- `ignore=sales.*`

  Replicates everything, ignoring the schema `sales`.

- `ignore=sales.quarter?`

  Replicates everything, ignoring all tables within the `sales` schema starting with `sales.quarter` and a single character. This would ignore `sales.quarter1` but replicate `sales.quarterlytotals`.

- `ignore=sales.quarter*`

  Replicates everything, ignoring all tables in the schema `sales` starting with `quarter`.

- `do=*.quarter`

  Replicates only the table named `quarter` within any schema.

- `do=sales.*totals,invoices`

  Replicates only tables in the `sales` schema that end with `totals`, and the entire `invoices` schema.

11.4.32. ReplicateColumns Filter

Removes selected columns from row-based transaction data.

Pre-configured filter name		`replicatecolumns`	
Classname		`com.continuent.tungsten.replicator.filter.ReplicateColumnsFilter`	
Property prefix		*`replicator.filter.replicatecolumns`*	
Stage compatibility			
tpm Option compatibility			
Data compatibility		Row events	
Parameters			
Parameter	Type	Default	Description
`ignore`	string	empty	Comma separated list of tables and optional columns names to ignore during replication
`do`	string	empty	Comma separated list of tables and optional column names to replicate

11.4.33. Row Add Database Name Filter

The `rowadddbname` filter adds a new column to every incoming row of data containing the schema name of the table. This can be used in combination with analytics replication targets where the information is being written into a single schema, concentrating data from multiple source databases into a single database. Optionally, the filter can also add the information as a primary key (required for some heterogeneous targets), and the hash of the source database name.

Pre-configured filter name		`rowadddbname`	
Classname		`com.continuent.tungsten.replicator.filter.JavaScriptFilter`	
Property prefix		*`replicator.filter.rowadddbname`*	
Stage compatibility		Any	
tpm Option compatibility			
Data compatibility		Row-events only	
Parameters			
Parameter	Type	Default	Description
`adddbhash`	boolean	true	Add a hash column, computed using the Java hash value of the string for the incoming source database name
`addkey`	boolean	true	Add the information to the primary key data in the THL, in addition to the column data
`fieldname`	string	dbname	The name of the database name column that will be added
`fieldhashname`	string	dbname	The name of the database has name column that will be added

The rowadddbname filter adds a column to every row of THL processed by the filter. This can be used when data is being written into a single target schema within an analytics environment, and where the source database can be used to identify a customer, project or dataset, and therefore queried within the analytics platform either specifically or with other datasets.

The filter is able to perform the following modifications to every row of incoming data:

- Add the source database or schema name.
- Add a numerical hash value of the string of the source database of schema name.
- Add the database name (and hash name) to the primary key data.

For example, the source THL:

```
- ROW# = 0
  - COL(1: id) = 12
  - COL(2: msg) = Hello
  - COL(3: msg2) = World
  - KEY(1: id) = NULL
```

And after the filter has been applied:

```
- ROW# = 0
  - COL(1: id) = 12
  - COL(2: msg) = Hello
  - COL(3: msg2) = World
  - COL(4: dbname) = msg
  - COL(5: dbname_hash) = 108417
  - KEY(1: id) = NULL
  - KEY(4: dbname) = NULL
  - KEY(5: dbname_hash) = NULL
```

This filter is a required component of deployments when replicating into a single schema within Vertica (see Deploying the Vertica Applier) and Amazon Redshift (see Deploying the Amazon Redshift Applier).

11.4.34. SetToString Filter

The SetToString converts the SET column type from the internal representation to a string-based representation in the THL. This achieved by accessing the extractor database, obtaining the table definitions, and modifying the THL data before it is written into the THL file.

Pre-configured filter name		settostring	
Classname		com.continuent.tungsten.replicator.filter.SetToStringFilter	
Property prefix		*replicator.filter.settostring*	
Stage compatibility		binlog-to-q	
tpm Option compatibility		--repl-svc-extractor-filters [467]	
Data compatibility		Row events	
Parameters			
Parameter	Type	Default	Description
user	string	*${replicator.global.extract.db.user}*	The username for the connection to the database for looking up column definitions
password	string	*${replicator.global.extract.db.password}*	The password for the connection to the database for looking up column definitions
url	string	jdbc:mysql:thin://${replicator.global.extract.db.host}: » ${replicator.global.extract.db.port}/${replicator.schema}?createDB=true	JDBC URL of the database connection to use for looking up column definitions

The SetToString filter should be used with heterogeneous replication to ensure that the data is represented as the string value, not the internal numerical representation.

In the THL output below, the table has a SET column, salesman:

```
mysql> describe salesadv;
+---------+-------------------------------------+------+-----+---------+----------------+
| Field   | Type                                | Null | Key | Default | Extra          |
+---------+-------------------------------------+------+-----+---------+----------------+
| id      | int(11)                             | NO   | PRI | NULL    | auto_increment |
| country | enum('US','UK','France','Australia') | YES  |     | NULL    |                |
```

```
| city     | int(11)                           | YES  |     | NULL    |               |
| salesman | set('Alan','Zachary')             | YES  |     | NULL    |               |
| value    | decimal(10,2)                     | YES  |     | NULL    |               |
+----------+-----------------------------------+------+-----+---------+---------------+
```

When extracted in the THL, the representation uses the internal value (for example, 1 for the first element of the set description). This can be seen in the THL output below.

```
SEQ# = 138 / FRAG# = 0 (last frag)
- TIME = 2013-08-01 19:09:35.0
- EPOCH# = 122
- EVENTID = mysql-bin.000012:0000000000021434;0
- SOURCEID = host31
- METADATA = [mysql_server_id=1;dbms_type=mysql;service=alpha;shard=test]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
- OPTIONS = [foreign_key_checks = 1, unique_checks = 1]
- SQL(0) =
 - ACTION = INSERT
 - SCHEMA = test
 - TABLE = salesadv
 - ROW# = 0
  - COL(1: id) = 2
  - COL(2: country) = 1
  - COL(3: city) = 8374
  - COL(4: salesman) = 1
  - COL(5: value) = 35000.00
```

For the `salesman` column, the corresponding value in the THL is `1`. With the `SetToString` filter enabled, the value is expanded to the corresponding string value:

```
SEQ# = 121 / FRAG# = 0 (last frag)
- TIME = 2013-08-01 19:05:14.0
- EPOCH# = 102
- EVENTID = mysql-bin.000012:0000000000018866;0
- SOURCEID = host31
- METADATA = [mysql_server_id=1;dbms_type=mysql;service=alpha;shard=test]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
- OPTIONS = [foreign_key_checks = 1, unique_checks = 1]
- SQL(0) =
 - ACTION = INSERT
 - SCHEMA = test
 - TABLE = salesadv
 - ROW# = 0
  - COL(1: id) = 1
  - COL(2: country) = US
  - COL(3: city) = 8374
  - COL(4: salesman) = Alan
  - COL(5: value) = 35000.00
```

The examples here also show the Section 11.4.18, “EnumToString Filter” and Section 11.4.5, “ColumnName Filter” filters.

11.4.35. Shard Filter

Used to enforce database schema sharding between specific Primaries

Pre-configured filter name		`shardfilter`	
Classname		`com.continuent.tungsten.replicator.filter.ShardFilter`	
Property prefix		*`replicator.filter.shardfilter`*	
Stage compatibility			
tpm Option compatibility			
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description
`enabled`	`boolean`	`false`	If set to true, enables the shard filter
`unknownShardPolicy`	string	error	Select the filter policy when the shard unknown; valid values are `accept`, `drop`, `warn`, and `error`
`unwantedShardPolicy`	string	error	Select the filter policy when the shard is unwanted; valid values are `accept`, `drop`, `warn`, and `error`
`enforcedHome`	`boolean`	`false`	If true, enforce the home for the shard
`allowWhitelisted`	`boolean`	`false`	If true, allow explicitly whitelisted shards

autoCreate	boolean	false	If true, allow shard rules to be created automatically

11.4.36. shardbyrules.js Filter

The shardbyrules filter allows you to specify granular schema and table level rules for sharding of transactions throguh the replicator. This can provide enhanced performance where regular schema only based sharding would not suit the profile of your application.

Pre-configured filter name		shardbyrules	
JavaScript Filter File		tungsten-replicator/support/filters-javascript/shardbyrules.js	
Property prefix		*replicator.filter.shardbyrules*	
Stage compatibility		q-to-dbms	
tpm Option compatibility		--svc-applier-filters [467]	
Data compatibility		ROW	
Parameters			
Parameter	Type	Default	Description
definitionsFile	string	support/filters-config/shards.json	JSON file containing the definition of which events and which tables to skip

Note

For this filter to function, you will need to ensure your database is configured for ROW based binary logging

The key part of the filter is configuring the rules to suit your sharding requirements. Start by copying the sample file and then editing to suit:

```
shell> cp /opt/continuent/tungsten/tungsten-replicator/support/filters-config/shards.json /opt/continuent/share/shards.json
```

Within the configuration, you would then specify this definitionsFile:

```
svc-applier-filters=shardbyrules
property=replicator.filter.shardbyrules.definitionsFile=/opt/continuent/share/shards.json
```

Example:

```
{
  "default": "defaultShardName",
  "schemas": [
    {
      "schema": "schemaA",
      "shardId": "MyShard1"
    },
    {
      "schema": "schemaB",
      "shardId": "MyShard2"
    }
  ],
  "tables": [
    {
      "schema": "schemaB",
      "table": "MyTable1",
      "shardId": "MyShard1"
    }
  ]
}
```

- schemaA gets assigned to MyShard1
- schemaB gets assigned to MyShard2
- With the exception of schemaB.MyTable1, which also gets assigned to MyShard1.

With this behavior, it would be able to exceute concurrently with transactions either hitting other tables from schemaB, or with tables from other schemas.

11.4.37. shardbyseqno.js Filter

Shards within the replicator enable data to be parallelized when they are applied on the Target.

Pre-configured filter name	shardbyseqno

JavaScript Filter File		tungsten-replicator/support/filters-javascript/shardbyseqno.js	
Property prefix		*replicator.filter.shardbyseqno*	
Stage compatibility		q-to-dbms	
tpm Option compatibility		--svc-applier-filters [467]	
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description
shards	numeric	(none)	Number of shards to be used by the applier

The shardbyseqno filter updates the shard ID, which is embedded into the event metadata, by a configurable number of shards, set by the *shards* parameter in the configuration:

```
replicator.filter.shardbyseqno=com.continuent.tungsten.replicator.filter.JavaScriptFilter
replicator.filter.shardbyseqno.script=${replicator.home}/samples/extensions/javascript/shardbyseqno.js
replicator.filter.shardbyseqno.shards=10
```

The filter works by setting the shard ID in the event using the setShardId() method on the event object:

```
event.setShardId(event.getSeqno() % shards);
```

> **Note**
>
> Care should be taken with this filter, as it assumes that the events can be applied in a completely random order by blindly updating the shard ID to a computed valued. Sharding in this way is best used when provisioning new Targets.

11.4.38. shardbytable.js Filter

An alternative to sharding by sequence number is to create a shard ID based on the individual database and table. The shardbytable filter achieves this at a row level by combining the schema and table information to form the shard ID. For all other events, including statement based events, the shard ID #UNKNOWN is used.

Pre-configured filter name		shardbytable	
JavaScript Filter File		tungsten-replicator/support/filters-javascript/shardbytable.js	
Property prefix		*replicator.filter.shardbytable*	
Stage compatibility		remote-to-thl	
tpm Option compatibility		--svc-remote-filters [467]	
Data compatibility		ROW	
Parameters			
Parameter	Type	Default	Description

> **Note**
>
> For this filter to function, you will need to ensure your database is configured for ROW based binary logging

The key part of the filter is the extraction and construction of the ID, which occurs during row processing:

```
oneRowChange = rowChanges.get(j);
schemaName = oneRowChange.getSchemaName();
tableName  = oneRowChange.getTableName();

id = schemaName + "_" + tableName;
if (proposedShardId == null)
{
  proposedShardId = id;
}
```

11.4.39. SkipEventByType Filter

The SkipEventByType filter enables you to skip individual events based on the event type, schema and table. For example, if you want to skip all DELETE events on the schema/table SALES.INVOICES (to prevent deletion of invoice data), this filter will skip the event entirely and it will not be applied to the target.

Pre-configured filter name		skipeventbytype	
Classname		com.continuent.tungsten.replicator.filter.SkipEventByTypeFilter	
Property prefix		*replicator.filter.skipeventbytype*	
Stage compatibility		any	
tpm Option compatibility		--repl-svc-extractor-filters [467], --repl-svc-applier-filters [467]	
Data compatibility		Row events	
Parameters			
Parameter	Type	Default	Description
definitionsFile	string	support/filters-config/skipeventbytype.json	JSON file containing the definition of which events and which tables to skip

Configuration of the filter is made using the generic JSON file, which supports both default options to happen for all tables not otherwise explicitly specified. The default JSON file allows all operations:

```
{
    "__default": {
        "INSERT" : "allow",
        "DELETE" : "allow",
        "UPDATE" : "allow"
    },
    "SCHEMA" : {
        "TABLE" : {
            "INSERT" : "allow",
            "DELETE" : "deny",
            "UPDATE" : "deny"
        }
    }
}
```

The default section handles the default response when an explicit schema or table name does not appear. Further sections are then organised by schema and then table name. Where the setting is `allow`, the operation will be processed. A `deny` skips the entire event.

To disable all `DELETE` operations, regardless of which table they occur in:

```
{
    "__default": {
        "INSERT" : "allow",
        "DELETE" : "deny",
        "UPDATE" : "allow"
    },
    "SCHEMA" : {
        "TABLE" : {
            "INSERT" : "allow",
            "DELETE" : "deny",
            "UPDATE" : "deny"
        }
    }
}
```

To normally allow all operations, except on the SALES.INVOICE schema/table:

```
{
    "__default": {
        "INSERT" : "allow",
        "DELETE" : "allow",
        "UPDATE" : "allow"
    },
    "SALES" : {
        "INVOICE" : {
            "INSERT" : "allow",
            "DELETE" : "deny",
            "UPDATE" : "deny"
        }
    }
}
```

11.4.40. TimeDelay (delay) Filter

The `TimeDelayFilter` delays writing events to the THL and should be used only on Appliers in the `remote-to-thl` stage. This delays writing the transactions into the THL files, but allows the application of the data to the database to continue without further intervention.

Pre-configured filter name	delay

Classname		com.continuent.tungsten.replicator.filter.TimeDelayFilter	
Property prefix		*replicator.filter.delay*	
Stage compatibility		remote-to-thl	
tpm Option compatibility		--repl-svc-thl-filters [468]	
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description
delay	numeric	300	Number of seconds to delay transaction processing row

The TimeDelayFilter delays the application of transactions recorded in the THL. The delay can be used to allow point-in-time recovery of DML operations before the transaction has been applied to the Target, or where data may need to be audited or checked before transactions are committed.

> **Note**
>
> For effective operation, Source and Targets should be synchronized using NTP or a similar protocol.

To enable the TimeDelayFilter, update the tungsten.ini configuration file to enable the filter. For example, to enable the delay for 600 seconds:

```
shell> vi /etc/tungsten/tungsten.ini
[serviceName]
...
svc-applier-filters=delay
property=replicator.filter.delay.delay=600
...

shel> tpm update
```

Time delay of transaction events should be performed with care, since the delay will prevent a Target from being up to date compared to the Source. In the event of a node failure, an up to date Target is required to ensure that data is safe.

11.4.41. tosingledb.js Filter

This filter updates the replicated information so that it goes to an explicit schema, as defined by the user. The filter can be used to combine multiple tables to a single schema.

Pre-configured filter name		tosingledb	
JavaScript Filter File		tungsten-replicator/support/filters-javascript/tosingledb.js	
Property prefix		*replicator.filter.ansiquotes*	
Stage compatibility		q-to-dbms	
tpm Option compatibility		--svc-applier-filters [467]	
Data compatibility		Any event	
Parameters			
Parameter	Type	Default	Description
db	string	(none)	Database name into which to replicate all tables
skip	string	(none)	Comma-separated list of databases to be ignored

A database can be optionally ignored through the skip parameter within the configuration:

```
--property=replicator.filter.tosingledb.db=centraldb \
--property=replicator.filter.tosingledb.skip=tungsten
```

The above configures all data to be written into centraldb, but skips the database tungsten.

Similar to other filters, the filter operates by explicitly changing the schema name to the configured schema, unless the skipped schema is in the event data. For example, at a statement level:

```
if(oldDb!=null && oldDb.compareTo(skip)!=0)
{
  d.setDefaultSchema(db);
}
```

11.4.42. truncatetext.js Filter

The truncatetext filter truncates a MySQL BLOB field.

Pre-configured filter name		truncatetext	
JavaScript Filter File		tungsten-replicator/support/filters-javascript/truncatetext.js	
Property prefix		*replicator.filter.truncatetext*	
Stage compatibility		binlog-to-q, q-to-dbms	
tpm Option compatibility		--svc-extractor-filters [467], --svc-extractor-filters [467]	
Data compatibility		Row events	
Parameters			
Parameter	Type	Default	Description
length	numeric	(none)	Maximum size of truncated field (bytes)

The length is determined by the *length* parameter in the properties:

```
replicator.filter.truncatetext=com.continuent.tungsten.replicator.filter.JavaScriptFilter
replicator.filter.truncatetext.script=${replicator.home.dir}/samples/extensions/javascript/truncatetext.js
replicator.filter.truncatetext.length=4000
```

Statement-based events are ignored, but row-based events are processed for each volume value, checking the column type, isBlob() method and then truncating the contents when they are identified as larger than the configured length. To confirm the type, it is compared against the Java class com.continuent.tungsten.replicator.extractor.mysql.SerialBlob, the class for a serialized BLOB value. These need to be processed differently as they are not exposed as a single variable.

```
if (value.getValue() instanceof com.continuent.tungsten.replicator.extractor.mysql.SerialBlob)
{
  blob = value.getValue();
  if (blob != null)
  {
    valueBytes = blob.getBytes(1, blob.length());
    if (blob.length() > truncateTo)
    {
      blob.truncate(truncateTo);
    }
  }
}
```

11.4.43. zerodate2null.js Filter

The zerodate2null filter looks complicated, but is very simple. It processes row data looking for date columns. If the corresponding value is zero within the column, the value is updated to NULL. This is required for MySQL to Oracle replication scenarios.

Pre-configured filter name		zerodate2null	
JavaScript Filter File		tungsten-replicator/support/filters-javascript/zerodate2null.js	
Property prefix		*replicator.filter.zerodate2null*	
Stage compatibility		q-to-dbms	
tpm Option compatibility		--svc-applier-filters [467]	
Data compatibility		Row events	
Parameters			
Parameter	Type	Default	Description

The filter works by examining the column specification using the getColumnSpec() method. Each column is then checked to see if the column type is a DATE, DATETIME or TIMESTAMP by looking the type ID using some stored values for the date type.

Because the column index and corresponding value index match, when the value is zero, the column value is explicitly set to NULL using the setValueNull() method.

```
for(j = 0; j < rowChanges.size(); j++)
{
  oneRowChange = rowChanges.get(j);
  columns = oneRowChange.getColumnSpec();
  columnValues = oneRowChange.getColumnValues();
  for (c = 0; c < columns.size(); c++)
```

```
  {
    columnSpec = columns.get(c);
    type = columnSpec.getType();
    if (type == TypesDATE || type == TypesTIMESTAMP)
    {
      for (row = 0; row < columnValues.size(); row++)
      {
        values = columnValues.get(row);
        value = values.get(c);

        if (value.getValue() == 0)
        {
          value.setValueNull()
        }
      }
    }
  }
}
```

11.5. Standard JSON Filter Configuration

A number of the filters that are included as part of Tungsten Cluster use a standardised form of configuration file that is designed to easy to use and familiar, while being flexible enough to support the needs of each filter. For the majority of filter configurations, the core focus of the configuration is based on a 'default' setting, and settings that are specific to a schema or table.

The JSON configuration follows this basic model. The following filters support the use of this JSON configuration file format:

- `convertstringfrommysql`
- `pkey`
- `skipeventbytype`

The basic format of the configuration is a JSON file that is split into two sections:

- A default section, which determines what will happen in the absence of a schema/table specific rule.
- A collection of schema and table specific entries that determine what happens for a specific schema/table combination.

Depending on the filter and use case, the information within both sections can then either be further divided into column-specific information, or the information may be configured as key/value pairs, or objects, to configure individual parts of the filter configuration.

For example, the following configuration file is from the `pkey` filter:

```
{
    "__default": {
        "IGNORE" : "pkey"
    },
    "test" : {
        "msg" : {
            "msg" : "pkey"
        }
    }
}
```

The above shows the the defaults section, and the schema/table specific section.

> **Note**
>
> Depending on the filter, the default section may merely be a placeholder to indicate the format of the file. The `_defaults` should never be removed.

The sample shows a full schema name, table name, and then column name configuration.

By comparison, the sample below has only schema and table name information, with the configuration within that section being used to define the key/value pairs for specific operations as part of the `skipeventbytype` filter:

```
{
    "__default": {
        "INSERT" : "allow",
        "DELETE" : "allow",
        "UPDATE" : "allow"
    },
    "SCHEMA" : {
        "TABLE" : {
            "INSERT" : "allow",
            "DELETE" : "deny",
```

```
            "UPDATE" : "deny"
        }
    }
}
```

The selection and execution of the rules is determined by some specific rules, as detailed in Section 11.5.1, “Rule Handling and Processing” and Section 11.5.2, “Schema, Table, and Column Selection”.

11.5.1. Rule Handling and Processing

The processing of the rules and the selection of the tables and appropriate response and operation is configured through the combination of the default and schema/table settings according to explicit rules:

- If the incoming data matches the schema and table (and optionally column) according to the rules, use the configuration information in that section.
- If the schema/table is not specified or does not have explicit configuration, use the configuration within the `__defaults` section instead.

The default rule is always processed and followed if there is no match for an explicit schema, table, or column definition.

11.5.2. Schema, Table, and Column Selection

The format of the JSON configuraiton and the selection of the schema, table, and column information is in the form of nested structure of JSON objects. The schema first, then the table, then optionally the column within a nested JSON structure. For example:

```
"test" : {
    "msg" : {
        "id" : "pkey"
    }
}
```

In the above example:

- `test` is the schema name
- `msg` is the table name within the `test` schema
- `id` is the column name within the `test.msg` table

For different tables within the same schema, place another entry at the same level:

```
"test" : {
    "msg" : {
        "id" : "pkey"
    },
    "orders" : {
        "id" : "pkey"
    },
}
```

The above now handles the tables `msg` and `orders` within the `test` schema.

Wildcards are also supported, using the `*` operator. For example:

```
"orders" : {
    "*" : {
        "INSERT" : "allow",
        "DELETE" : "deny",
        "UPDATE" : "deny"
    }
}
```

Would match all tables within the `orders` schema. If multiple definitions exist, then the matching operates on the closest match first. For example:

```
"orders" : {
    "sales" : {
        "INSERT" : "deny",
        "DELETE" : "deny",
        "UPDATE" : "deny"
    },
    "*" : {
        "INSERT" : "allow",
        "DELETE" : "deny",
        "UPDATE" : "deny"
    }
```

```
}
```

In the above, if the schema/table combination `orders.sales` is seen, the rule for that is always used first as it is explicitly stated. Only tables that do not match the wildcards will use the wildcard entry. If neither an explicit schema/table or wildcard exist, the default is used.

11.6. JavaScript Filters

In addition to the supplied Java filters, Tungsten Replicator also includes support for custom script-based filters written in JavaScript and supported through the JavaScript filter. This filter provides a JavaScript environment that exposes the transaction information as it is processed internally through an object-based JavaScript API.

The JavaScript implementation is provided through the Rhino open-source implementation. Rhino provides a direct interface between the underlying Java classes used to implement the replicator code and a full JavaScript environment. This enables scripts to be developed that have access to the replicator constructs and data structures, and allows information to be updated, reformatted, combined, extracted and reconstructed.

At the simplest level, this allows for operations such as database renames and filtering. More complex solutions allow for modification of the individual data, such as removing nulls, bad dates, and duplication of information.

Warning

If you previously implemented custom filters with older releases of Tungsten Replicator or with the now deprecated Open Source (OSS) release, you would have edited the `static-SERVICE.properties` file.

This is no longer a supported method of implementing custom filters, and doing so will break automated upgrades through tpm.

To enable custom filters, follow the process here: Section 11.6.2, “Installing Custom JavaScript Filters”

11.6.1. Writing JavaScript Filters

The JavaScript interface to the replicator enables filters to be written using standard JavaScript with a complete object-based interface to the internal Java objects and classes that make up the THL data.

For more information on the Rhino JavaScript implementation, see Rhino.

The basic structure of a JavaScript filter is as follows:

```
// Prepare the filter and setup structures

prepare()
{

}

// Perform the filter process; function is called for each event in the THL

filter(event)
{

// Get the array of DBMSData objects
    data = event.getData();

    // Iterate over the individual DBMSData objects
    for(i=0;i<data.size();i++)
    {
      // Get a single DBMSData object
      d = data.get(i);

      // Process a Statement Event; event type is identified by comparing the object class type

      if (d = instanceof com.continuent.tungsten.replicator.dbms.StatementData)
      {
        // Do statement processing
      }
      else if (d = instanceof com.continuent.tungsten.replicator.dbms.RowChangeData)
      {
        // Get an array of all the row changes
        rows = data.get(i).getRowChanges();

        // Iterate over row changes
        for(j=0;j<rows.size();j++)
        {
          // Get the single row change
          rowchange = rows.get(j);
```

```
        // Identify the row change type
        if (rowchange.getAction() == "INSERT")
        {
        }
        ....

    }
  }
 }
}
```

The following sections will examine the different data structures, functions, and information available when processing these individual events.

11.6.1.1. Implementable Functions

Each JavaScript filter must defined one or more functions that are used to operate the filter process. The `filter()` [515] function must be defined, as it contains the primary operation sequence for the defined filter. The function is supplied the event from the THL as the events are processed by the replicator.

In addition, two other JavaScript functions can optionally be defined that are executed before and after the filter process. Additional, user-specific, functions can be defined within the filter context to support the filter operations.

- *`prepare()`*

  The `prepare()` [515] function is called when the replicator is first started, and initializes the configured filter with any values that may be required during the filter process. These can include loading and identifying configuration values, creating lookup, exception or other reference tables and other internal JavaScript tables based on the configuration information, and reporting the generated configuration or operation for debugging.

- *`filter(event)`*

  The `filter()` [515] function is the main function that is called each time an event is loaded from the THL. The *`event`* is parsed as the only parameter to the function and is an object containing all the statement or row data for a given event.

- *`release()` [515]*

  The `release()` [515] function is called when the filter is deallocated and removed, typically during shutdown of the replicator, although it may also occur when a processing thread is restarted.

11.6.1.2. Getting Configuration Parameters

The JavaScript interface enables you to get two different sets of configuration properties, the filter specific properties, and the general replicator properties. The filter specific properties should be used configure and specify configuration information unique to that instance of the filter configuration. Since multiple filter configurations using the same filter definition can be created, using the filter-specific content is the simplest method for obtaining this information.

- Getting Filter Properties

  To obtain the properties configured for the filter within the static configuration file according to the context of the filter configuration, use the `filterProperties` class with the `getString()` method. For example, the `dbrename` filter uses two properties, dbsource and dbtarget to identify the database to be renamed and the new name. The definition for the filter within the configuration file might be:

  ```
  replicator.filter.jsdbrename=com.continuent.tungsten.replicator.filter.JavaScriptFilter
  replicator.filter.jsdbrename.script=${replicator.home.dir}/support/filters-javascript/dbrename.js
  replicator.filter.jsdbrename.dbsource=contacts
  replicator.filter.jsdbrename.dbtarget=nyc_contacts
  ```

  Within the JavaScript filter, they are retrieved using:

  ```
  sourceName = filterProperties.getString("dbsource");
  targetName = filterProperties.getString("dbtarget");
  ```

- Generic Replicator Properties

  General properties can be retrieved using the `properties` class and the `getString()` method:

  ```
  master = properties.getString("replicator.thl.remote_uri");
  ```

11.6.1.3. Logging Information and Exceptions

Information about the filtering process can be reported into the standard `trepsvc.log` file by using the `logger` object. This supports different methods according to the configured logging level:

- `logger.info()` — information level entry, used to indicate configuration, loading or progress.
- `logger.debug()` — information will be logged when debugging is enabled, used when showing progress during development.
- `logger.error()` — used to log an error that would cause a problem or replication to stop.

For example, to log an informational entry that includes data from the filter process:

```
logger.info("regexp: Translating string " + valueString.valueOf());
```

To raise an exception that causes replication to stop, a new `ReplicatorException` object must be created that contains the error message:

```
if(col == null)
{
  throw new com.continuent.tungsten.replicator.ReplicatorException(
    "dropcolumn.js: column name in " + schema + "." + table +
    " is undefined - is colnames filter enabled and is it before the dropcolumn filter?"
    );
}
```

The error string provided will be used as the error provided through trepctl, in addition to raising and exception and backtrace within the log.

11.6.1.4. Exposed Data Structures

Within the `filter()` [515] function that must be defined within the JavaScript filter, a single *`event`* object is supplied as the only argument. That event object contains all of the information about a single event as recorded within the THL as part of the replication process. Each event contains metadata information that can be used to identify or control the content, and individual statement and row data that contain the database changes.

The content of the information is a compound set of data that contains one or more further blocks of data changes, which in turn contains one or more blocks of SQL statements or row data. These blocks are defined using the Java objects that describe their internal format, and are exposed within the JavaScript wrapper as JavaScript objects, that can be parsed and manipulated.

At the top level, the Java object provided to the to the `filter()` [515] function as the *`event`* argument is `ReplDBMSEvent`. The `ReplDBMSEvent` class provides the core event information with additional management metadata such as the global transaction ID (seqno), latency of the event and sharding information.

That object contains one or more `DBMSData` objects. Each `DBMSData` object contains either a `StatementData` object (in the case of a statement based event), or a `RowChangeData` object (in the case of row-based events). For row-based events, there will be one or more `OneRowChange` [519] objects for each individual row that was changed.

When processing the event information, the data that is processed is live and should be updated in place. For example, when examining statement data, the statement needs only be updated in place, not re-submitted. Statements and rows can also be explicitly removed or added by deleting or extending the arrays that make up the objects.

A basic diagram of the structure is shown in the diagram below:

`ReplDBMSEvent`	`DBMSData`	`StatementData`	
	`DBMSData`	`StatementData`	
	`DBMSData`	`RowChangeData`	`OneRowChange` [519]
			`OneRowChange` [519]
			...
		`StatementData`	
`ReplDBMSEvent`	`DBMSData`	`RowChangeData`	`OneRowChange` [519]
			`OneRowChange` [519]
			...

A single event can contain both statement and row change information within the list of individual `DBMSData` events. An event or

11.6.1.4.1. `ReplDBMSEvent` Objects

The base object from which all of the data about replication can be obtained is the `ReplDBMSEvent` class. The class contains all of the information about each event, including the global transaction ID and statement or row data.

The interface to the underlying information is through a series of methods that provide the embedded information or data structures, described in the table below.

Method	Description
getAppliedLatency()	Returns the latency of the embedded event. See Section E.2.8, "Terminology: Fields *appliedLatency*"
getData()	Returns an array of the DBMSData objects within the event
getDBMSEvent()	Returns the original DBMSEvent object
getEpochNumber()	Get the Epoch number of the stored event. See THL EPOCH# [587]
getEventId()	Returns the native event ID. See THL EVENTID [588]
getExtractedTstamp()	Returns the timestamp of the event.
getFragno()	Returns the fragment ID. See THL SEQNO [587]
getLastFrag()	Returns true if the fragment is the last fragment in the event.
getSeqno()	Returns the native sequence number. See THL SEQNO [587]
getShardId()	Returns the shard ID for the event.
getSourceId()	Returns the source ID of the event. See THL SOURCEID [588]
setShardId()	Sets the shard ID for the event, which can be used by the filter to set the shard.

The primary method used is getData(), which returns an array of the individual DBMSData objects contain in the event:

```
function filter(event)
{
  data = event.getData();

if(data != null)
  {

    for (i = 0; i < data.size(); i++)
    {
        change = data.get(i);
...
```

Access to the underlying array structure uses the get() method to request individual objects from the array. The size() method returns the length of the array.

Removing or Adding Data Changes

Individual DBMSData objects can be removed from the replication stream by using the remove() method, supplying the index of the object to remove:

```
data.remove(1);
```

The add() method can be used to add new data changes into the stream. For example, data can be duplicated across tables by creating and adding a new version of the event, for example:

```
if(d.getDefaultSchema() != null &&
   d.getDefaultSchema().compareTo(sourceName)==0)
{
  newStatement = new
     com.continuent.tungsten.replicator.dbms.StatementData(d.getQuery(),
                                                           null,
                                                           targetName);
  data.add(data.size(),newStatement);
}
```

The above code looks for statements within the sourceName schema and creates a copy of each statement into the targetName schema.

The first argument to add() is the index position to add the statement. Zero (0) indicates before any existing changes, while using size() on the array effectively adds the new statement change at the end of the array.

Updating the Shard ID

The setShardId() method can also be used to set the shard ID within an event. This can be used in filters where the shard ID is updated by examining the schema or table being updated within the embedded SQL or row data. An example of this is provided in Section 11.4.38, "shardbytable.js Filter".

11.6.1.4.2. DBMSData Objects

The DBMSData object provides encapsulation of either the SQL or row change data within the THL. The class provides no methods for interacting with the content, instead, the real object should be identified and processed accordingly. Using the JavaScript instanceof operator the underlying type can be determined:

```
if (d != null &&
    d instanceof com.continuent.tungsten.replicator.dbms.StatementData)
{
   // Process Statement data
}
else if (d != null &&
    d instanceof com.continuent.tungsten.replicator.dbms.RowChangeData)
{
   // Process Row data
}
```

Note the use of the full object class for the different `DBMSData` types.

For information on processing `StatementData`, see Section 11.6.1.4.3, "`StatementData` Objects". For row data, see Section 11.6.1.4.4, "`RowChangeData` Objects".

11.6.1.4.3. `StatementData` Objects

The `StatementData` class contains information about data that has been replicated as an SQL statement, as opposed to information that is replicated as row-based data.

Processing and filtering statement information relies on editing the original SQL query statement, or the metadata recorded with it in the THL, such as the schema name or character set. Care should be taken when modifying SQL statement data to ensure that you are modifying the right part of the original statement. For example, a search and replace on an SQL statement should be made with care to ensure that embedded data is not altered by the process.

The key methods used for interacting with a `StatementData` object are listed below:

Method	Description
`getQuery()`	Returns the SQL statement
`setQuery()`	Updates the SQL statement
`appendToQuery()`	Appends a string to an existing query
`getDefaultSchema()`	Returns the default schema in which the statement was executed. The schema may be null for explicit or multi-schema queries.
`setDefaultSchema()`	Set the default schema for the SQL statement
`getTimestamp()`	Gets the timestamp of the query. This is required if data must be applied with a relative value by combining the timestamp with the relative value

Updating the SQL

The primary method of processing statement based data is to load and identify the original SQL statement (using `getQuery()`, update or modify the SQL statement string, and then update the statement within the THL again using `setQuery()`. For example:

```
sqlOriginal = d.getQuery();
sqlNew = sqlOriginal.replaceAll('NOTEPAD','notepad');
d.setQuery(sqlNew);
```

The above replaces the uppercase 'NOTEPAD' with a lowercase version in the query before updating the stored query in the object.

Changing the Schema Name

Some schema and other information is also provided in this structure. For example, the schema name is provided within the statement data and can be explicitly updated. In the example below, the schema "products" is updated to "nyc_products":

```
if (change.getDefaultSchema().compareTo("products") == 0)
{
  change.setDefaultSchema("nyc_products");
}
```

A similar operation should be performed for any row-based changes. A more complete example can be found in Section 11.4.8, "`dbrename.js` Filter".

11.6.1.4.4. `RowChangeData` Objects

`RowChangeData` is information that has been written into the THL in row format, and therefore consists of rows of individual data divided into the individual columns that make up each row-based change. Processing of these individual changes must be performed one row at a time using the list of `OneRowChange` [519] objects provided.

The following methods are supported for the `RowChangeData` object:

Method	Description
appendOneRowChange(rowChange)	Appends a single row change to the event, using the supplied OneRowChange [519] object.
getRowChanges()	Returns an array list of all the changes as OneRowChange [519] objects.
setRowChanges(rowChanges)	Sets the row changes within the event using the supplied list of OneRowChange objects.

For example, a typical row-based process will operate as follows:

```
if (d != null && d instanceof com.continuent.tungsten.replicator.dbms.RowChangeData)
 {
   rowChanges = d.getRowChanges();

   for(j = 0; j < rowChanges.size(); j++)
   {
     oneRowChange = rowChanges.get(j);
     // Do row filter
```

The OneRowChange [519] object contains the changes for just one row within the event. The class contains the information about the tables, field names and field values. The following methods are supported:

Method	Description
getAction()	Returns the row action type, i.e. whether the row change is an INSERT, UPDATE or DELETE
getColumnSpec()	Returns the specification of each column within the row change
getColumnValues()	Returns the value of each column within the row change
getSchemaName()	Gets the schema name of the row change
getTableName()	Gets the table name of the row change
setColumnSpec()	Sets the column specification using an array of column specifications
setColumnValues()	Sets the column values
setSchemaName()	Sets the schema name
setTableName()	Sets the table name

Changing Schema or Table Names

The schema, table and column names are exposed at different levels within the OneRowChange [519] object. Updating the schema name can be achieved by getting and setting the name through the getSchemaName() and setSchemaName() methods. For example, to add a prefix to a schema name:

```
rowchange.setSchemaName('prefix_' + rowchange.getSchemaName());
```

To update a table name, the getTableName() and setTableName() can be used in the same manner:

```
oneRowChange.setTableName('prefix_' + oneRowChange.getTableName());
```

Getting Action Types

Row operations are categorised according to the action of the row change, i.e. whether the change was an insert, update or delete operation. This information can be extracted from each row change by using the getAction() method:

```
action = oneRowChange.getAction();
```

The action information is returned as a string, i.e. INSERT, UPDATE, or DELETE. This enables information to be filtered according to the changes; for example by selectively modifying or altering events.

For example, DELETE events could be removed from the list of row changes:

```
for(j=0;j<rowChanges.size();j++)
{
  oneRowChange = rowChanges.get(j);
  if (oneRowChange.actionType == 'DELETE')
  {
    rowChanges.remove(j);
    j--;
  }
}
```

The j-- is required because as each row change is removed, the size of the array changes and our current index within the array needs to be explicitly modified.

Extracting Column Definitions

To extract the row data, the `getColumnValues()` method returns the an array containing the value of each column in the row change. Obtaining the column specification information using `getColumnSpec()` returns a corresponding specification of each corresponding column. The column data can be used to obtain the column type information

To change column names or values, first the column information should be identified. The column information in each row change should be retrieved and/or updated. The `getColumnSpec()` returns the column specification of the row change. The information is returned as an array of the individual columns and their specification:

```
columns = oneRowChange.getColumnSpec();
```

For each column specification a `ColumnSpec` object is returned, which supports the following methods:

Method	Description
`getIndex()`	Gets the index of the column within the row change
`getLength()`	Gets the length of the column
`getName()`	Returns the column name if available
`getType()`	Gets the type number of the column
`getTypeDescription()`	
`isBlob()`	Returns true if the column is a blob
`isNotNull()`	Returns true if the column is configured as `NOT NULL`
`isUnsigned()`	Returns true if the column is unsigned.
`setBlob()`	Set the column blob specification
`setIndex()`	Set the column index order
`setLength()`	Returns the column length
`setName()`	Set the column name
`setNotNull()`	Set whether the column is configured as `NOT NULL`
`setSigned()`	Set whether the column data is signed
`setType()`	Set the column type
`setTypeDescription()`	Set the column type description

To identify the column type, use the `getType()` method which returns an integer matching the underlying data type. There are no predefined types, but common values include:

Type	Value	Notes
`INT`	4	
`CHAR` or `VARCHAR`	12	
`TEXT` or `BLOB`	2004	Use `isBlob()` to identify if the column is a blob or not
`TIME`	92	
`DATE`	91	
`DATETIME` or `TIMESTAMP`	92	
`DOUBLE`	8	

Other information about the column, such as the length, and value types (unsigned, null, etc.) can be determined using the other functions against the column specification.

Extracting Row Data

The `getColumnValues()` method returns an array that corresponds to the information returned by the `getColumnSpec()` method. That is, the method returns a complementary array of the row change values, one element for each row, where each row is itself a further array of each column:

```
values = oneRowChange.getColumnValues();
```

This means that index 0 of the array from `getColumnSpec()` refers to the same column as index 0 of the array for a single row from `getColumnValues()`.

`getColumnSpec()`	msgid	message	msgdate
`getColumnValues()`			

getColumnSpec()	msgid	message	msgdate
[0]	1	Hello New York!	Thursday, June 13, 2013
[1]	2	Hello San Francisco!	Thursday, June 13, 2013
[2]	3	Hello Chicago!	Thursday, June 13, 2013

This enables the script to identify the column type by the index, and then the corresponding value update using the same index. In the above example, the `message` field will always be index 1 within the corresponding values.

Each value object supports the following methods:

Method	Description
getValue()	Get the current column value
setValue()	Set the column value to the supplied value
setValueNull()	Set the column value to NULL

For example, within the `zerodate2null` sample, dates with a zero value are set to NULL using the following code:

```
columns = oneRowChange.getColumnSpec();
columnValues = oneRowChange.getColumnValues();
for (c = 0; c < columns.size(); c++)
{
  columnSpec = columns.get(c);
  type = columnSpec.getType();

  if (type == TypesDATE || type == TypesTIMESTAMP)
  {
    for (row = 0; row < columnValues.size(); row++)
    {
      values = columnValues.get(row);
      value = values.get(c);

      if (value.getValue() == 0)
      {
        value.setValueNull()
      }
    }
  }
}
```

In the above example, the column specification is retrieved to determine which columns are date types. Then the list of embedded row values is extracted, and iterates over each row, setting the value for a date that is zero (0) to be NULL using the `setValueNull()` method.

An alternative would be to update to an explicit value using the `setValue()` method.

11.6.2. Installing Custom JavaScript Filters

Once you have written your JavaScript filter, and ready to install it you need to follow the steps below. This will allow you to configure and apply the filter to your installation using the standard tpm procedure.

For this example, we will assume your new JavaScript file is called number2binary.js, and the filter has two additional boolean configuration properties 'roundup' and 'debug'

11.6.2.1. Step 1: Copy JavaScript files

By default, the software package will be contained in `/opt/continuent/software/tungsten-clustering-5.4.1-41` Adjust the path in the examples accordingly if your environment differs.

The JavaScript file for your new filter[s] need copying to the following location:

```
/opt/continuent/software/tungsten-clustering-5.4.1-41/tungsten-replicator/samples/extensions/javascript
```

11.6.2.2. Step 2: Create Template Files

You need to create a template file which contains the location of the JavaScript file and the additional configuration properties with the appropriate default values.

Create a file called number2binary.tpl that contains the following:

```
replicator.filter.number2binary=com.continuent.tungsten.replicator.filter.JavaScriptFilter
replicator.filter.number2binary.script=${replicator.home.dir}/samples/extensions/javascript/number2binary.js
```

```
replicator.filter.number2binary.roundup=true
replicator.filter.number2binary.debug=false
```

This tpl file needs to be copied into the following directory:

```
/opt/continuent/software/tungsten-clustering-5.4.1-41/tungsten-replicator/samples/conf/filters/default
```

11.6.2.3. Step 3: (Optional) Copy json files

If your filter uses json files to load configuration data, this needs to be copied into the `/opt/continuent/share` directory and also included in the tpl file created in Step 2. An example is as follows:

```
replicator.filter.{FILTERNAME}.definitionsFile=/opt/continuent/share/{FILTERNAME}.json
```

11.6.2.4. Step 4: Update Configuration

Now that all the files are in place you can include the custom filter in your configuration.

Any properties set with a default value in the tpl file, only need including if you wish to overwrite the default value

The following examples show how you can now include this in your tpm configuration:

For ini installations add the following to your tungsten.ini

```
svc-extractor-filters={existing filter definitions},number2binary
property=replicator.filter.number2binary.roundup=false
property=replicator.filter.number2binary.debug=true
```

For staging installations

```
shell> cd {staging-dir}

shell> tools/tpm configure SERVICENAME
{other-configuration-values-as-requires} \
--svc-extractor-filters={existing filter definitions},number2binary \
--property=replicator.filter.number2binary.roundup=false \
--property=replicator.filter.number2binary.debug=true

shell> tools/tpm install
```

In the above examples we used the `svc-extractor-filters` [467] property for the extractor replicator. If you are applying your custom filters to your applier, then use `svc-applier-filters` [467] instead

Your custom filters are now installed in a clean and easy to manage process allowing you to use tpm for all future update processes

If there is a problem with the JavaScript filter during restart, the replicator will be placed into the `OFFLINE` state and the reason for the error will be provided within the replicator `trepsvc.log` log.

Chapter 12. Performance, Tuning and Testing

To help improve the performance of Tungsten Cluster, a number of guides and tuning techniques are provided in this chapter. This may involve parameters entirely within Tungsten Cluster, or changes and modifications to the parameters within the OS.

Tuning related to the Tungsten Replicator functionality

- Section 12.1, "Block Commit" — Increasing performance of replication solutions making use of block commit.

Tuning related to the network performance

- Section 12.2, "Improving Network Performance" — Increasing performance of networking between components by tuning OS parameters.

12.1. Block Commit

The replicator commits changes read from the THL and commits these changes in Replicas during the applier stage according to the block commit size or interval. These replace the single *replicator.global.buffer.size* parameter that controls the size of the buffers used within each stage of the replicator.

When applying transactions to the database, the decision to commit a block of transactions is controlled by two parameters:

- When the event count reaches the specified event limit (set by `--svc-applier-block-commit-size` [466])
- When the commit timer reaches the specified commit interval (set by `--svc-applier-block-commit-interval` [466])

The default operation is for block commits to take place based on the transaction count. Commits by the timer are disabled. The default block commit size is 10 transactions from the incoming stream of THL data; the block commit interval is zero (0), which indicates that the interval is disabled.

When both parameters are configured, block commit occurs when either value limit is reached. For example,if the event count is set to 10 and the commit interval to 50s, events will be committed by the applier either when the event count hits 10 or every 50 seconds, whichever is reached first. This means, for example, that even if only one transaction exists, when the 50 seconds is up, that single transaction will be applied.

In addition, the execution of implied commits during specific events within the replicator can also be controlled to prevent fragmented block commits by using the *replicator.stage.q-to-dbms.blockCommitPolicy* property. This property can have either of the following values:

- `strict` — Commit block on service name changes, multiple fragments in a transaction, or unsafe_for_block_commit. This is the default setting.
- `lax` — Don't commit in any of these cases.

The block commit size can be controlled using the `--repl-svc-applier-block-commit-size` [466] option to tpm, or through the `blockCommitRowCount`.

The block commit interval can be controlled using the `--repl-svc-applier-block-commit-interval` [466] option to tpm, or through the `blockCommitInterval`. If only a number is supplied, it is used as the interval in milliseconds. Suffix of s, m, h, and d for seconds, minutes, hours and days are also supported.

```
shell> ./tools/tpm update alpha \
    --repl-svc-applier-block-commit-size=20 \
    --repl-svc-applier-block-commit-interval=100s
```

> **Note**
>
> The block commit parameters are supported only in applier stages; they have no effect in other stages.

Modification of the block commit interval should be made only when the commit window needs to be altered. The setting can be particularly useful in heterogeneous deployments where the nature and behaviour of the target database is different to that of the source extractor.

For example, when replicating to Oracle, reducing the number of transactions within commits reduces the locks and overheads:

```
shell> ./tools/tpm update alpha \
    --repl-svc-applier-block-commit-interval=500
```

This would apply two commits every second, regardless of the block commit size.

When replicating to a data warehouse engine, particularly when using batch loading, such as Redshift, Vertica and Hadoop, larger block commit sizes and intervals may improve performance during the batch loading process:

```
shell> ./tools/tpm update alpha \
    --repl-svc-applier-block-commit-size=100000 \
    --repl-svc-applier-block-commit-interval=60s
```

This sets a large block commit size and interval enabling large batch loading.

12.1.1. Monitoring Block Commit Status

The block commit status can be monitored using the trepctl status -name tasks command. This outputs the *lastCommittedBlockSize* and *lastCommittedBlockTime* values which indicate the size and interval (in seconds) of the last block commit.

```
shell> trepctl status -name tasks
Processing status command (tasks)...
...
NAME                     VALUE
----                     -----
appliedLastEventId    : mysql-bin.000015:0000000000001117;0
appliedLastSeqno      : 5271
appliedLatency        : 4656.231
applyTime             : 0.066
averageBlockSize      : 0.500
cancelled             : false
commits               : 10
currentBlockSize      : 0
currentLastEventId    : mysql-bin.000015:0000000000001117;0
currentLastFragno     : 0
currentLastSeqno      : 5271
eventCount            : 5
extractTime           : 0.394
filterTime            : 0.017
lastCommittedBlockSize: 1
lastCommittedBlockTime: 0.033
otherTime             : 0.001
stage                 : q-to-dbms
state                 : extract
taskId                : 0
Finished status command (tasks)...
```

12.2. Improving Network Performance

The performance of the network can be critical when replicating data. The information transferred over the network contains the full content of the THL in addition to a small protocol overhead. Improving your network performance can have a significant impact on the overall performance of the replication process.

When using the Connector and client applications, improving the network performance will aid the overall performance of your application during both the client to connector, and connector to MySQL server connectivity.

The following network parameters should be configured within your `/etc/sysctl.conf` and can safely applied to all the hosts within your cluster deployments:

```
# Increase size of file handles and inode cache
fs.file-max = 2097152

# tells the kernel how many TCP sockets that are not attached to any
# user file handle to maintain. In case this number is exceeded,
# orphaned connections are immediately reset and a warning is printed.
net.ipv4.tcp_max_orphans = 60000

# Do not cache metrics on closing connections
net.ipv4.tcp_no_metrics_save = 1

# Turn on window scaling which can enlarge the transfer window:
net.ipv4.tcp_window_scaling = 1

# Enable timestamps as defined in RFC1323:
net.ipv4.tcp_timestamps = 1

# Enable select acknowledgments:
net.ipv4.tcp_sack = 1

# Maximum number of remembered connection requests, which did not yet
# receive an acknowledgment from connecting client.
net.ipv4.tcp_max_syn_backlog = 10240

# recommended default congestion control is htcp
net.ipv4.tcp_congestion_control=htcp

# recommended for hosts with jumbo frames enabled
net.ipv4.tcp_mtu_probing=1

# Number of times SYNACKs for passive TCP connection.
net.ipv4.tcp_synack_retries = 2
```

```
# Allowed local port range
net.ipv4.ip_local_port_range = 1024 65535

# Protect Against TCP Time-Wait
net.ipv4.tcp_rfc1337 = 1

# Decrease the time default value for tcp_fin_timeout connection
net.ipv4.tcp_fin_timeout = 15

# Increase number of incoming connections
# somaxconn defines the number of request_sock structures
# allocated per each listen call. The
# queue is persistent through the life of the listen socket.
net.core.somaxconn = 1024

# Increase number of incoming connections backlog queue
# Sets the maximum number of packets, queued on the INPUT
# side, when the interface receives packets faster than
# kernel can process them.
net.core.netdev_max_backlog = 65536

# Increase the maximum amount of option memory buffers
net.core.optmem_max = 25165824

# Increase the maximum total buffer-space allocatable
# This is measured in units of pages (4096 bytes)
net.ipv4.tcp_mem = 65536 131072 262144
net.ipv4.udp_mem = 65536 131072 262144

### Set the max OS send buffer size (wmem) and receive buffer
# size (rmem) to 12 MB for queues on all protocols. In other
# words set the amount of memory that is allocated for each
# TCP socket when it is opened or created while transferring files

# Default Socket Receive Buffer
net.core.rmem_default = 25165824

# Maximum Socket Receive Buffer
net.core.rmem_max = 25165824

# Increase the read-buffer space allocatable (minimum size,
# initial size, and maximum size in bytes)
net.ipv4.tcp_rmem = 20480 12582912 25165824
net.ipv4.udp_rmem_min = 16384

# Default Socket Send Buffer
net.core.wmem_default = 25165824

# Maximum Socket Send Buffer
net.core.wmem_max = 25165824

# Increase the write-buffer-space allocatable
net.ipv4.tcp_wmem = 20480 12582912 25165824
net.ipv4.udp_wmem_min = 16384

# Increase the tcp-time-wait buckets pool size to prevent simple DOS attacks
net.ipv4.tcp_max_tw_buckets = 1440000
# net.ipv4.tcp_tw_recycle = 1
net.ipv4.tcp_tw_reuse = 1
```

12.3. Tungsten Replicator Block Commit and Memory Usage

Replicators are implemented as Java processes, which use two types of memory: stack space, which is allocated per running thread and holds objects that are allocated within individual execution stack frames, and heap memory, which is where objects that persist across individual method calls live. Stack space is rarely a problem for Tungsten as replicators rarely run more than 200 threads and use limited recursion. The Java defaults are almost always sufficient. Heap memory on the other hand runs out if the replicator has too many transactions in memory at once. This results in the dreaded Java OutOfMemory exception, which causes the replicator to stop operating. When this happens you need to look at tuning the replicator memory size.

To understand replicator memory usage, we need to look into how replicators work internally. Replicators use a "pipeline" model of execution that streams transactions through 1 or more concurrently executing stages. As you can can see from the attached diagram, an Applier pipeline might have a stage to read transactions from the Extractor and put them in the THL, a stage to read them back out of the THL into an in-memory queue, and a stage to apply those transactions to the Target. This model ensures high performance as the stages work independently. This streaming model is quite efficient and normally permits Tungsten to transfer even exceedingly large transactions, as the replicator breaks them up into smaller pieces called transaction fragments.

The pipeline model has consequences for memory management. First of all, replicators are doing many things at one, hence need enough memory to hold all current objects. Second, the replicator works fastest if the in-memory queues between stages are large enough that they do not ever become empty. This keeps delays in upstream processing from delaying things at the end of the pipeline. Also, it allows replica-

tors to make use of block commit. Block commit is an important performance optimization in which stages try to commit many transactions at once on Targets to amortize the cost of commit. In block commit the end stage continues to commit transactions until it either runs out of work (i.e., the upstream queue becomes empty) or it hits the block commit limit. Larger upstream queues help keep the end stage from running out of work, hence increase efficiency.

Bearing this in mind, we can alter replicator behavior in a number of ways to make it use less memory or to handle larger amounts of traffic without getting a Java OutOfMemory error. You should look at each of these when tuning memory:

- Property wrapper.java.memory in file `wrapper.conf`. This controls the amount of heap memory available to replicators. 1024 MB is the minimum setting for most replicators. Busy replicators, those that have multiple services, or replicators that use parallel apply should consider using 2048 MB instead. If you get a Java OutOfMemory exception, you should first try raising the current setting to a higher value. This is usually enough to get past most memory-related problems. You can set this at installation time as the `--repl-java-mem-size` [452] parameter.

- Property *`replicator.global.buffer.size`* in the replicator properties file. This controls two things, the size of in-memory queues in the replicator as well as the block commit size. If you still have problems after increasing the heap size, try reducing this value. It reduces the number of objects simultaneously stored on the Java heap. A value of 2 is a good setting to try to get around temporary problems. This can be set at installation time as the `--repl-buffer-size` [436] parameter.

- Property replicator.stage.q-to-dbms.blockCommitRowCount in the replicator properties file. This parameter sets the block commit count in the final stage in the Applier pipeline. If you reduce the global buffer size, it is a good idea to set this to a fixed size, such as 10, to avoid reducing the block commit effect too much. Very low block commit values in this stage can cut update rates on Targets by 50% or more in some cases. This is available at installation time as the `--repl-svc-applier-block-commit-size` [466] parameter.

- Property replicator.extractor.dbms.transaction_frag_size in the `replicator.properties` file. This parameter controls the size of fragments for long transactions. Tungsten automatically breaks up long transactions into fragments. This parameter controls the number of bytes of binlog per transaction fragment. You can try making this value smaller to reduce overall memory usage if many transactions are simultaneously present. Normally however this value has minimal impact.

Finally, it is worth mentioning that the main cause of out-of-memory conditions in replicators is large transactions. In particular, Tungsten cannot fragment individual statements or row changes, so changes to very large column values can also result in OutOfMemory conditions. For now the best approach is to raise memory, as described above, and change your application to avoid such transactions.

The replicator commits changes read from the THL and commits these changes in Targets during the applier stage according to the block commit size or interval. These replace the single *`replicator.global.buffer.size`* parameter that controls the size of the buffers used within each stage of the replicator.

When applying transactions to the database, the decision to commit a block of transactions is controlled by two parameters:

- When the event count reaches the specified event limit (set by `blockCommitRowCount`)

- When the commit timer reaches the specified commit interval (set by `blockCommitInterval`)

The default operation is for block commits to take place based on the transaction count. Commits by the timer are disabled. The default block commit size is 10 transactions from the incoming stream of THL data; the block commit interval is zero (0), which indicates that the interval is disabled.

When both parameters are configured, block commit occurs when either value limit is reached. For example,if the event count is set to 10 and the commit interval to 50s, events will be committed by the applier either when the event count hits 10 or every 50 seconds, whichever is reached first. This means, for example, that even if only one transaction exists, when the 50 seconds is up, that single transaction will be applied.

The block commit size can be controlled using the `--repl-svc-applier-block-commit-size` [466] option to tpm, or through the `blockCommitRowCount`.

The block commit interval can be controlled using the `--repl-svc-applier-block-commit-interval` [466] option to tpm, or through the `blockCommitInterval`. If only a number is supplied, it is used as the interval in milliseconds. Suffix of s, m, h, and d for seconds, minutes, hours and days are also supported.

```
shell> ./tools/tpm update alpha \
    --repl-svc-applier-block-commit-size=20 \
    --repl-svc-applier-block-commit-interval=100s
```

Note

The block commit parameters are supported only in applier stages; they have no effect in other stages.

Modification of the block commit interval should be made only when the commit window needs to be altered. The setting can be particularly useful in heterogeneous deployments where the nature and behaviour of the target database is different to that of the source extractor.

For example, when replicating to Oracle, reducing the number of transactions within commits reduces the locks and overheads:

```
shell> ./tools/tpm update alpha \
```

```
    --repl-svc-applier-block-commit-interval=500
```

This would apply two commits every second, regardless of the block commit size.

When replicating to a data warehouse engine, particularly when using batch loading, such as Redshift, Vertica and Hadoop, larger block commit sizes and intervals may improve performance during the batch loading process:

```
shell> ./tools/tpm update alpha \
    --repl-svc-applier-block-commit-size=100000 \
    --repl-svc-applier-block-commit-interval=60s
```

This sets a large block commit size and interval enabling large batch loading.

12.4. Connector Memory Management

The memory model within the Tungsten Connector works as follows:

- Memory consumption consists of the core memory, plus the buffered memory used for each connection.
- Each connection uses the maximum size of an `INSERT`, `UPDATE` or `SELECT`, up to the configured size of the MySQL `max_allowed_packet` parameter.

For example, with 1000 concurrent connections, and a result or insert size of 1 MB, the memory usage will be 1 GB.

The default setting for the Tungsten Connector memory size is 256 MB. The memory allocation can be increased using tpm update and the `--conn-java-mem-size` [437] option:

For example, during installation:

```
shell> tpm install ... --conn-java-mem-size=1024
```

Or to update using tpm update:

```
shell> tpm update ... --conn-java-mem-size=1024
```

12.5. Functional Testing

The following chapter includes a number of suggested functional tests that can be performed following installation in a Testing/POC environment

For a test to be successful, normal operations should be restored after every test. The default Primary server should regain Primary role with all replicators and data sources ONLINE

The tests are split into the following categories:

- Section 12.5.1, “Manual and Automatic Failover”
- Section 12.5.2, “Backup and Restore”
- Section 12.5.3, “Connectivity”
- Section 12.5.4, “Performance and Other Tests”

A PDF version of these tests can be downloaded by clicking here

12.5.1. Manual and Automatic Failover

Failover Test 1 - Administrator uses Tungsten to promote new Primary

Scenario	`shell> cctrl`
	`cctrl> use usa`
	`[LOGICAL] /usa> switch`

Expectation	• The Primary role will move a different server. Remaining servers will be reconfigured accordingly. • Examine how the application performs during the process • Data should be consistent

Failover Test 2 – Manually kill the Primary database process

Scenario	`shell> cctrl`

	`cctrl> use usa` `[LOGICAL] /usa> service Primary/mysql stop`
Expectation	• The database server stops and the Primary role is moved to another server. • Examine how the application performs during the process • Data should be consistent

Failover Test 3 – Remove power from the Primary database server

Scenario	Pull the power plug on the Primary server or run a restart command if that is not an option.
Expectation	• The database server stops and the Primary role is moved to another server. • Examine how the application performs during the process • Data should be consistent

Failover Test 4 – Manually kill a Replica database process

Scenario	`shell> cctrl`
	`cctrl> use usa`
	`[LOGICAL] /usa> service Replica1/mysql stop`

Expectation	• The Replica data source is marked as FAILED. • Examine how the application performs during the process

12.5.2. Backup and Restore

Backup Test 1 – Take a backup of a Replica and restore it to the same server

Scenario	`shell> cctrl`
	`cctrl> use usa`
	`[LOGICAL] /usa> datasource Replica1 backup`
	`[LOGICAL] /usa> datasource Replica1 restore`

Expectation	• The commands should complete successfully.

Backup Test 2 – Restore the backup to another server

Scenario	`shell> rsync -avze ssh /opt/continuent/backups/ Replica2:/opt/continuent/backups/`
	`shell> cctrl`
	`cctrl> use usa`
	`[LOGICAL] /usa> datasource Replica2 restore`

Expectation	• The commands should complete successfully.

Backup Test 3 – Take a backup of the Primary and restore to a Replica

Scenario	`shell> cctrl`
	`cctrl> use usa`
	`[LOGICAL] /usa> datasource Primary backup`
	`Primary> rsync -avze ssh /opt/continuent/backups/ Replica2:/opt/continuent/backups/`
	`[LOGICAL] /usa> datasource Replica2 restore`

Expectation	• The restore command should complete successfully, or. • Run `trepctl online -from-event ######:########` to bring the Replica ONLINE

12.5.3. Connectivity

Connectivity Test 1 – Connect to the connector and verify Primary host

Scenario	`shell> mysql -h`hostname` -P9999 -uapp -p -e"select @@hostname for update"`
Expectation	• The Primary hostname is returned.

Connectivity Test 2 – Verify access to Replicas

This test is only required if read/write splitting has been enabled. It should be run from a connector running on a server other than the Primary.

Scenario	`shell> mysql -h`hostname` -P9999 -uapp -p -e"select @@hostname"`
Expectation	• A hostname is returned. • Repeat the process on other hosts until a Replica hostname is returned

Connectivity Test 3 – Verify access to the Primary before and after a switch

Scenario	`shell> cctrl`
	`cctrl> use usa`
	`[LOGICAL] /usa> switch`

Expectation	• Run Test 1 again and verify the new Primary hostname is returned.

12.5.4. Performance and Other Tests

Performance Test 1 – Run a load test against the cluster

Scenario	Run load tests of some variety against the cluster to ensure the Connector and Replicator properly handle the load. Recommended load test tools are: • HammerDB. • sysbench
Expectation	Solution can handle 1TB of data with a minimum of 24k reads per minute and 1k writes per minute, over three tests. • Insert only from multiple locations • Read/write test • Heavy read test with few writes

Replicator Testing

Scenario	Evaluate system responsiveness in conjunction with performance tests (above). This is not a test of network speed
Expectation	Quick replication latency betweens regions (<100ms greater than the current ping latency)

Network Partition Testing

Scenario	Simulate a partitioned network (for example, by modifying security group rules in AWS), and continue to do reads and writes on multiple clusters for 30 minutes.
Expectation	After resolving the partition, clusters should resync.

Scenario	Create a similar network partition, and write the same record on both sides of the partition
Expectation	After resolving the partition, the replicators on both sides should report errors. Demonstrate possible resolutions: • Remove record on side, skip record on the other side, and bring replication back online. The record not removed will be replicated • Remove both records and skip both transactions • Modify records and bring replicators online

Appendix A. Release Notes

A.1. Tungsten Clustering 5.4.1 GA (28 October 2019)

Version End of Life. 29 Mar 2023

Release 5.4.1 contains both significant improvements as well as some needed bugfixes.

Improvements, new features and functionality

- Tungsten Manager
  - Improved how the Manager and Replicator behave when MySQL dies on the Primary node.

    This improvement will induce a change of behavior in the product during failover by default, possibly causing a delay in failover as a way to protect data integrity.

    The new default setting for 6.1.1 is:

    ```
    replicator.store.thl.stopOnDBError=false
    ```

    This means that the Manager will wait until the Replicator reads all remaining binlog events on the failing Primary node.

    Failover will only continue once:

    - all available events are completely read from the binary logs on the Primary node
    - all events have reached the Replicas

      WARNING:

      The new default means that the failover time could take longer than it used to.

    When `replicator.store.thl.stopOnDBError=true`, then the Replicator will stop extracting once it is unable to update the `trep_commit_seqno` table in MySQL, and the Manager will perform the failover without waiting, at the risk of possible data loss due to leaving binlog events behind. All such situations are logged.

    For use cases where failover speed is more important than data accuracy, those NOT willing to wait for long failover can set `replicator.store.thl.stopOnDBError=true` and still use tungsten_find_orphaned to manually analyze and perform the data recovery. For more information, please see Section 9.25, “The tungsten_find_orphaned Command”.

    Issues: CT-583
  - Improved the ability of the manager to detect un-extracted, desirable binary log events when recovering the old Primary via cctrl after a failover.

    The cctrl recover command will now fail if:

    - any unextracted binlog events exist on the old Primary that we are trying to recover
    - the old Primary THL contains more events than the Replicas

    In this case, the cctrl recover command will display text similar to the following:

    ```
    Recovery failed because the failed Primary has unextracted events in
    the binlog. Please run the tungsten_find_orphaned script to inspect
    this events. Provided you have a recent backup available, you can
    try to restore the data source by issuing the following command:
                datasource {hostname} restore
    Please consult the user manual at:
    https://docs.continuent.com/tungsten-clustering-6.1/operations-restore.html
    ```

    The tungsten_find_orphaned script is designed to locate orphaned MySQL binary logs that were not extracted into THL before a failover. For more information, please see Section 9.25, “The tungsten_find_orphaned Command”.

    Issues: CT-996
  - Improved the ability to configure the manager's behavior upon failover.

    During a failover, the manager will now wait until the selected Replica has applied all stored THL events before promoting that node to Primary.

This wait time can be configured via the `manager.failover.thl.apply.wait.timeout=0` property.

The default value is 0, which means "wait indefinitely until all stored THL events are applied".

Any value other than zero invites data loss due to the fact that once the Replica is promoted to Primary, any unapplied stored events in the THL will be ignored, and therefore lost.

Whenever a failover occurs, the Replica with most events stored in the local THL is selected so that when the events are eventually applied, the data is as close to the original Primary as possible with the least number of events missed.

That is usually, but not always, the most up-to-date Replica, which is the one with the most events applied.

There should be a good balance between the value for `manager.failover.thl.apply.wait.timeout` and the value for `policy.slave.promotion.latency.threshold=900`, which is the number of seconds to which a Replica must be current with the Primary in order to qualify as a candidate for failover. The default is 15 minutes (900 seconds).

Issues: CT-1022

Bug Fixes

- Command-line Tools
  - Installing with disable-security-controls=false or when updating using: tools/tpm update --replace-jgroups-certificate --replace-tls-certificate would generate self-signed security certs that have a 1-year expiration which will cause installs to break eventually.

    This expiration time value is controlled by the tpm command option `--java-tls-key-lifetime`, which is now set to 10 years or 3,650 days by default.

    Issues: CT-937
  - Updated the check_tungsten.sh command to have the executable bit set.

    Issues: CT-1037
  - Updated the check_tungsten_services and zabbix_tungsten_services commands to auto-detect active witnesses.

    Issues: CT-1043
- Tungsten Manager
  - Fixed an issue where the Manager would show an exception when the MySQL check script did not get expected results.

    Issues: CT-912
  - Fixed use case where xtrabackup would timeout during backup via cctrl

    Issues: CT-1045
  - Improve ability to find needed binaries, both locally and over SSH, for commands: tungsten_find_orphaned and tungsten_is_recoverable

    Issues: CT-1053

A.2. Tungsten Clustering 5.4.0 GA (31 July 2019)

Version End of Life. 29 Mar 2023

Release 5.4.0 contains both significant improvements as well as some needed bugfixes. One of the main features of this release is MySQL 8 support.

The Tungsten Stack now supports the new MySQL 8.0 authentication plugins. Both `sha256_password` and `caching_sha2_password` (the new default) are supported by the Replicator, Manager and Connector.

More info on these authentication plugins can be found here: https://dev.mysql.com/doc/refman/8.0/en/sha256-pluggable-authentication.html

The Drizzle driver has been updated to support these new authentication methods, and the MySQL Connector/J 8 is also supported.

Behavior Changes

The following changes have been made to Tungsten Cluster and may affect existing scripts and integration tools. Any scripts or environment which make use of these tools should check and update for the new configuration:

- Tungsten Connector
  - The Connector `passThroughMode` configuration option is now deprecated.

    The following `passThroughMode` entry will be removed from `tungsten-connector/conf/connector.properties`. There is currently no tpm option for this, and it is undocumented. The default will be kept to `passThroughMode=true`.

    ```
    # The Tungsten Connector offers an extra fast data transfer mode known as
    # pass-through. When the following switch enabled (default), the Connector
    # will directly transfer data packets between the client and the server.
    # When disabled, every native MySQL command will be translated into a JDBC call.
    passThroughMode=true
    ```

    Issues: CT-897

Known Issue

The following issues are known within this release but not considered critical, nor impact the operation of Tungsten Cluster. They will be addressed in a subsequent patch release.

- Tungsten Connector
  - Some applications might fail to connect to the Connector with MariaDB 10+

    When using MariaDB 10+, the Connector will be confused by the 10 and will think it is a MySQL 8+ server. By default, the Connector will offer to connect with `caching_sha2_password`. If the application does not know how to switch authentication plugins, it will fail with a message similar to the following:

    ```
    The server requested authentication method unknown to the client [caching_sha2_password]
    ```

    As a work-around, you may specify the authentication plugin using the following tpm command option:

    ```
    --property=defaultAuthPlugin=mysql_native_password
    ```

    Issues: CT-1033

Improvements, new features and functionality

- Command-line Tools
  - A new utility script has been added to the release, tungsten_post_process, which assists with the graceful maintenance of the static cross-site replicator configuration files on disk.

    Issues: CT-761

    For more information, see Section 9.38, “The tungsten_post_process Command”.
  - A new utility script has been added to the release, tungsten_reset_manager, which assists with the graceful reset of the manager's dynamic state files on disk.

    Issues: CT-850

    For more information, see Section 9.41, “The tungsten_reset_manager Command”.
- Tungsten Connector
  - The Tungsten Stack now supports the new MySQL 8.0 authentication plugins. Both `sha256_password` and `caching_sha2_password` (the new default) are supported by the Replicator, Manager and Connector.

    More info on these authentication plugins can be found here: https://dev.mysql.com/doc/refman/8.0/en/sha256-pluggable-authentication.html

    The Drizzle driver has been updated to support these new authentication methods, and the MySQL Connector/J 8 is also supported.

    In order to be fully transparent with the new defaults, when connected to a MySQL 8+ data source, the Connector will advertise `caching_sha2_password` as the default plugin.

    With earlier versions of MySQL (pre-8.0), the previous default `mysql_native_password` is used by default and advertised to the client applications.

    In order to override the default behavior, a new Connector property option for tpm, property=defaultAuthPlugin={autodetect|caching_sha2_password|mysql_native_password}, and is set to `autodetect` by default.

    Note that if property=defaultAuthPlugin is set to `caching_sha2_password`, the `sha256_password` authentication is automatically also supported.

> **Warning**
>
> Please note that the Connector does not support public key retrieval as of yet.
>
> Also note that, for backwards compatibility, the Connector forces the "CLIENT_DEPRECATE_EOF" to false, disallowing the usage of client session tracking requests (https://dev.mysql.com/doc/refman/5.7/en/session-state-tracking.html)

Issues: CT-771

- When logging is set to `debug` or `trace`, the Connector will print individual queries. In the past, advanced logging limited the display size of requests to 256 characters to prevent overwhelming the logs in terms of both space and filesystem I/O.

  Some customers need to display more than that, so it is now possible to adjust the size of the statements displayed in `debug` or `trace` logging modes. This is handled by a new Connector property option for tpm, property=statement.display.size.in.kb=NNN, which is defined as the maximum query length to display in Kbytes, and now defaults to 1KB.

  > **Warning**
  >
  > Warning: setting this option to a high value while DEBUG or TRACE is enabled will quickly fill logs and disk, in addition to using up disk I/O's!

  For example, if the raw query size is 4KB, then a setting of 1KB would simply display the first 1024 bytes of the query and truncate/discard the rest from a logging perspective.

  For more information about configuring debug and trace logging, please visit Section C.2.2, "Generating Advanced Diagnostic Information".

  Issues: CT-990

Bug Fixes

- Installation and Deployment
  - Fixing the rpm-based post-install chown command so that symlinked directories get correct ownership.

    Issues: CT-767

  - The Tungsten Clustering RPM now preserves the original OS group memberships for the `tungsten` user.

    Issues: CT-867

- Command-line Tools
  - Long service names within cctrl could cause output to fail when displaying information. The underlying issue has been fixed. Because long service names can cause formatting issues, a new option, `--cctrl-column-width` has been added which can be used to configure the minimum column width used to display information.

    Issues: CT-773, CT-926

- Tungsten Connector
  - MySQL ping commands are now reconnected/retried upon "server gone away" error (Proxy mode ONLY).

    Issues: CT-863, CT-885

  - OLD BEHAVIOR: If the Primary data source was not accessible when the Connector started (i.e. connection refused, etc.), the connector would still fully initialize, leading to a running Connector without an accessible data source. This has the side effects of having default configuration values for both `wait_timeout` and `server_version` instead of properly auto-detected values based on the MySQL server settings.

    NEW BEHAVIOR: The Connector will now wait indefinitely for a Primary to become available before finishing startup.

    Issues: CT-930

  - Introduced a new tpm flag allowing for tuning Connector thread stack size, which can be required in particular cases where large requests are sent as text to a connector configured for automated read/write splitting (smartscale and direct reads).

    The setting is commented out by default, leaving the JVM use its own default, generally 1024.

    Setting tpm option `connector-thread-stack-size={value in kb}` will override this value.

> **Note**
>
> Please note that since the new size will be allocated for each incoming connection, increasing the thread stack size will affect the total runtime memory used by the connector instance

Issues: CT-973

- Tungsten Manager
  - Fixed an edge case where the Primary node and the coordinator node are the same, then the node was rebooted. The failover would not complete and throws an error.

    Issues: CT-479

  - Remove spurious warnings during composite switch or failover.

    Issues: CT-487

  - Fixed a case when get_replicator_roles and cctrl 'ls -l' didn't work if a replicator was stopped.

    When a replicator is not running insert the `Replicator.HOST` to the `ReplicationNotification`. It was wrongly inserted into the `Replicator.DATASERVERHOST`. This fixes the `get_replicator_roles` script. Also substituted hard-coded strings for their constant values.

    Issues: CT-760, CT-876

Appendix B. Prerequisites

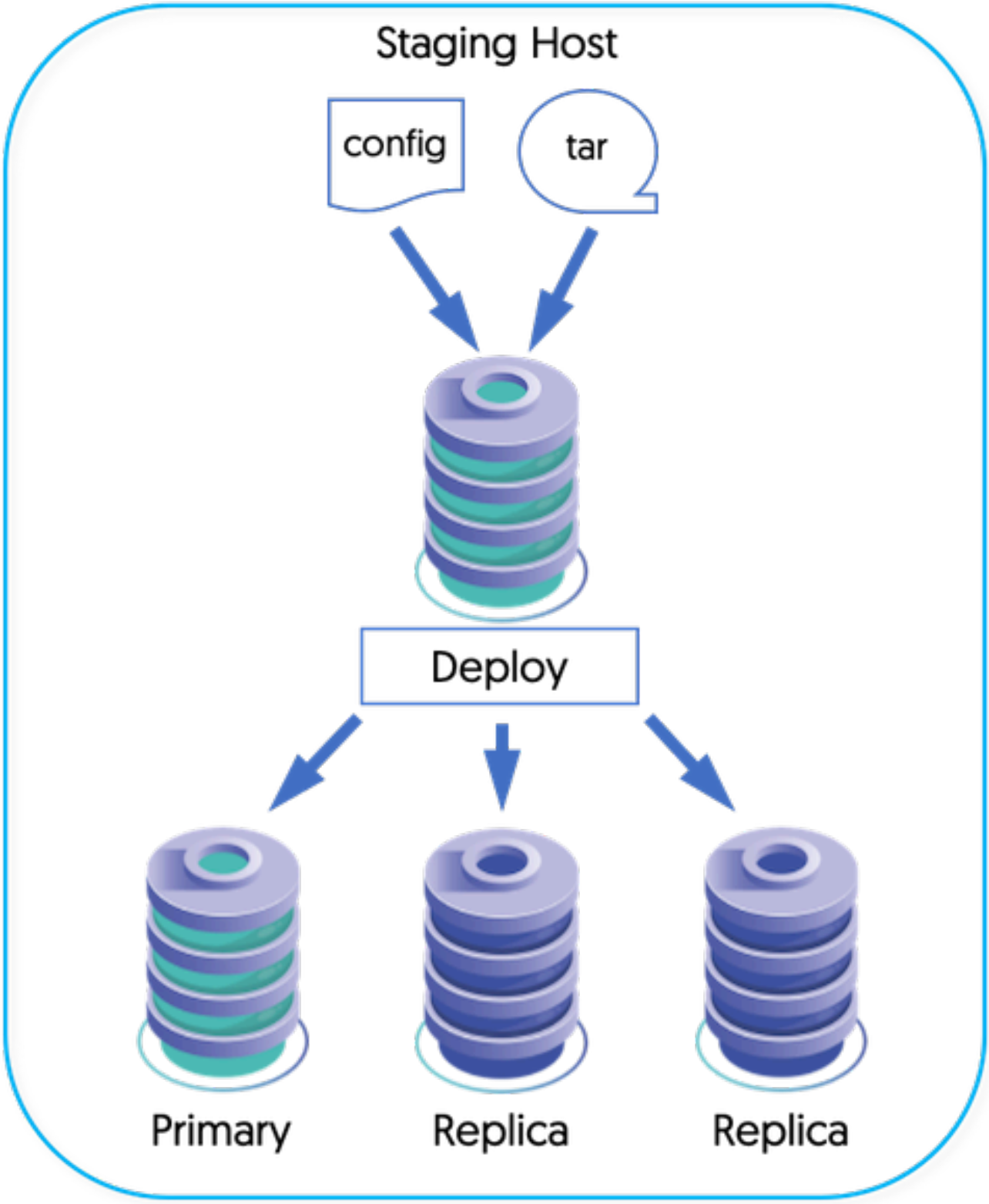
Before you install Tungsten Cluster, there are a number of setup and prerequisite installation and configuration steps that must have taken place before any installation can continue. Section B.1, “Staging Host Configuration” and Section B.2, “Host Configuration” must be performed on every host within your chosen cluster or replication configuration. Additional steps are required to configure explicit databases, such as Section B.3, “MySQL Database Setup”, and will need to be performed on each appropriate host.

B.1. Staging Host Configuration

The staging host will form the base of your operation for creating your cluster. The primary role of the staging host is to hold the Tungsten Cluster™ software, and to install, transfer, and initiate the Tungsten Cluster™ service on each of the nodes within the cluster. The staging host can be a separate machine, or a machine that will be part of the cluster.

The recommended way to use Tungsten Cluster™ is to configure SSH on each machine within the cluster and allow the tpm tool to connect and perform the necessary installation and setup operations to create your cluster environment, as shown in Figure B.1, “Tungsten Deployment”.

Figure B.1. Tungsten Deployment



The staging host will be responsible for pushing and configuring each machine. For this to operate correctly, you should configure SSH on the staging server and each host within the cluster with a common SSH key. This will allow both the staging server, and each host within the cluster to communicate with each other.

You can use an existing login as the base for your staging operations. For the purposes of this guide, we will create a unique user, `tungsten`, from which the staging process will be executed.

1. Create a new Tungsten user that will be used to manage and install Tungsten Cluster™. The recommended choice for MySQL installations is to create a new user, `tungsten`. You will need to create this user on each host in the cluster. You can create the new user using adduser:

   ```
   shell> sudo adduser tungsten
   ```

   You can add the user to the `mysql` group adding the command-line option:

   ```
   shell> sudo usermod -G mysql -a tungsten
   ```

2. Login as the `tungsten` user:

   ```
   shell> su - tungsten
   ```

3. Create an SSH key file, but do not configure a password:

   ```
   tungsten:shell> ssh-keygen -t rsa
   Generating public/private rsa key pair.
   Enter file in which to save the key (/home/tungsten/.ssh/id_rsa):
   Created directory '/home/tungsten/.ssh'.
   Enter passphrase (empty for no passphrase):
   Enter same passphrase again:
   Your identification has been saved in /home/tungsten/.ssh/id_rsa.
   Your public key has been saved in /home/tungsten/.ssh/id_rsa.pub.
   The key fingerprint is:
   e3:fa:e9:7a:9d:d9:3d:81:36:63:85:cb:a6:f8:41:3b tungsten@staging
   The key's randomart image is:
   +--[ RSA 2048]----+
   |                 |
   |                 |
   |             .   |
   |           . .   |
   |        S .. +   |
   |       . o .X .  |
   |        .oEO + . |
   |       .o.=o. o  |
   |      o=+..    . |
   +-----------------+
   ```

   This creates both a public and private keyfile; the public keyfile will be shared with the hosts in the cluster to allow hosts to connect to each other.

4. Within the staging server, profiles for the different cluster configurations are stored within a single directory. You can simplify the management of these different services by configuring a specific directory where these configurations will be stored. To set the directory, specify the directory within the `$CONTINUENT_PROFILES` environment variable, adding this variable to your shell startup script (`.bashrc`, for example) within your staging server.

   ```
   shell> mkdir -p /opt/continuent/software/conf
   shell> mkdir -p /opt/continuent/software/replicator.conf
   shell> export CONTINUENT_PROFILES=/opt/continuent/software/conf
   shell> export REPLICATOR_PROFILES=/opt/continuent/software/replicator.conf
   ```

We now have a staging server setup, an SSH keypair for our login information, and are ready to start setting up each host within the cluster.

B.2. Host Configuration

Each host in your cluster must be configured with the `tungsten` user, have the SSH key added, and then be configured to ensure the system and directories are ready for the Tungsten services to be installed and configured.

There are a number of key steps to the configuration process:

- Creating a user environment for the Tungsten service
- Creating the SSH authorization for the user on each host
- Configuring the directories and install locations
- Installing necessary software and tools

- Configuring sudo access to enable the configured user to perform administration commands

> **Important**
>
> The operations in the following sections must be performed on each host within your cluster. Failure to perform each step may prevent the installation and deployment of Tungsten cluster.

B.2.1. Creating the User Environment

The `tungsten` user should be created with a home directory that will be used to hold the Tungsten distribution files (not the installation files), and will be used to execute and create the different Tungsten services.

For Tungsten to work correctly, the `tungsten` user must be able to open a larger number of files/sockets for communication between the different components and processes as . You can check this by using ulimit:

```
shell> ulimit -a
core file size          (blocks, -c) 0
data seg size           (kbytes, -d) unlimited
file size               (blocks, -f) unlimited
max locked memory       (kbytes, -l) unlimited
max memory size         (kbytes, -m) unlimited
open files                      (-n) 256
pipe size            (512 bytes, -p) 1
stack size              (kbytes, -s) 8192
cpu time               (seconds, -t) unlimited
max user processes              (-u) 709
virtual memory          (kbytes, -v) unlimited
```

The system should be configured to allow a minimum of 65535 open files. You should configure both the `tungsten` user and the database user with this limit by editing the `/etc/security/limits.conf` file:

```
tungsten    -    nofile    65535
mysql       -    nofile    65535
```

In addition, the number of running processes supported should be increased to ensure that there are no restrictions on the running processes or threads:

```
tungsten    -    nproc    8096
mysql       -    nproc    8096
```

You must logout and log back in again for the ulimit changes to take effect.

You may also need to set the limit settings on the specific service if your operating system uses the systemctl service management framework. To configure your file limits for the specific service:

1. Copy the MySQL service configuration file template to the configuration directory if it does not already exist:

   ```
   shell> sudo cp /lib/systemd/system/mysql.service /etc/systemd/system/
   ```

   > **Note**
   >
   > Please note that the filename `mysql.service` will vary based on multiple factors. Do check to be sure you are using the correct file. For example, in some cases the filename would be `mysqld.service`

2. Edit the proper file used above, and append to or edit the existing entry to ensure the value of `infinity` for the key `LimitNOFILE`:

   ```
   LimitNOFILE=infinity
   ```

   This configures an unlimited number of open files, you can also specify a number, for example:

   ```
   LimitNOFILE=65535
   ```

3. Reload the systemctl daemon configuration:

   ```
   shell> sudo systemctl daemon-reload
   ```

4. Now restart the MySQL service:

   ```
   shell> service mysql restart
   ```

   > **Warning**
   >
   > On Debian/Ubuntu hosts, limits are not inherited when using su/sudo. This may lead to problems when remotely starting or restarting services. To resolve this issue, uncomment the following line within `/etc/pam.d/su`:

```
session required pam_limits.so
```

Integration with AppArmor

Make sure that Apparmor, if configured, has been enabled to support access to the `/tmp` directory for the MySQL processes. For example, add the following to the MySQL configuration file (usually `/etc/apparmor.d/local/usr.sbin.mysqld`):

```
/tmp/** rwk
```

B.2.2. Configuring Network and SSH Environment

The hostname, DNS, IP address and accessibility of this information must be consistent. For the cluster to operate successfully, each host must be identifiable and accessible to each other host, either by name or IP address.

Individual hosts within your cluster must be reachable and must conform to the following:

- Do not use the `localhost` or `127.0.0.1` addresses.
- Do not use Zeroconf (`.local`) addresses. These may not resolve properly or fully on some systems.
- The server hostname (as returned by the hostname) must match the names you use when configuring your service.
- The IP address that resolves on the hostname for that host must resolve to the IP address (not `127.0.0.1`). The default configuration for many Linux installations is for the hostname to resolve to the same as `localhost`:

  ```
  127.0.0.1 localhost
  127.0.0.1 host1
  ```

- Each host in the cluster must be able to resolve the address for all the other hosts in the cluster. To prevent errors within the DNS system causing timeouts or bad resolution, all hosts in the cluster, in addition to the witness host, should be added to `/etc/hosts`:

  ```
  127.0.0.1     localhost
  192.168.1.60  host1
  192.168.1.61  host2
  192.168.1.62  host3
  192.168.1.63  host4
  ```

  In addition to explicitly adding hostnames to `/etc/hosts`, the name server switch file, `/etc/nsswitch.conf` should be updated to ensure that hosts are searched first before using DNS services. For example:

  ```
  hosts:          files dns
  ```

  Important

  Failure to add explicit hosts and change this resolution order can lead to transient DNS resolving errors triggering timeouts and failsafe switching of hosts within the cluster.

- The IP address of each host within the cluster must resolve to the same IP address on each node. For example, if `host1` resolves to `192.168.0.69` on `host1`, the same IP address must be returned when looking up `host1` on the host `host2`.

To double check this, you should perform the following tests:

1. Confirm the hostname:

   ```
   shell> uname -n
   ```

   Warning

   The hostname cannot contain underscores.

2. Confirm the IP address:

   ```
   shell> hostname --ip-address
   ```

3. Confirm that the hostnames of the other hosts in the cluster resolve correctly to a valid IP address. You should confirm on each host that you can identify and connect to each other host in the planned cluster:

   ```
   shell> nslookup host1
   shell> ping host1
   ```

If the host does not resolve, either ensure that the hosts are added to the DNS service, or explicitly add the information to the `/etc/hosts` file.

Warning

If using `/etc/hosts` then you must ensure that the information is correct and consistent on each host, and double check using the above method that the IP address resolves correctly for every host in the cluster.

Witness Hosts

Tungsten Cluster includes support for verifying the network status using a *witness* host.

Active Witness Hosts operate as standalone managers, and therefore require the same rights and requirements as a standard Tungsten Cluster host.

B.2.2.1. Network Ports

The following network ports should be open between specific hosts to allow communication between the different components:

Component	Source	Destination	Port	Purpose
All Services	All Nodes	All Nodes	ICMP Ping	Checking availability (Default method)
#	#	#	7	Checking availability
Database Service	Database Host	Database Host	2112	THL replication
#	#	#	7800-7805	Manager Remote Method Invocation (RMI)
#	#	#	9997	Manager Remote Method Invocation (RMI)
#	#	#	10000-10001	Replication connection listener port
#	#	#	11999-12000	Tungsten manager
Connector Service	Connector Host	Manager Hosts	11999	Tungsten manager
Connector Service	#	#	13306	Database connectivity
Client Application	Client	Connector	3306	Database connectivity for client

For composite clusters, communication between each cluster within the composite configuration can be limited to the following ports:

Component	Port	Purpose
Database service	9997	Manager Remote Method Invocation (RMI)
#	2112	THL replication
#	11999-12000	Tungsten Manager
Client Application	13306	MySQL port for Connectivity
Manager Hosts	ICMP Ping	Checking availability (default method)
#	7	Checking availability

For Composite Active/Active and Multi-Site/Active-Active clusters that communicate through replication, the communication between sites can be limited to the following ports:

Component	Port	Purpose
#	2114	THL replication
#	10002-10003	Replication connection listener ports
Client Application	13306	MySQL port for Connectivity
Manager Hosts	ICMP Ping	Checking availability (default method)

Component	Port	Purpose
#	7	Checking availability

If a system has a firewall enabled, in addition to enabling communication between hosts as in the table above, the localhost must allow port-to-port traffic on the loopback connection without restrictions. For example, using iptables this can be enabled using the following command rule:

```
shell> iptables -A INPUT -i lo -m state --state NEW -j ACCEPT
```

B.2.2.2. SSH Configuration

For password-less SSH to work between the different hosts in the cluster, you need to copy both the public and private keys between the hosts in the cluster. This will allow the staging server, and each host, to communicate directly with each other using the designated login.

To achieve this, on each host in the cluster:

1. Copy the public (`.ssh/id_rsa.pub`) and private key (`.ssh/id_rsa`) from the staging server to the `~tungsten/.ssh` directory.
2. Add the public key to the `.ssh/authorized_keys` file.

   ```
   shell> cat .ssh/id_rsa.pub >> .ssh/authorized_keys
   ```

3. Ensure that the file permissions on the `.ssh` directory are correct:

   ```
   shell> chmod 700 ~/.ssh
   shell> chmod 600 ~/.ssh/*
   ```

With each host configured, you should try to connecting to each host from the staging server to confirm that the SSH information has been correctly configured. You can do this by connecting to the host using ssh:

```
tungsten:shell> ssh tungsten@host
```

You should have logged into the host at the `tungsten` home directory, and that directory should be writable by the `tungsten` user.

B.2.2.3. Host Availability Checks

The manager checks the availability of other hosts, for example to determine whether the host is still up, rather than just an individual service on that host. These checks must be able to be performed by one of the two available methods. Without these checks, it is possible for the availability of hosts to be falsely determined. These checks are performed using one of two protocols:

- ping — the preferred, and default, method using the system ping (ICMP) command.
- `default` — no longer the default method even though it is labeled that way. Uses the TCP/IP echo protocol on port 7. The port must be available on the source and destination host, not blocked by a system or network firewall.

The configuration of which service to use depends on the setting of the `--mgr-ping-method` [456] option during configuration. If no option is given, tpm will test ping first and then try `default` after. An error will be thrown if neither option works for all members of the dataservice.

B.2.3. Directory Locations and Configuration

On each host within the cluster you must pick, and configure, a number of directories to be used by Tungsten Cluster™, as follows:

- `/tmp` Directory

  The `/tmp` directory must be accessible and executable, as it is the location where some software will be extracted and executed during installation and setup. The directory must be writable by the `tungsten` user.

  On some systems, the `/tmp` filesystem is mounted as a separate filesystem and explicitly configured to be non-executable (using the `noexec` filesystem option). Check the output from the mount command.

- Installation Directory

  Tungsten Cluster™ needs to be installed in a specific directory. The recommended solution is to use `/opt/continuent`. This information will be required when you configure the cluster service.

  The directory should be created, and the owner and permissions set for the configured user:

  ```
  shell> sudo mkdir /opt/continuent
  shell> sudo chown -R tungsten: /opt/continuent
  shell> sudo chmod 700 /opt/continuent
  ```

- Home Directory

  The home directory of the `tungsten` user must be writable by that user.

B.2.4. Configure Software

Tungsten Cluster™ relies on the following software. Each host must use the same version of each tool.

Software	Versions Supported	Notes
perl	-	Check using perl -v
rsync	-	Check using rsync --help
Ruby	1.8.7, 1.9.3, or 2.0.0 to 2.7.0 [a]	JRuby is not supported
Ruby OpenSSL Module	-	Checking using ruby -ropenssl -e 'p "works"'
Ruby Gems	-	
Ruby `io-console` module	-	Install using gem install io-console [b]
Ruby `net-ssh` module	-	Install using gem install net-ssh [c]
Ruby `net-scp` module	-	Install using gem install net-scp [d]
GNU tar	-	gtar is required for Solaris due to limitations in the native tar command
Java Runtime Environment	Java SE 8 (or compatible)	See note below for more detail.

[a] Ruby 1.9.1 and 1.9.2 are not supported; these releases remove the execute bit during installation.
[b] `io-console` is only needed for SSH activities, and only needed for Ruby v2.0 and greater.
[c] For Ruby 1.8.7 the minimum version of net-ssh is 2.5.2, install using gem install net-ssh -v 2.5.2
[d] For Ruby 1.8.7 the minimum version of net-scp is 1.0.4, install using gem install net-scp -v 1.0.4

These tools must be installed, running, and available to all users on each host.

To check the current version for any installed tool, login as the configured user (e.g. `tungsten`), and execute the command to get the latest version. For example:

- Java

  Run java -version:

```
shell> java -version
openjdk version "1.8.0_102"
OpenJDK Runtime Environment (build 1.8.0_102-b14)
OpenJDK 64-Bit Server VM (build 25.102-b14, mixed mode)
```

> **Important**
>
> See Section 2.2.5, “Java Requirements” for more detail on Java requirements and known issues with certain builds.

  On certain environments, a separate tool such as alternatives (RedHat/CentOS) or update-alternatives (Debian/Ubuntu) may need to be used to switch Java versions globally or for individual users. For example, within CentOS:

```
shell> alternatives --display
```

> **Important**
>
> It is recommended to switch off all automated software and operating system update procedures. These can automatically install and restart different services which may be identified as failures by Tungsten Replicator. Software and Operating System updates should be handled by following the appropriate Section 6.14, “Performing Database or OS Maintenance” procedures.

It also recommended to install ntp or a similar time synchronization tool so that each host in the cluster has the same physical time.

B.2.5. sudo Configuration

Tungsten requires that the user you have configured to run the server has sudo credentials so that it can run and install services as `root`.

Within Linux environments you can do this by editing the `/etc/sudoers` file using visudo and adding the following lines:

```
## Allow tungsten to run any command
tungsten ALL=(ALL) NOPASSWD: ALL
```

Warning

The above syntax is applicable to most Linux environments, however double check if your environment uses different syntax!

sudo can also be configured to handle only specific directories or files. For example, when using xtrabackup, or additional tools in the Tungsten toolkit, such as tungsten_provision_slave, additional commands must be added to the permitted list:

```
tungsten ALL=(ALL) NOPASSWD: /sbin/service, /usr/bin/innobackupex, /bin/rm, »
    /bin/mv, /bin/chown, /bin/chmod, /usr/bin/scp, /bin/tar, /usr/bin/which, »
    /etc/init.d/mysql, /usr/bin/test, /usr/bin/systemctl, »
    /opt/continuent/tungsten/tungsten-replicator/scripts/xtrabackup.sh, »
    /opt/continuent/tungsten/tools/tpm, /usr/bin/innobackupex-1.5.1, »
    /bin/cat, /bin/find, /usr/bin/whoami, /bin/sh, /bin/rmdir, /bin/mkdir, »
    /usr/bin/mysql_install_db, /usr/bin/mysqld, /usr/bin/xtrabackup
```

Note

On some versions of sudo, use of sudo is deliberately disabled for ssh sessions. To enable support via ssh, comment out the requirement for `requiretty`:

```
#Defaults    requiretty
```

B.2.6. SELinux Configuration

To determine the surrent state of SELinux enforcement, use the getenforce command. For example:

```
shell> getenforce
Disabled
```

To disable SELinux, use the setenforce command. For example:

```
shell> setenforce 0
```

Should your company policy enforce the use of SELinux, then you will need to configure various SELinux contexts to allow Tungsten to operate.

When SELinux is enabled, systemctl may refuse to start mysqld if the listener port or location on disk have been changed. The solution is to inform SELinux about any changed or additional resources.

Tungsten best practice is to change the default MySQL port from `3306` to `13306` so that requesting clients do not accidentally connect directly to the database without being routed by the Connector.

If using a non-standard port for MySQL and SELinux is enabled, you must also change the port context, for example:

```
shell > semanage port -a -t mysqld_port_t -p tcp 13306
```

Ensure the file contexts are set correctly for SELinux. For example, to allow MySQL data to be stored in a non-standard location (i.e. `/data`):

```
shell > semanage fcontext -a -t etc_runtime_t /data
shell > restorecon -Rv /data/

shell > semanage fcontext -a -t mysqld_db_t "/data(/.*)?"
shell > restorecon -Rv /data/*
```

B.3. MySQL Database Setup

For replication between MySQL hosts, you must configure each MySQL database server to support the required user names and core MySQL configuration.

Important

For MySQL extraction, Tungsten Cluster must have write access to the database so that status and progress information can be recorded correctly.

Note

Native MySQL replication should not be running when you install Tungsten Cluster™. The replication service will be completely handled by Tungsten Cluster™, and the normal replication, management and monitoring techniques will not provide you with the information you need.

B.3.1. MySQL Version Support

For a full list of MySQL Versions supported, see Table 2.3, “MySQL/Tungsten Version Support”

B.3.2. MySQL Configuration

Each MySQL Server should be configured identically within the system. Although binary logging must be enabled on each host, replication should not be configured, since Tungsten Replicator will be handling that process.

The configured `tungsten` user must be able to read the MySQL configuration file (for installation) and the binary logs. Either the `tungsten` user should be a member of the appropriate group (i.e. `mysql`), or the permissions altered accordingly.

> **Important**
>
> Parsing of mysqld_multi configuration files is not currently supported. To use a mysqld_multi installation, copy the relevant portion of the configuration file to a separate file to be used during installation.

To setup your MySQL servers, you need to do the following:

- Configure your `my.cnf` settings. The following changes should be made to the `[mysqld]` section of your `my.cnf` file:
  - By default, MySQL is configured only to listen on the localhost address (127.0.0.1). The `bind-address` parameter should be checked to ensure that it is either set to a valid value, or commented to allow listening on all available network interfaces:

    ```
    #bind-address = 127.0.0.1
    ```

  - Specify the server id

    Each server must have a unique server id:

    ```
    server-id = 1
    ```

    The best practice is for all servers to have a unique ID across all clusters. For example, use a numbering scheme like 0101, 0102, 0201, 0201, where the leading two digits are the cluster number and the last two digits are the node number, which allows for 99 participating clusters with 99 nodes each.

  - (Optional) Reconfigure the default MySQL TCP/IP port

    Change the listening port to 13306. The Tungsten Connector will listen on the normal port 3306 for MySQL connections and send them to the database using port 13306.

    ```
    port = 13306
    ```

    If you are not using Tungsten Connector, the setting can remain at the default of 3306.

  - Ensure that the maximum number of open files matches the configuration of the database user. This was configured earlier at 65535 files.

    ```
    open_files_limit = 65535
    ```

  - Enable binary logs

    Tungsten Replicator operates by reading the binary logs on each machine, so logging must be enabled:

    ```
    log-bin = mysql-bin
    ```

  - Set the `sync_binlog` parameter to 1 (one).

    > **Note**
    >
    > In MySQL 5.7, the default value is 1.

    The MySQL `sync_binlog` parameter sets the frequency at which the binary log is flushed to disk. A value of zero indicates that the binary log should not be synchronized to disk, which implies that only standard operating system flushing of writes will occur. A value greater than one configures the binary log to be flushed only after `sync_binlog` events have been written. This can introduce a delay into writing information to the binary log, and therefore replication, but also opens the system to potential data loss if the binary log has not been flushed when a fatal system error occurs.

    Setting a value of value 1 (one) will synchronize the binary log on disk after each event has been written.

    ```
    sync_binlog = 1
    ```

  - Increase MySQL protocol packet sizes

    The replicator can apply statements up to the maximum size of a single transaction, so the maximum allowed protocol packet size must be increase to support this:

```
max_allowed_packet = 52m
```

- Configure InnoDB as the default storage engine

  Tungsten Cluster needs to use a transaction safe storage engine to ensure the validity of the database. The InnoDB storage engine also provides automatic recovery in the event of a failure. Using MyISAM can lead to table corruption, and in the event of a switchover or failure, and inconsistent state of the database, making it difficult to recover or restart replication effectively.

  InnoDB should therefore be the default storage engine for all tables, and any existing tables should be converted to InnoDB before deploying Tungsten Cluster.

  ```
  default-storage-engine = InnoDB
  ```

- Configure InnoDB Settings

  Tungsten Replicator creates tables and must use InnoDB tables to store the status information for replication configuration and application:

  The MySQL option `innodb_flush_log_at_trx_commit` configures how InnoDB writes and confirms writes to disk during a transaction. The available values are:

  - A value of 0 (zero) provides the best performance, but it does so at the potential risk of losing information in the event of a system or hardware failure. For use with Tungsten Cluster™ the value should never be set to 0, otherwise the cluster health may be affected during a failure or failover scenario.

  - A value of 1 (one) provides the best transaction stability by ensuring that all writes to disk are flushed and committed before the transaction is returned as complete. Using this setting implies an increased disk load and so may impact the overall performance.

    When using Tungsten Cluster in an Composite Active/Active, fan-in or data critical cluster, the value of `innodb_flush_log_at_trx_commit` should be set to 1. This not only ensures that the transactional data being stored in the cluster are safely written to disk, this setting also ensures that the metadata written by Tungsten Cluster™ describing the cluster and replication status is also written to disk and therefore available in the event of a failover or recovery situation.

  - A value of 2 (two) ensures that transactions are committed to disk, but data loss may occur if the disk data is not flushed from any OS or hardware-based buffering before a hardware failure, but the disk overhead is much lower and provides higher performance.

    This setting must be used as a minimum for *all* Tungsten Cluster™ installations, and should be the setting for all configurations that do not require `innodb_flush_log_at_trx_commit` set to `1`.

  At a minimum `innodb_flush_log_at_trx_commit` should be set to `2`; a warning will be generated if this value is set to zero:

  ```
  innodb_flush_log_at_trx_commit = 2
  ```

  MySQL configuration settings can be modified on a running cluster, providing you switch your host to maintenance mode before reconfiguring and restarting MySQL Server. See Section 6.14, “Performing Database or OS Maintenance”.

Optional configuration changes that can be made to your MySQL configuration:

- InnoDB Flush Method

  ```
  innodb_flush_method=O_DIRECT
  ```

  The InnoDB flush method can effect the performance of writes within MySQL and the system as a whole.

  O_DIRECT is generally recommended as it eliminates double-buffering of InnoDB writes through the OS page cache. Otherwise, MySQL will be contending with Tungsten and other processes for pages there — MySQL is quite active and has a lot of hot pages for indexes and the like this can result lower i/o throughput for other processes.

  Tungsten particularly depends on the page cache being stable when using parallel apply. There is one thread that scans forward over the THL pages to coordinate the channels and keep them from getting too far ahead. We then depend on those pages staying in cache for a while so that all the channels can read them — as you are aware parallel apply works like a bunch of parallel table scans that are traveling like a school of sardines over the same part of the THL. If pages get kicked out again before all the channels see them, parallel replication will start to serialize as it has to wait for the OS to read them back in again. If they stay in memory on the other hand, the reads on the THL are in-memory, and fast. For more information on parallel replication, see Section 4.1, “Deploying Parallel Replication”.

- Increase InnoDB log file size

  The default InnoDB Redo Log file size is 48MB. This should be increased to a larger file size for performance and other reasons. Values of 512MB are common.

To change the file size, read the corresponding information in the MySQL manual for configuring the file size information. Please see both "MySQL Redo Log" and "Optimizing MySQL InnoDB Redo Logging".

- Binary Logging Format

  Tungsten Replicator works with both statement and row-based logging, and therefore also mixed-based logging. The chosen format is entirely up to the systems and preferences, and there are no differences or changes required for Tungsten Replicator to operate. For native MySQL to MySQL Primary/Replica replication, either format will work fine.

  Depending on the exact use case and deployment, different binary log formats imply different requirements and settings. Certain deployment types and environments require different settings:

  - For Composite Active/Active deployments, use row-based logging. This will help to avoid data drift where statements make fractional changes to the data in place of explicit updates.
  - Use row-based logging for heterogeneous deployments. All deployments to Oracle, MongoDB, Vertica and others rely on row-based logging.
  - Use mixed replication if warnings are raised within the MySQL log indicating that statement only is transferring possibly dangerous statements.
  - Use statement or mixed replication for transactions that update many rows; this reduces the size of the binary log and improves the performance when the transaction are applied on the Replica.
  - Use row replication for transactions that have temporary tables. Temporary tables are replicated if statement or mixed based logging is in effect, and use of temporary tables can stop replication as the table is unavailable between transactions. Using row-based logging also prevents these tables entering the binary log, which means they do not clog and delay replication.

  The configuration of the MySQL server can be permanently changed to use an explicit replication by modifying the configuration in the configuration file:

  ```
  binlog-format = row
  ```

  > **Note**
  >
  > In MySQL 5.7, the default format is `ROW`.

  For temporary changes during execution of explicit statements, the binlog format can be changed by executing the following statement:

  ```
  mysql> SET binlog-format = ROW;
  ```

- `innodb_stats_on_metadata=0`

  Although optional, we would highly recommend setting this property as it has been shown to improve performance by preventing statistics updates every time the information_schema is queried.

  You must restart MySQL after any changes have been made.

- Ensure the `tungsten` user can access the MySQL binary logs by either opening up the directory permissions, or adding the `tungsten` user to the group owner for the directory.

B.3.3. MySQL Configuration for Active/Active Deployments

If you are inserting to the same table at the same time at two or more different sites, and using bi-directional or active/active replication, then special care must be taken to avoid primary key conflicts. Either the auto-increment keys on each need to be offset so they do not conflict, or the application needs to be be able to generate unique keys taking multiple sites into account.

> **Important**
>
> The following configuration is *required* if your application is relying upon the MySQL-native auto-increment primary key feature:

Use the `auto-increment-increment` and `auto-increment-offset` variables to affect the way that MySQL generates the next value in an auto-increment field.

For example, edit `my.cnf` on all servers:

```
# for all servers at site 1

auto-increment-increment = 10
```

```
auto-increment-offset = 1
```

```
# for all servers at site 2

auto-increment-increment = 10
auto-increment-offset = 2
```

```
# for all servers at site 3

auto-increment-increment = 10
auto-increment-offset = 3
```

Important

Restart MySQL on all servers.

B.3.4. MySQL Configuration for Heterogeneous Deployments

The following are *required* for replication to heterogeneous targets to ensure that MySQL has been configured and generating row change information correctly:

- MySQL must be using Row-based replication for information to be replicated to heterogenous targets. For the best results, you should change the global binary log format, ideally in the configuration file (`my.cnf`):

  ```
  binlog-format = row
  ```

  Alternatively, the global binlog format can be changed by executing the following statement:

  ```
  mysql> SET GLOBAL binlog-format = ROW;
  ```

  For MySQL 5.6.2 and later, you must enable full row log images:

  ```
  binlog-row-image = full
  ```

  This information will be forgotten when the MySQL server is restarted; placing the configuration in the `my.cnf` file will ensure this option is permanently enabled.

- Table format should be updated to UTF8 by updating the MySQL configuration (`my.cnf`):

  ```
  character-set-server=utf8
  collation-server=utf8_general_ci
  ```

  Tables must also be configured as UTF8 tables, and existing tables should be updated to UTF8 support before they are replicated to prevent character set corruption issues.

- To prevent timezone configuration storing zone adjusted values and exporting this information to the binary log and PostgreSQL, fix the timezone configuration to use UTC within the configuration file (`my.cnf`):

  ```
  default-time-zone='+00:00'
  ```

B.3.5. MySQL User Configuration

- Tungsten User Login

  The `tungsten` user connects to the MySQL database and applies the data from the replication stream from other datasources in the dataservice. The user must therefore be able execute any SQL statement on the server, including grants for other users. The user *must* have the following privileges in addition to privileges for creating, updating and deleting DDL and data within the database:

  - `SUPER` privilege is required so that the user can perform all administrative operations including setting global variables.
  - `GRANT OPTION` privilege is required so that users and grants can be updated.

  To create a user with suitable privileges:

  ```
  mysql> CREATE USER tungsten@'%' IDENTIFIED BY 'password';
  mysql> GRANT ALL ON *.* TO tungsten@'%'  WITH GRANT OPTION;
  ```

  The connection will be made from the host to the local MySQL server. You may also need to create an explicit entry for this connection. For example, on the host `host1`, create the user with an explicit host reference:

  ```
  mysql> CREATE USER tungsten@'host1' IDENTIFIED BY 'password';
  mysql> GRANT ALL ON *.* TO tungsten@'host1'  WITH GRANT OPTION;
  ```

  The above commands enable logins from any host using the user name/password combination. If you want to limit the configuration to only include the hosts within your cluster you must create and grant individual user/host combinations:

```
mysql> CREATE USER tungsten@'client1' IDENTIFIED BY 'password';
mysql> GRANT ALL ON *.* TO tungsten@'client1'  WITH GRANT OPTION;
```

> **Note**
>
> If you later change the cluster configuration and add more hosts, you will need to update this configuration with each new host in the cluster.

- MySQL Application Login

  Tungsten Connector requires a user that can be used as the application user to connect to the MySQL server. The login will allow connections to the MySQL databases servers to be used in a consistent fashion across different hosts within the cluster. You must configure this user with access to your database, and then use it as the 'application' user in your cluster configuration.

  ```
  mysql> CREATE USER app_user@'%' IDENTIFIED BY 'password!';
  mysql> GRANT ALL ON *.* TO app_user@'%';
  mysql> REVOKE SUPER ON *.* FROM app_user@'%';
  ```

  Additional application user logins can be configured by using the `user.map` file within your Tungsten Cluster™ configuration.

  As noted above, the creation of explicit host-specific user entries may be required.

  In situations where only minimal privileges are desired for the required application user, nothing additional is needed beyond the implied usage granted by the create user command:

  ```
  mysql> CREATE USER app_user@'%' IDENTIFIED BY 'password!';
  mysql> SHOW GRANTS FOR app_user;
  +----------------------------------+
  | Grants for app_user@%            |
  +----------------------------------+
  | GRANT USAGE ON *.* TO 'app_user'@'%' |
  +----------------------------------+
  ```

  The Connector requires this user to be able to gather critical configuration information, listed below:

  - An internal-only show slave status request needs access to the `trep_commit_seqno` table in the replication tracking schema:

    ```
    tungsten_%DATASERVICE%.trep_commit_seqno
    ```

  - Configuration fetch:

    ```
    select @@wait_timeout;
    ```

  - Configuration fetch:

    ```
    select @@version;
    ```

  - Configuration fetch:

    ```
    SELECT ID FROM INFORMATION_SCHEMA.COLLATIONS WHERE COLLATION_NAME=@@collation_server LIMIT 1;
    ```

  - Keepalive mechanism:

    ```
    SELECT 'KEEP_ALIVE';
    ```

  - Calling a tungsten command inside the Connector during a command-line client session:

    ```
    tungsten connection status;
    ```

    will execute the following SQL query:

    ```
    SHOW STATUS LIKE 'ssl_cipher';
    ```

  - Calling a tungsten command inside the Connector during a command-line client session:

    ```
    tungsten show processlist;
    ```

    will execute the following SQL query:

    ```
    SHOW FULL PROCESSLIST;
    ```

- If you configure the connector to run in Proxy mode, and you issue the `SHOW SLAVE STATUS` command, then any user executing this statement will require the select privilege on the tracking schema table `trep_commit_seqno`. The following DDL can be used as an example:

  ```
  GRANT SELECT ON tungsten_<servicename>.trep_commit_seqno TO '<user>'@'<host>';
  ```

This will need to be executed after installation, following the initial creation of the tracking schema and tables.

B.3.6. MySQL Unprivileged Users

By default, the `tungsten` user needs to be given `SUPER` privileges within MySQL so that the user can apply, create and access all the tables and data within the MySQL database. In some situations, this level of access is not available within the MySQL environment, for example, when using a server that is heavily secured, or Amazon's RDS service.

For this situation, the Tungsten Cluster can be configured to use an 'unprivileged' user configuration. This configuration does not require the `SUPER` privilege, but instead needs explicit privileges on the schema created by Tungsten Cluster, and on the schemas that it will update when applying events.

The capability can be enabled by using the following two options and behaviors:

- `--privileged-master=false` [461]

  When privileged_master is disabled:

  - A Primary replicator will not attempt to suppress binlog writes during operations.
  - A Primary replicator Will not issue a `FLUSH LOGS` command when the replicator starts.
  - The current replicator position is not updated within the `trep_commit_seqno` table.

  The `tungsten` user that connects to the database must be configured to work with the MySQL service using the following grants:

```
mysql> GRANT ALL ON tungsten_alpha.* to tungsten@'%' IDENTIFIED BY 'secret';
mysql> GRANT SELECT ON *.* TO tungsten@'%' IDENTIFIED BY 'secret';
mysql> GRANT REPLICATION SLAVE ON *.* TO tungsten@'%' IDENTIFIED BY 'secret';
mysql> REVOKE SUPER ON *.* FROM tungsten@'%';
```

- `--privileged-slave=false` [461]

  When privileged_slave is disabled:

  - The current replicator position is not updated within the `trep_commit_seqno` table.

```
mysql> GRANT ALL ON tungsten_batch.* to tungsten@'%' IDENTIFIED BY 'secret';
mysql> GRANT SELECT,INSERT,UPDATE ON *.* TO tungsten@'%' IDENTIFIED BY 'secret';
mysql> GRANT REPLICATION SLAVE ON *.* TO tungsten@'%' IDENTIFIED BY 'secret';
mysql> REVOKE SUPER ON *.* FROM tungsten@'%';
```

  Optionally, `INSERT` and `UPDATE` privileges can be explicitly added to the user permissions for the tables/databases that will be updated during replication.

B.4. Prerequisite Checklist

To simplify the process of preparing your hosts, the checklist below is designed to provide a quick summary of the main prerequisites required.

A PDF version of this checklist can also be downloaded here

Host Specific

Pre-Req	Complete?
Create OS User – Typically called `tungsten`	
Set `ulimit` for OS User	
Configure sudoers	
Disable SELinux	
Compile `/etc/hosts`	
Setup SSH between hosts	
Create directory for installation (Typically, `/opt/continuent`)	
Create directory for software package if using tar bundle (Typically, `/opt/continuent/software`)	
Create directory for configuration file if INI Install (`/etc/tungsten`)	
Check ownership of new directories set to new OS user	

Pre-Req	Complete?
Install Perl (if not already present)	
Install Ruby	
Install Ruby gems : `net-ssh`	
Install Ruby gems : `net-scp`	
Install Ruby gems : `io-console`	
Install Java 8	
Install rsync	

Network Specific

Pre-Req	Complete?
Ensure Network ports open	

Database Specific (All Topologies)

Pre-Req	Complete?
Ensure `server-id` unique amongst all nodes	
Increase Open Files limits	
Ensure `bin-logging` enabled for cluster nodes, or source replicator nodes	
Review `sync_binlog` parameter	
Increase, if required, `max_allowed_packet`	
Review InnoDB settings	
Set `binlog_format` to ROW (Essential for Active/Active or heterogeneous deployments)	
Ensure `auto_increment` offsets adjusted for Active/Active deployments	
Create DB user with FULL privileges and `GRANT OPTION` – typically called `tungsten` (Used by managers and replicators)	

Database Specific for Clustering Deployments

Pre-Req	Complete?
Change DB port from default (eg 13306)	
Create user with FULL privileges except `SUPER`, for use by connectors – typically called `app_user`	
Ensure additional application DB user accounts have `REPLICATION CLIENT` privilege (Only if connectors configured to use `SMARTSCALE`)	

Appendix C. Troubleshooting

The following sections contain both general and specific help for identifying, troubleshooting and resolving problems. Key sections include:

- General notes on contacting and working with support and supplying information, see Section C.1, “Contacting Support”.
- Error/Cause/Solution guidance on specific issues and error messages, and how the reason can be identified and resolved, see Section C.3, “Error/Cause/Solution”.
- Additional troubleshooting for general systems and operational issues.

C.1. Contacting Support

The support portal may be accessed at https://continuent.zendesk.com.

Continuent offers paid support contracts for Continuent Tungsten and Tungsten Replicator. If you are interested in purchasing support, contact our sales team at sales@continuent.com.

C.1.1. Support Request Procedure

Please use the following procedure when requesting support so we can provide prompt service. If we are unable to understand the issue due to lack of required information, it will prevent us from providing a timely response.

1. Please provide a clear description of the problem
2. Which environment is having the issue? [Prod, QA, Dev, etc.]
3. What is the impact upon the affected environment?
4. Identify the problem host or hosts and the role [Primary, Replica, etc]
5. Provide the steps you took to see the problem in your environment
6. Upload the resulting zip file from tpm diag, potentially run more than once on different hosts as needed. Alternatively, use the tungsten_send_diag command.
7. Provide steps already taken and commands already run to resolve the issue
8. Have you searched your previous support cases? https://continuent.zendesk.com.
9. Have you checked the Continuent documentation? https://docs.continuent.com
10. Have you checked our general knowledge base? For our Error/Cause/Solution guidance on specific issues and error messages, and how the reason can be identified and resolved, see Section C.3, “Error/Cause/Solution”.

C.1.2. Creating a Support Account

You can create a support account by logging into the support portal at https://continuent.zendesk.com. Please use your work email address so that we can recognize it and provide prompt service. If we are unable to recognize your company name it may delay our ability to provide a response.

Be sure to allow email from `helpdesk@continuent.com` and `notifications-helpdesk@continuent.com`. These addresses will be used for sending messages from Zendesk.

C.1.3. Open a Support Ticket

Login to the support portal and click on 'Submit a Request' at the top of the screen. You can access this page directly at https://continuent.zendesk.com/requests/new.

C.1.4. Open a Support Ticket via Email

Send an email to helpdesk@continuent.com from the email address that you used to create your support account. You can include a description and attachments to help us diagnose the problem.

C.1.5. Getting Updates for all Company Support Tickets

If multiple people in your organization have created support tickets, it is possible to get updates on any support tickets they open. You should see your organization name along the top of the support portal. It will be listed after the Check Your Existing Requests tab.

To see all updates for your organization, click on the organization name and then click the Subscribe link.

If you do not see your organization name listed in the headers, open a support ticket asking us to create the organization and list the people that should be included.

C.1.6. Support Severity Level Definitions

Summary of the support severity levels with initial response targets:

- Urgent: initial response within an hour

  Represents a reproducible emergency condition (i.e. a condition that involves either data loss, data corruption, or lack of data availability) that makes the use or continued use of any one or more functions impossible. The condition requires an immediate solution. Continuent guarantees a maximum one (1) hour initial response time. Continuent will continue to work with Customer until Customer's database is back in production. The full resolution and the full root cause analysis will be provided when available.

- High: initial response within four (4) hours

  Represents a reproducible, non-emergency condition (i.e. a condition that does not involve either data loss, data corruption or lack of database availability) that makes the use or continued use of any one or more functions difficult, and cannot be circumvented or avoided on a temporary basis by Customer. Continuent guarantees a maximum four (4) hours initial response time.

- Normal: initial response within one (1) business day

  Represents a reproducible, limited problem condition that may be circumvented or avoided on a temporary basis by Customer. Continuent guarantees a maximum one (1) business day initial response time.

- Low: no guaranteed initial response interval

  Represents minor problem conditions or documentation errors that are easily avoided or circumvented by Customer. Additional request for new feature suggestions, which are defined as new functionality in existing product, are also classified as low severity level. Continuent does not guarantee any particular initial response time, or a commitment to fix in any particular time frame unless Customer engages Continuent for professional services work to create a fix or a new feature.

C.2. Support Tools

C.2.1. Generating Diagnostic Information

To aid in the diagnosis of issues, a copy of the logs and diagnostic information will help the support team to identify and trace the problem. There are two methods of providing this information:

- Using tpm diag

  The tpm diag command will collect the logs and configuration information from the active installation and generate a Zip file with the diagnostic information for all hosts within it. The command should be executed from the staging directory. Use tpm query staging to determine this directory:

  ```
  shell> tpm query staging
  tungsten@host1:/home/tungsten/tungsten-clustering-5.4.1-41
  shell> cd /home/tungsten/tungsten-clustering-5.4.1-41
  shell> ./tools/tpm diag
  ```

  The process will create a file called `tungsten-diag-2014-03-20-10-21-29.zip`, with the corresponding date and time information replaced. This file should be included in the reported support issue as an attachment.

  For a staging directory installation, tpm diag will collect together all of the information from each of the configured hosts in the cluster. For an INI file based installation, tpm diag will connect to all configured hosts if ssh is available. If a warning that ssh is not available is generated, tpm diag must be run individually on each host in the cluster.

- Manually Collecting Logs

  If tpm diag cannot be used, or fails to return all the information, the information can be collected manually:

  1. Run tpm reverse on all the hosts in the cluster:

     ```
     shell> tpm reverse
     ```

  2. Collect the logs from each host. Logs are available within the `service_logs` directory. This contains symbolic links to the actual log files. The original files can be included within a tar archive by using the `-h` option. For example:

```
shell> cd /opt/continuent
shell> tar zcfh host1-logs.tar.gz ./service_logs
```

The tpm reverse and log archives can then be submitted as attachments with the support query.

C.2.2. Generating Advanced Diagnostic Information

To aid in the diagnosis of difficult issues, below are tools and procedures to assist in the data collection.

> **Warning**
>
> ONLY excute the below commands and procedures when requested by Continuent support staff.

Manager Memory Usage Script

We have provided a script to easily tell us how much memory a given manager is consuming.

Place the script on all of your manager hosts (i.e. into the tungsten OS user home directory).

> **Note**
>
> The script assumes that 'cctrl' is in the path. If not, then change the script to provide a full path for cctrl.

```
shell> su - tungsten
shell> vi tungsten_manager_memory
#!/bin/bash
memval=`echo gc | cctrl | grep used | tail -1 | awk -F: '{print $2}' | tr -d ' |'`
megabytes=`expr $memval / 1000000`
timestamp=`date +"%F %T" | tr '-' '/'`
echo "$timestamp | `hostname` | $megabytes MB"

shell> chmod 750 tungsten_manager_memory
shell> ./tungsten_manager_memory
```

This script is ideally run from cron and the output redirected to time-stamped log files for later correlation with manager issues.

Manager Thread Dump Procedure

This procedure creates a Manager memory thread dump for detailed analysis.

Run this command on manager hosts when requested by Continuent support.

This will append the detailed thread dump information to the log file named `tmsvc.log` in the `/opt/continuent/tungsten/tungsten-manager/log` directory.

```
shell> su - tungsten
shell> manager dump
shell> tungsten_send_diag -f /opt/continuent/tungsten/tungsten-manager/log/tmsvc.log -c {case_number}
```

Manager Heap Dump Procedure

This procedure creates a Manager memory heap dump for detailed analysis.

Run this command on manager hosts when requested by Continuent support.

This will create a file named `{hostname}.hprof` in the directory where you run it.

```
shell> su - tungsten
shell> jmap -dump:format=b,file=`hostname`.hprof `ps aux | grep JANINO | grep -v grep | awk '{print $2}'`
shell> tungsten_send_diag -f `hostname`.hprof -c {case_number}
```

Configuring Connector Debug Logging

This procedure allows the Connector to be configured for debug logging.

Perform this procedure on Connector hosts when requested by Continuent support.

> **Warning**
>
> Enabling Connector debug logging will decrease performance dramatically. Disk writes will increase as will disk space consumption. Do not use in production environments unless instructed to do so by Continuent support. In

any case, run in this mode for as short a period of time as possible - just long enough to gather the needed debug information. After that is done, disable debug logging.

To enable debug logging, edit the Connector configuration file `tungsten-connector/conf/log4j.properties` and turn Connector logging from INFO to DEBUG (or to TRACE for verbose logging):

```
shell> su - tungsten
shell> vi /opt/continuent/tungsten/tungsten-connector/conf/log4j.properties
# Enable debug for the connector only
logger.Connector.name=com.continuent.tungsten.connector
# WAS: logger.Connector.level=INFO
logger.Connector.level=DEBUG
logger.Connector.additivity=false
shell> connector reconfigure
```

To disable debug logging, edit the Connector configuration file `tungsten-connector/conf/log4j.properties` and revert the change from `DEBUG` to `INFO`.

C.2.3. Using tungsten_upgrade_manager

tungsten_upgrade_manager is used to correct a cctrl display bug in the Manager that causes the `useSSL` value shown via `cctrl> ls -l` to be false when it should be true after an upgrade from v6 to v7.

Warning

Only use the tungsten_upgrade_manager command when instructed to do so by Continuent Support!

C.3. Error/Cause/Solution

C.3.1. Lots of entries added to replicator log

Last Updated: 2015-06-01

Condition or Error

The logging level used by Tungsten Cluster creates a lot of entries, including `WARN`, this generates a lot of information that is difficult to find the real errors and problems. How do i change the logging level?

Causes

- By default, Tungsten Cluster reports a lot of information and detail, including `INFO` and other levels of detail that may generate a lot of information. For example:

```
INFO | jvm 1 | 2016/02/18 10:16:46 | 2016-02-18 15:16:46,789 [brm - remote-to-thl-0] WARN filter.ReplicateFilter »
Ignoring query : No schema found for this query from event 4020717251 (SET @current_db_user := NULL...)
INFO | jvm 1 | 2016/02/18 10:16:46 | 2016-02-18 15:16:46,789 [brm - remote-to-thl-0] WARN filter.ReplicateFilter »
Ignoring query : No schema found for this query from event 4020717257 (SET @disabled_trigger := NULL...)
INFO | jvm 1 | 2016/02/18 10:16:46 | 2016-02-18 15:16:46,789 [brm - remote-to-thl-0] WARN filter.ReplicateFilter »
Ignoring query : No schema found for this query from event 4020717257 (SET @cols := ''...)
INFO | jvm 1 | 2016/02/18 10:16:46 | 2016-02-18 15:16:46,789 [brm - remote-to-thl-0] WARN filter.ReplicateFilter »
Ignoring query : No schema found for this query from event 4020717257 (SET @current_user_fk := NULL...)
INFO | jvm 1 | 2016/02/18 10:16:46 | 2016-02-18 15:16:46,789 [brm - remote-to-thl-0] WARN filter.ReplicateFilter »
Ignoring query : No schema found for this query from event 4020717257 (SET @current_db_user := NULL...)
INFO | jvm 1 | 2016/02/18 10:16:46 | 2016-02-18 15:16:46,789 [brm - remote-to-thl-0] WARN filter.ReplicateFilter »
Ignoring query : No schema found for this query from event 4020717259 (SET @disabled_trigger := NULL...)
INFO | jvm 1 | 2016/02/18 10:16:46 | 2016-02-18 15:16:46,789 [brm - remote-to-thl-0] WARN filter.ReplicateFilter »
Ignoring query : No schema found for this query from event 4020717259 (SET @cols := ''...)
INFO | jvm 1 | 2016/02/18 10:16:46 | 2016-02-18 15:16:46,789 [brm - remote-to-thl-0] WARN filter.ReplicateFilter »
Ignoring query : No schema found for this query from event 4020717259 (SET @current_user_fk := NULL...)
INFO | jvm 1 | 2016/02/18 10:16:46 | 2016-02-18 15:16:46,789 [brm - remote-to-thl-0] WARN filter.ReplicateFilter »
Ignoring query : No schema found for this query from event 4020717259 (SET @current_db_user := NULL...)
```

Rectifications

- The logging level used to report status and other information, and that is written into the log, can be changed to reduce or lower the reporting level. To do this:

  1. Edit the `~tungsten_home/tungsten/tungsten-replicator/conf/log4j.properties`
  2. Find the following line:

     ```
     log4j.logger.com.continuent.tungsten.replicator.filter.ReplicateFilter=DEBUG, stdout
     ```

  This will change the logging level so that only entries at `DEBUG` and higher will be output.

C.3.2. Backup/Restore is not bringing my host back to normal

Last Updated: 2013-11-01

Condition or Error

A backup/restore was performed as requested, but the host is still not coming up.

Causes

- When you backup a node, the backup is stored on that physical server. The correct backup file from an active server should be used on the host being restored.

Rectifications

- You can use that backup to restore another server in two ways:
  - If the backup directory is shared between servers using NFS or a clustered file system, the commands will work like you tried.
  - You must copy the backup files between nodes. See Section 6.10.3, "Restoring from Another Replica" for instructions on that.

C.3.3. Services requires a reset

Last Updated: 2016-05-18

Condition or Error

The replicator service needs to be reset, for example if your MySQL service has been reconfigured, or when resetting a data warehouse or batch loading service after a significant change to the configuration.

Causes

- If the replicator stops replicating effectively, or the configuration and/or schema of a source or target in a datawarehouse loading solution has changed significantly. This will reset the service, starting extraction from the current point, and the target/Replica from the new Primary position. It will also reset all the positions for reading and writing.

Rectifications

- To reset a service entirely, without having to perform a re-installation, you should follow these steps. This will reset both the THL, source database binary log reading position and the target THL and starting point.

  1. Take the Replica offline:

     ```
     Replica-shell> trepctl offline
     ```

  2. Take the Primary offline:

     ```
     Replica-shell> trepctl offline
     ```

  3. Use trepctl to reset the service on the Primary and Replica. You must use the service name explicitly on the command-line:

     ```
     Primary-shell> trepctl -service alpha reset -y
     Replica-shell> trepctl -service alpha reset -y
     ```

  4. Put the Replica online:

     ```
     Replica-shell> trepctl offline
     ```

  5. Put the Primary online:

     ```
     Replica-shell> trepctl offline
     ```

C.3.4. Error: could not settle on encryption_client algorithm

Last Updated: 2015-06-01

Condition or Error

The following error is reported when trying to connect:

```
Error: could not settle on encryption_client algorithm
```

Causes

- Can be due to missing an acceptable cipher on any one of the hosts.

Rectifications

- This is a list of acceptable ciphers:

```
aes128-cbc
3des-cbc
blowfish-cbc
cast128-cbc
aes192-cbc
aes256-cbc
rijndael-cbc@lysator.liu.se
idea-cbc
none
arcfour128
arcfour256
```

These can be configured in `/etc/ssh/sshd_config` under Ciphers.

Try adding a supported cipher [`aes256-cbc`_ to the end of the ciphers in your ssh server config file. Note that SSH and OpenSSL ciphers are mapped, for example like the following:

```
// Maps the SSH name of a cipher to it's corresponding OpenSSL name
SSH_TO_OSSL = {
 "3des-cbc" => "des-ede3-cbc",
 "blowfish-cbc" => "bf-cbc",
 "aes256-cbc" => "aes-256-cbc",
 "aes192-cbc" => "aes-192-cbc",
 "aes128-cbc" => "aes-128-cbc",
 "idea-cbc" => "idea-cbc",
 "cast128-cbc" => "cast-cbc",
 "arcfour128" => "rc4",
 "arcfour256" => "rc4",
 "arcfour512" => "rc4",
 "none" => "none"
}
```

C.3.5. ERROR backup.BackupTask Backup operation failed: null

Last Updated: 2019-01-11

Condition or Error

A full Xtrabackup backup has failed, and left the datasource's replicator offline.

Causes

- A common cause of this failure is the existance of zero-length `store-*.properties` files in the `backups/{serviceName}/` directory.

Rectifications

- Simply remove any zero-byte `store-*.properties` files from the `backups/{serviceName}/` directory and retry the backup.

C.3.6. Unable to update the configuration of an installed directory

Last Updated: 2013-08-07

Condition or Error

Running an update or configuration with tpm returns the error 'Unable to update the configuration of an installed directory'

Causes

- Updates to the configuration of a running cluster must be performed from the staging directory where Tungsten Cluster was originally installed.

Rectifications

- Change to the staging directory and perform the necessary commands with tpm. To determine the staging directory, use:

```
shell> tpm query staging
```

Then change to the staging directory and perform the updates:

```
shell> ./tools/tpm configure ....
```

More Information

Chapter 2, *Deployment*

C.3.7. Cluster remains in MAINTENANCE mode after tpm update

Last Updated: 2021-10-14

Condition or Error

Afer issuing ./tools/tpm update --replace-release from a remote staging host, the cluster policy remains in `MAINTENANCE` mode.

Causes

- Known issue occuring from v6.1.5 onwards.

Rectifications

- Following the update, log into cctrl and check the cluster policy mode. If the cluster is still in `MAINTENANCE` and this is NOT expected, issue:

```
cctrl> set policy automatic
```

C.3.8. Missing events, or events not extracted correctly

Last Updated: 2016-04-20

Condition or Error

You have missing events, or events that have been correctly extraction from a Tungsten Cluster host.

Causes

- There are multiple potential causes for this issue, including, but not limited t

Rectifications

- **Note**

  Before proceeding, ensure you have access to the failed Primary server and the new Primary server, if one was promoted. Ensure that your environment is properly initialized. For more information, see Initializing shell environment for VMware Continuent (2105429).

The example operations below are for a service called `east`.

Note

To identify transactions that have not been extracted from a MySQL Primary running VMware Continuent replication:

1. Identify the last transaction replicated to the Replica servers.
   - If a new Primary has already been promoted or created:
     a. Run the following command:

     ```
     shell> trepctl -service east status
     ```

     Note the value of *`latestEpochNumber`*. Assume 5385 is the value of *`latestEpochNumber`*.

     b. Confirm this is the point where replication switched from the failed Primary to the new Primary.

     Now determine the THL and associated data from that THL sequence number using:

     ```
     shell> thl -service east list -headers -low 5385 -high 5385
     ```

     Now compare the last value on each line to ensure they are different. This value indicates the Primary host for the sequence number.

     If there are no differences, you need to refer to the trepsvc.log file of the new Primary to find the point where it became the Primary. Search for [binlog-to-q-0] Setting extractor position from the end of the log. This shows where the Primary started the

extraction process from a new sequence number. Run the above check for each sequence number until you find the point where extraction switched from one Primary to another.

- If no new Primary has been promoted but the Primary did fail:

  Run the following command to determine the current sequence number on the Replicas:

  ```
  shell> dsctl -service east get
  ```

  If these values are different between multiple Replicas, use the lowest reported sequence to reset the position. If the dsctl utility is not available, see the `trep_commit_seqno` table for information on the last replicated transaction for the Replica. The location of this table is different depending on your Replica DBMS.

  Assume 5384 is the value of seqno returned by the command.

2. Check the output of the following command on the Primary and Replicas:

   ```
   shell> thl -service east list -headers -seqno 5384
   ```

   The output should be used to confirm that each host reports the same information. If there are differences, it is indicative of larger problems and you should reprovision from a known good datasource.

3. Run the following command to read the events from the Primary:

   ```
   shell> tungsten_read_master_events --service=east --after=5384
   ```

   This will display the mysqlbinlog output for any transactions that were applied after the listed sequence number.

   Use this information to determine the next course of action for your application. You may can choose to ignore the transactions if they are not important or add them to the remaining servers manually and then repair replication.

More Information

Section 6.8.1, “Identifying a Transaction Mismatch”

C.3.9. Triggers not firing correctly on Replica

Last Updated: 2013-11-01

Condition or Error

Newly created triggers are not firing when executed

Causes

- If a new user (definer) was used to create the triggers, they may fail to be executed, raising the following warning in the logs:

  ```
  INFO | jvm 1 | 2013/10/16 04:21:33 | WARNING: Could not execute query »
   org.drizzle.jdbc.internal.common.query.DrizzleQuery@60dc4c81: The »
   MySQL server is running with the --read-only option so it cannot »
   execute this statement
  INFO | jvm 1 | 2013/10/16 04:21:33 | 2013-10-16 04:21:33,208 ERROR »
   replicator.pipeline.SingleThreadStageTask [q-to-dbms] Event »
   application failed: seqno=524545571 fragno=0 message=java.sql.SQLException: »
   Statement failed on slave but succeeded on master
  INFO | jvm 1 | 2013/10/16 04:21:33 | com.continuent.tungsten.replicator.applier.ApplierException: »
   java.sql.SQLException: Statement failed on slave but succeeded on master
  ```

  This is an indication that the new definer does not have the required `SUPER` privilege and that a trigger is failing to run.

Rectifications

- In order to fix this issue, the new definer should be given the SUPER privilege on each server and then replication should be restarted. The `SUPER` privilege allows the user to run a statement on a Replica server where the read_only flag has been turned on. If necessary, the scope of the privilege can be restricted to an individual schema. The `GRANT` statement should be done on every database server, while the shun and recover should only be done on the Replicas.

  ```
  mysql> grant SUPER on *.* to user;
  mysql> flush privileges;
  ```

  Within cctrl:

  ```
  cctrl> datasource hostname shun;
  cctrl> datasource hostname recover;
  ```

You should continue to review the `tungsten-replicator/log/trepsvc.log` file to see what log messages are being written there. It appears that replication is still failing and it is probably related to the same issue. If you want us to review logs to interpret the results for you, you can upload the log file here and someone will look at it.

More Information

Section C.4.1, "Triggers"

C.3.10. Replicator reports an Out of Memory error

Last Updated: 2013-11-01

Condition or Error

Replicator reports an Out of Memory error

Causes

- The configured memory sizes within the replicator are too small for the data being replicated and applied.

Rectifications

- Raise the *`repl-java-mem-size`* parameter, for example to 3072 (specified in megabytes) within `tungsten.ini` and issue tpm update.

More Information

Section F.4, "Memory Tuning and Performance"

C.3.11. [S1000][unixODBC][MySQL][ODBC 5.3(w) Driver]SSL connection error: unknown error number [ISQL]ERROR: Could not SQLConnect

Last Updated: 2015-06-01

Condition or Error

We have a new server dedicated to Zabbix monitoring. Zabbix uses an ODBC connection for MySQL. When we try to connect to a Tungsten connector from the new server using ODBC we receive an error:

```
[S1000][unixODBC][MySQL][ODBC 5.3(w) Driver]SSL connection error: unknown error number
[ISQL]ERROR: Could not SQLConnect
```

Causes

- The underlying cause is related to an SSL or encryption error, either the certificate is wrong, or the ciphers being used are not supported.

  Examine the `connector.log` on the Tungsten server we are connecting to returns an error with each attempt:

  ```
  INFO | jvm 1 | 2016/05/20 13:07:17 | WARN [MySQLProtocolHandler] - [172.16.0.120:43571] Error during transfer of authentication packet: no cipher suites
  ```

  Connecting from to the new server using the mysql client may work:

  ```
  [root@zabbix etc]# mysql -uzabbix -pZ@bbix487sql -hnas-db-ct01-a.safemls.net
  Welcome to the MariaDB monitor. Commands end with ; or \g.
  Your MySQL connection id is 40019
  Server version: 5.6.20-68.0-log-tungsten Percona Server (GPL), Release 68.0, Revision 656
  ```

  Connecting directly MySQL database on port 13306 using the ODBC connection may also work:

  ```
  [root@zabbix etc]# isql -v ct01
  +---------------------------------------+
  | Connected! |
  | |
  | sql-statement |
  | help [tablename] |
  | quit |
  | |
  +---------------------------------------+
  ```

Rectifications

- zabbix is trying to connect to the connector with SSL encryption, but the SSL is not operating. The easiest way to bypass this is disable SSL connections for ODBC. Add the following entry in `odbc.ini` (under the section for the host you're testing):

```
useSSL = No
```

C.3.12. Latency is high: master:ONLINE, progress=41331580333, THL latency=78849.733

Last Updated: 2015-06-01

Condition or Error

Latency is high: master:ONLINE, progress=41331580333, THL latency=78849.733

Causes

- There are many possible causes for this error, however, if you see the following within the log on the Primary it may indicate a specific issue:

```
INFO | jvm 1 | 2016/02/09 15:01:54 | at com.continuent.tungsten.replicator.thl.CommitSeqnoTable.updateLastCommitSeqno(CommitSeqnoTable.java:548)
INFO | jvm 1 | 2016/02/09 15:01:54 | at com.continuent.tungsten.replicator.thl.CatalogManager.updateCommitSeqnoTable(CatalogManager.java:223)
INFO | jvm 1 | 2016/02/09 15:01:54 | at com.continuent.tungsten.replicator.thl.THL.updateCommitSeqno(THL.java:593)
INFO | jvm 1 | 2016/02/09 15:01:54 | at com.continuent.tungsten.replicator.thl.THLStoreApplier.apply(THLStoreApplier.java:163)
INFO | jvm 1 | 2016/02/09 15:01:54 | at com.continuent.tungsten.replicator.pipeline.SingleThreadStageTask.apply(SingleThreadStageTask.java:768)
INFO | jvm 1 | 2016/02/09 15:01:54 | at com.continuent.tungsten.replicator.pipeline.SingleThreadStageTask.runTask(SingleThreadStageTask.java:501)
INFO | jvm 1 | 2016/02/09 15:01:54 | at com.continuent.tungsten.replicator.pipeline.SingleThreadStageTask.run(SingleThreadStageTask.java:176)
INFO | jvm 1 | 2016/02/09 15:01:54 | at java.lang.Thread.run(Thread.java:745)
INFO | jvm 1 | 2016/02/09 15:01:54 |
```

  The stack trace shows that the replicator is updating the trep_commit_seqno table which is normally a very fast operation.

  The underlying reason may either be:

  - It is possible that updates to MySQL are somehow getting delayed, which would slow down the operation of the replicator as it updates each status update.
  - Check the block commit size, as low values will increase the number of updates to the table, and if the MySQL server updates are slow, this in turn slows down the operation of the replicator.

Rectifications

- Focus on making sure the IO system and MySQL commits are not being blocked.

  You can try increasing `replicator.stage.q-to-thl.blockCommitRowCount` so the replicator has less commits to MySQL on the Primary.

  You can continue to track progress through trepctl status -name tasks as you may see the `appliedLastSeqno` value updating less often if you increase this by a lot. Beware that increasing this value too much increases possible data loss since it creates less sync points with the Replicas.

C.3.13. Connector shows errors with "java.net.SocketException: Broken pipe"

Last Updated: 2013-11-01

Condition or Error

When using DirectReads, the connector reports errors with a broken pipe.

Causes

- The most likely culprit for this error is that the `wait_timeout` and/or `interactive_timeout` is too low. This causes a problem because pooled connections get timeouts and are closed by the MySQL server.

Rectifications

- Change the configuration for your MySQL server (in `my.cnf`) to increase these timeouts.

C.3.14. The Primary replicator stopped with a JDBC error.

Last Updated: 2015-06-01

Condition or Error

The Primary replicator stopped with a JDBC error.

Causes

- The error log may show a more detailed failure with the JDBC error message:

```
INFO | jvm 1 | 2016/02/08 17:16:24 | 2016-02-08 17:16:24,627 [qktdb - pool-2-thread-1] ERROR management.tungsten.TungstenPlugin Unable to start replicat
INFO | jvm 1 | 2016/02/08 17:16:24 | java.lang.NumberFormatException: For input string: "0000002417562130"
INFO | jvm 1 | 2016/02/08 17:16:24 | at java.lang.NumberFormatException.forInputString(NumberFormatException.java:65)
INFO | jvm 1 | 2016/02/08 17:16:24 | at java.lang.Integer.parseInt(Integer.java:495)
INFO | jvm 1 | 2016/02/08 17:16:24 | at java.lang.Integer.valueOf(Integer.java:582)
INFO | jvm 1 | 2016/02/08 17:16:24 | at com.continuent.tungsten.replicator.extractor.mysql.MySQLExtractor.setLastEventId(MySQLExtractor.java:1139)
INFO | jvm 1 | 2016/02/08 17:16:24 | at com.continuent.tungsten.replicator.extractor.ExtractorWrapper.setLastEventId(ExtractorWrapper.java:243)
INFO | jvm 1 | 2016/02/08 17:16:24 | at com.continuent.tungsten.replicator.extractor.ExtractorWrapper.setLastEvent(ExtractorWrapper.java:219)
INFO | jvm 1 | 2016/02/08 17:16:24 | at com.continuent.tungsten.replicator.pipeline.StageTaskGroup.prepare(StageTaskGroup.java:210)
INFO | jvm 1 | 2016/02/08 17:16:24 | at com.continuent.tungsten.replicator.pipeline.Stage.prepare(Stage.java:272)
INFO | jvm 1 | 2016/02/08 17:16:24 | at com.continuent.tungsten.replicator.pipeline.Pipeline.prepare(Pipeline.java:274)
INFO | jvm 1 | 2016/02/08 17:16:24 | at com.continuent.tungsten.replicator.conf.ReplicatorRuntime.prepare(ReplicatorRuntime.java:642)
INFO | jvm 1 | 2016/02/08 17:16:24 | at com.continuent.tungsten.replicator.management.tungsten.TungstenPlugin.online(TungstenPlugin.java:391)
INFO | jvm 1 | 2016/02/08 17:16:24 | at com.continuent.tungsten.replicator.management.OpenReplicatorManager$OfflineToSynchronizingAction.doAction(OpenRe
INFO | jvm 1 | 2016/02/08 17:16:24 | at com.continuent.tungsten.fsm.core.StateMachine.applyEvent(StateMachine.java:220)
INFO | jvm 1 | 2016/02/08 17:16:24 | at com.continuent.tungsten.fsm.event.EventProcessor.run(EventProcessor.java:78)
INFO | jvm 1 | 2016/02/08 17:16:24 | at java.util.concurrent.Executors$RunnableAdapter.call(Executors.java:471)
INFO | jvm 1 | 2016/02/08 17:16:24 | at java.util.concurrent.FutureTask.run(FutureTask.java:262)
INFO | jvm 1 | 2016/02/08 17:16:24 | at java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolExecutor.java:1145)
INFO | jvm 1 | 2016/02/08 17:16:24 | at java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPoolExecutor.java:615)
INFO | jvm 1 | 2016/02/08 17:16:24 | at java.lang.Thread.run(Thread.java:745)
```

  The underlying reason for the error is that MySQL has created a binlog over 2GB and the replicator could not process the event due to the limit of a Java integer.

Rectifications

- The solution for this error, if the log is a rotate event (use mysqlbinlog) is to reposition the replicator using tungsten_set_position.

C.3.15. cctrl reports MANAGER(state=STOPPED)

Last Updated: 2013-11-01

Condition or Error

cctrl reports the status for the manager as `MANAGER(state=STOPPED)`

Causes

- The manager has stopped running, possibly due to a fault or error state.

Rectifications

- Restart the manager process on this server is not running. You can start it by running:

```
shell> manager start
```

  Or:

```
shell> /opt/continuent/tungsten/tungsten-manager/bin/manager start
```

More Information

Section 4.2.3, “Restarting the Manager Service”

C.3.16. trepctl status hangs

Last Updated: 2013-11-01

Condition or Error

The trepctl status command hangs at the end of the output after a "cannot fork" error.

Causes

- This can be caused by THL corruption on the Replica.

  This can be also be caused by an Out-Of-Memory condition in either the replicator or in the OS itself.

Rectifications

- You can recreate the THL files on the Replica[s] ONLY. This can be achieved by deleting the existing THL files, which will cause the Replica replicator to download all of the THL data from the Primary again:

```
shell> replicator stop
shell> cd /opt/continuent
shell> mv thl thl.old;
shell> mkdir thl
shell> replicator start
shell> trepctl status
```

To increase the Replicator memory, add or edit the following tpm configuration option, then run tpm update:

```
repl-java-mem-size=2048
```

C.3.17. Attempt to write new log record with equal or lower fragno: seqno=3 previous stored fragno=32767 attempted new fragno=-32768

Last Updated: 2016-05-18

Condition or Error

The number of fragments in a single transaction has been exceeded.

Causes

- The maximum number of fragments within a single transaction within the network protocol is limited to 32768. If there is a very large transaction that exceeds this number of fragments, the replicator can stop and be unable to continue. The total transaction size is a combination of the fragment size (default is 1,000,000 bytes, or 1MB), and this maximum number (approximately 32GB).

Rectifications

- It is not possible to change the number of fragments in a single transaction, but the size of each fragment can be increased to handle much larger single transactions. To change the fragment size, configure the *replicator.extractor.dbms.transaction_frag_size* parameter. For example, by doubling the size, a transaction of 64GB could be handled:

  ```
  replicator.extractor.dbms.transaction_frag_size=2000000
  ```

  If you change the fragment size in this way, the service on the extractor must be reset so that the transaction can be reprocessed and the binary log is parsed again. You can reset the service by using the trepctl reset command.

C.3.18. Replicator runs out of memory

Last Updated: 2016-05-18

Condition or Error

The replicator runs out of memory, triggers a stack trace indicator a memory condition, or the replicator fails to extract the transaction information from the MySQL binary log.

Causes

- The replicator operates by extracting (or applying) an entire transaction. This means that when extracting data from the binary log, and writing that to THL, or extracting from the THL in preparation for applying to the target, the entire transaction, or an entire statement within a multi-statement transaction, must be held in memory.

  In the event of a very large transaction having to be extracted, this can cause a problem with the memory configuration. The actual configuration of how much memory is used is determined through a combination of the number of fragments, the size of the internal buffer used to store those fragments, and the overall fragment size.

Rectifications

- Although you can increase the overall memory allocated to the replicator, changing the internal sizes used can also improve the performance and ability to extract data.

  First, try reducing the size of the buffer (*replicator.global.buffer.size*) used to hold the transaction fragments. The default for this value is 10, but reducing this to 5 or less will ease the required memory:

  ```
  replicator.global.buffer.size=10
  ```

  Altering the size of each fragment can also help, as it reduces the memory required to hold the data before it is written to disk and sent out over the network to Replica replicators. Reducing the fragment size will reduce the memory footprint. The size is controlled by the *replicator.extractor.dbms.transaction_frag_size* parameter:

  ```
  replicator.extractor.dbms.transaction_frag_size=1000000
  ```

Note that if you change the fragment size, you may need to reset the service on the extractor so that the binary log is parsed again. You can reset the service by using the trepctl reset command.

C.3.19. ERROR 1010 (HY000) at line 5094506: Error dropping database (can't rmdir './mysql-bin/', errno: 17)

Last Updated: 2013-11-01

Condition or Error

Loading a mysqldump into a MySQL server from a backup/restore fails.

Causes

- The problem may be that your MySQL binary logs are in a subdirectory of your MySQL `data` directory, causing MySQL to view them as a schema.

Rectifications

- Possible steps to resolution:

  1. Modify the dump file so it isn't trying to drop a schema named after the bin log directory
  2. Update the mysql configuration so the bin logs aren't in a directory in the data dir. mysql sees all directories in the data dir as a schema

C.3.20. ERROR >> host1 >> can't alloc thread

Last Updated: 2019-03-04

Condition or Error

tpm installation fails with this error

Causes

- Most common occurenece of this error is often attributed to OS permissions.

Rectifications

- - Review Section B.2.3, “Directory Locations and Configuration”
  - Ensure all installation paths are owned by the correct OS user
  - Ensure OS user configured with correct sudo rights

C.3.21. ERROR 1580 (HY000) at line 5093787: You cannot 'DROP' a log table if logging is enabled

Last Updated: 2013-11-01

Condition or Error

Loading a mysqldump into a MySQL server from a backup/restore fails.

Causes

- This appears to be a bug in MySQL that causes mysqldump loads to fail.

Rectifications

- You should be able to import the dump by switching off the slow query log globally before running the import:

```
mysql> SET GLOBAL slow_query_log=0
```

C.3.22. WARNING: An illegal reflective access operation has occurred

Last Updated: 2020-01-21

Condition or Error

The following Warning may be seen in the Manager Logs when running v6.1.2 and above in conjunction with Java 9 and above

```
WARNING: An illegal reflective access operation has occurred
WARNING: Illegal reflective access by org.drools.core.rule.builder.dialect.asm.ClassGenerator
(file:/opt/continuent/releases/tungsten-clustering-6.1.2-75_pid16553/tungsten-manager/lib/drools-core-6.3.0.Final.jar)
to method java.lang.ClassLoader.defineClass(java.lang.String,byte[],int,int)
WARNING: Please consider reporting this to the maintainers of org.drools.core.rule.builder.dialect.asm.ClassGenerator
WARNING: Use --illegal-access=warn to enable warnings of further illegal reflective access operations
WARNING: All illegal access operations will be denied in a future release
```

Causes

- This is a known issue due to new encapsulation controls in Java 9+

Rectifications

- This warning does not affect operations of the Cluster and can be safely ignored

C.3.23. ERROR 2013 (HY000) at line 583: Lost connection to MySQL server during query

Last Updated: 2013-11-01

Condition or Error

Client was disconnected during a query with the error number.

Causes

- Usually this means that the MySQL server has closed the connection or the server has restarted. The exact cause will be more difficult to determine.

Rectifications

- We need a bit more information to provide assistance.

  1. Were you connected through the Tungsten Connector?
  2. Did anything else happen on the servers?
  3. If you were connected through the Tungsten Connector, please upload the tungsten-connector/log/connector.log file from the server you were connected to.

C.3.24. pendingExceptionMessage": "Unable to update last commit seqno: Incorrect datetime value: '2016-03-13 02:02:26' for column 'update_timestamp' at row 1

Last Updated: 2015-06-01

Condition or Error

The following error is reported when applying an event:

```
pendingExceptionMessage": "Unable to update last commit seqno: Incorrect datetime value: '2016-03-13 02:02:26' for column 'update_timestamp' at row 1
```

Causes

- The underlying reason for this error is the format and value of the datetime value that is being represented are either incompatible with the current SQL mode within MySQL, or the datetime combination is one that occurs during a DST switch, which may be incompatible with the SQL mode.

Rectifications

- The solution is to update the SQL mode so that explicit changes are ignored when applying the data, rather than using the information defined during the session. To update the settings. Because the problem will be short lived and specific to the data being applied it can be done temporarily:

  - Edit file `/opt/continuent/tungsten/tungsten-replicator/conf/static-endtest.properties`
  - Find this line:

```
replicator.applier.dbms.ignoreSessionVars=autocommit
```

- Change the line to:

```
replicator.applier.dbms.ignoreSessionVars=autocommit|sql_mode
```

- Restart the replicator using:

```
shell> replicator restart
```

- Wait for the replicator to come online, and process the change that originally caused the problem. Once the data has been replicated, revert the settings in the file back to the old value and restart the replicator again.

C.3.25. Too many open processes or files

Last Updated: 2013-10-09

Condition or Error

The operating system or environment reports that the `tungsten` or designated Tungsten Cluster user has too many open files, processes, or both.

Causes

- User limits for processes or files have either been exhausted, or recommended limits for user configuration have not been set.

Rectifications

- Check the output of ulimit and check the configure file and process limits:

```
shell> ulimit -a
core file size (blocks, -c) 0
data seg size (kbytes, -d) unlimited
file size (blocks, -f) unlimited
max locked memory (kbytes, -l) unlimited
max memory size (kbytes, -m) unlimited
open files (-n) 256
pipe size (512 bytes, -p) 1
stack size (kbytes, -s) 8192
cpu time (seconds, -t) unlimited
max user processes (-u) 709
virtual memory (kbytes, -v) unlimited
```

  If the figures reported are less than the recommended settings, see Section B.2.1, “Creating the User Environment” for guidance on how these values should be changed.

More Information

Section B.2.1, “Creating the User Environment”

C.3.26. Replication latency very high

Last Updated: 2013-11-01

Condition or Error

The latency of updates on the Replicas is very high

Causes

- First the reason and location of the delay should be identified. It is possible for replication data to have been replicated quickly, but applying the data changes is taking a long time. Using row-based replication may increase the latency due to the increased quantity of data that must be transferred.

Rectifications

- Check the replication format:

```
shell> grep binlog_format /etc/my.cnf
binlog_format=ROW
```

  Slow Replicas can be the cause, but it may require some configuration changes.

C.3.27. Backup agent name not found: xtrabackup-full

Last Updated: 2015-06-01

Condition or Error

A backup was taken with xtrabackup-full from the Primary. Replica appears to not be configured for xtrabackup-full, which results in there being issues with the restore. How can we configure the Replica to use xtrabackup-full for restore?

Causes

- The underlying cause and indication is that the xtrabackup has not been installed properly on the Replica, or not installed at all, at the point when Tungsten Cluster was being installed. The following will be seen in the status output after a failed restore:

```
minimumStoredSeqNo : -1
offlineRequests : NONE
pendingError : Unable to spawn restore request
pendingErrorCode : NONE
pendingErrorEventId : NONE
pendingErrorSeqno : -1
pendingExceptionMessage: Backup agent name not found: xtrabackup-full
```

  Probably the other hosts didn't require this setting specifically because xtrabackup was installed and detected when Tungsten Cluster was installed on them.

Rectifications

- The steps you need are:

  1. Install xtrabackup if not already installed on the Replica in question
  2. If using the INI configuration method, add the line below to `/etc/tungsten/tungsten.ini`:

     ```
     backup-method=xtrabackup-full
     ```

     And then run tpm update on that Replica host to update the configuration.

     Or if using staging method, update the configuration using:

     ```
     shell> tpm update --backup-method=xtrabackup-full
     ```

C.3.28. WARN [KeepAliveTimerTask] - Error while sending a KEEP_ALIVE query to connection.

Last Updated: 2017-02-15

Condition or Error

Connections to MySQL through the connector report KeepAliveTimerTask errors in the `connector.log` file

Causes

- Possible causes include local scripts that kill stale connections after some fixed period of time, or the wait_timeout was changed without restarting the connector, or a bug that was fixed in v4.0.3

Rectifications

- Upgrade to the latest version if you are running a version below 4.0.3

  Check for local scripts that are killing connections

  Restart the Connector

```
shell> connector restart
```

C.3.29. Event application failed: seqno=20725782 fragno=0 message=java.sql.SQLDataException: Data too long for column 'eventid' at row 1

Last Updated: 2013-11-01

Condition or Error

Event application failed: seqno=20725782 fragno=0 message=java.sql.SQLDataException: Data too long for column 'eventid' at row 1

Causes

- The issue is that the eventid column in tungsten.heartbeat is shorter than tungsten.eventid. You could do an alter on the Primary to extend that column and let that replicate out. The column sizes match in the next version.

Rectifications

- The tables must be updated:

```
mysql> ALTER TABLE `heartbeat` CHANGE `eventid` `eventid` VARCHAR( 128 ) \
 CHARACTER SET utf8 COLLATE utf8_general_ci NULL DEFAULT NULL;
```

This will update the tables from the following structure:

```
mysql> SHOW CREATE TABLE tungsten.heartbeat;
heartbeat | CREATE TABLE `heartbeat` (
 `id` bigint(20) NOT NULL DEFAULT '0',
 `seqno` bigint(20) DEFAULT NULL,
 `eventid` varchar(32) DEFAULT NULL,
 `source_tstamp` timestamp NULL DEFAULT NULL,
 `target_tstamp` timestamp NULL DEFAULT NULL,
 `lag_millis` bigint(20) DEFAULT NULL,
 `salt` bigint(20) DEFAULT NULL,
 `name` varchar(128) DEFAULT NULL,
 PRIMARY KEY (`id`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8

mysql> SHOW CREATE TABLE tungsten.trep_commit_seqno;
trep_commit_seqno | CREATE TABLE `trep_commit_seqno` (
 `seqno` bigint(20) DEFAULT NULL,
 `fragno` smallint(6) DEFAULT NULL,
 `last_frag` char(1) DEFAULT NULL,
 `source_id` varchar(128) DEFAULT NULL,
 `epoch_number` bigint(20) DEFAULT NULL,
 `eventid` varchar(128) DEFAULT NULL,
 `applied_latency` int(11) DEFAULT NULL,
 `update_timestamp` timestamp NULL DEFAULT NULL
) ENGINE=InnoDB DEFAULT CHARSET=utf8
```

Afterwards the table will be formatted:

```
heartbeat | CREATE TABLE `heartbeat` (
 `id` bigint(20) NOT NULL DEFAULT '0',
 `seqno` bigint(20) DEFAULT NULL,
 `eventid` varchar(128) DEFAULT NULL,
 `source_tstamp` timestamp NULL DEFAULT NULL,
 `target_tstamp` timestamp NULL DEFAULT NULL,
 `lag_millis` bigint(20) DEFAULT NULL,
 `salt` bigint(20) DEFAULT NULL,
 `name` varchar(128) DEFAULT NULL,
 PRIMARY KEY (`id`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8
```

C.3.30. MySQL 8.0+, User Roles and Smartscale

Last Updated: 2021-11-29

Condition or Error

When configuring a connector to use SmartScale, you receive an error indicating users do not ave the required repl_client privilege despite the privilege being granted via a Role [New in MySQL 8.0]

Causes

- Known issue occuring in all versions that support MySQL 8.0. This is due to tpm not aware of Roles, and therefore unable to determine that privileges have been grated in this way.

Rectifications

- Providing you are certain the correct privileges have been granted, you can simply instruct tpm to ignore this particulare validate check by adding the following option to your configuration:

```
skip-validation-check=MySQLConnectorPermissionsCheck
```

C.3.31. element 'mysql_readonly' not found in path

Last Updated: 2015-06-01

Condition or Error

We are getting the following INFO message in the `tmsvc.log` every few seconds (host1 is the Primary), logs attached:

```
INFO | jvm 1 | 2016/03/04 15:09:38 | |host1 |
INFO | jvm 1 | 2016/03/04 15:09:38 | +-------------------------------------------------------------------------+
INFO | jvm 1 | 2016/03/04 15:09:38 | |element 'mysql_readonly' not found in path |
INFO | jvm 1 | 2016/03/04 15:09:38 | |'/podsjqe/sjqedb1/conf/service/' while searching for entry |
INFO | jvm 1 | 2016/03/04 15:09:38 | |'podsjqe/sjqedb1/conf/service/mysql_readonly' |
INFO | jvm 1 | 2016/03/04 15:09:38 | +-------------------------------------------------------------------------+
```

Causes

- This is caused by the manager

Rectifications

- To prevent INFO messages being reported in the `/opt/continuent/tungsten/tungsten-manager/log/tmsvc.log` file:

  1. Put the cluster into *`MAINTENANCE`* mode
  2. Stop all managers
  3. Start all managers starting with the Primary
  4. Put the cluster into *`AUTOMATIC`* mode

C.3.32. cctrl hangs

Last Updated: 2013-11-01

Condition or Error

cctrl hangs

Causes

- Within Tungsten Cluster 1.5.3 there is a known issue related to how the managers handle failed network connections. It's an indication that there was a network issue at some point.

Rectifications

- The temporary workaround is to put the cluster into maintenance mode, stop all managers, wait 10 seconds, then start them backup again.

More Information

Section 4.2.3, “Restarting the Manager Service”

C.3.33. Replicator fails to connect after updating password

Last Updated: 2013-11-01

Condition or Error

Tungsten Replicator fails to connect after changing the `tungsten` user password.

Causes

- The most likely cause is that the configuration within `~/.my.cnf` was forcing a connection to the cluster as `tungsten` user, and user change may have only been made on one host and not replicated to the other MySQL servers.

Rectifications

- First, update the credentials in `~/.my.cnf` and ensure you can connect to all the Replicas with the updated credentials.

  Also check that tpm has been configured with the right password and that all servers have the right information. Errors such as:

  ```
  ERROR>>host1>>Unable to connect to the MySQL server using »
   tungsten@host1:3306 (WITH PASSWORD) (MySQLLoginCheck)
  ```

Indicate that the password may not have been replicated properly. Check the following:

1. Check the user configuration information within each MySQL server and compare the values:

```
mysql> select * from mysql.user where user='tungsten';
```

2. For any node that is not up to date, update the password manually:

```
shell> mysql -u root -ppassword -P 3306 -h host1
mysql> UPDATE `mysql`.`user` SET Password=PASSWORD('secret') WHERE User='tungsten';
mysql> flush privileges;
```

3. Update the tpm and Tungsten Cluster configuration:

```
shell> ./tools/tpm update alpha --datasource-password=secret
```

4. Restart the replicators:

```
shell> replicator restart
```

Then put the replicators offline/online to refresh the configuration:

```
[LOGICAL] /alpha > datasource host1 offline
DataSource 'host1@alpha' is now OFFLINE
[LOGICAL] /alpha > datasource host1 online
Setting server for data source 'host1' to READ-ONLY
```

C.3.34. There were issues configuring the sandbox MySQL server

Last Updated: 2016-04-20

Condition or Error

- The command tungsten_provision_thl fails when using Percona Server.
- When running the command tungsten_provision_thl, you see the error:

```
There were issues configure the sandbox MySQL server
```

- MySQL Sandbox fails when using Percona Server.
- In the `$CONTINUENT_ROOT/service_logs/provision_thl.log` file, you see entries similar to:

```
mysqld: error while loading shared libraries: libssl.so.6: cannot open shared object file: No such file or directory
```

- In the `$CONTINUENT_ROOT/provision_thl.log` file, you see entries similar to:

```
mysql_install_db Error in my_thread_global_end(): 1 threads didn't exit
```

Causes

- This issue occurs because of a problem in Percona Server tarball distributions.

  There are two issues with Percona Server tarball distributions, which depends on the version you have downloaded.

  Look in the log file $CONTINUENT_ROOT/service_logs/provision_thl.log for:

  - `mysqld: error while loading shared libraries: libssl.so.6`
  - `mysql_install_db Error in my_thread_global_end()`

Rectifications

- To resolve this issue in Centos, install openssl by running the command:

```
shell> sudo yum install openssl098e
```

Alternatively, use Oracle MySQL or MariaDB which do not experience these issues.

> **Note**
>
> VMware does not endorse or recommend any particular third party utility.

More Information

Section 9.39, “The tungsten_provision_thl Command”

C.3.35. Starting replication after performing a restore because of an invalid restart sequence number

Last Updated: 2013-11-01

Condition or Error

Starting replication fails because of an invalid restart sequence number. Checking the sequence number, `trep_commit_seqno` shows an empty or invalid table contents:

```
mysql> select * from tungsten.trep_commit_seqno;
+-------+--------+-----------+-----------+--------------+---------+-----------------+---------------------+
| seqno | fragno | last_frag | source_id | epoch_number | eventid | applied_latency | update_timestamp |
+-------+--------+-----------+-----------+--------------+---------+-----------------+---------------------+
| -1 | NUL L | NULL | NULL | NULL | NULL | -1 | 2013-10-27 23:44:05 |
+-------+--------+-----------+-----------+--------------+---------+-----------------+---------------------+
1 row in set (0.00 sec)
```

Causes

- The restore may have failed to correctly restore the `tungsten` tables.

Rectifications

- Retry the restore process, making sure the replicator is stopped and there are no updates to the table taking place:

  1. Ensure no replicator processes are running:

     ```
     shell> replicator stop
     ```

     Ensure the `/opt/continuent/thl` directory is empty:

     ```
     shell> tpm reset-thl
     ```

  2. Restore the backup using whatever backup/restore tool you used.
  3. Check that `trep_commit_seqno` has a valid restart position in it
  4. ```
     shell> replicator start
     ```

C.3.36. MySQL is incorrectly configured

Last Updated: 2013-11-01

Condition or Error

The configuration of MySQL was wrong; it included `autocommit=0` and the wrong `server-id`

Causes

- Pre-requisites were not followed correctly.

Rectifications

- Edit `my.cnf` and clean up. Restart MySQL if possible. Alternatively, set manually:

```
mysql> set GLOBAL autocommit=1;
Query OK, 0 rows affected (0.00 sec)

mysql> set GLOBAL server_id=2;
Query OK, 0 rows affected (0.01 sec)
```

C.4. Known Issues

C.4.1. Triggers

Tungsten Replicator does not automatically shut off triggers on Replicas. This can create problems on Replicas as the trigger will run twice. Typical symptoms are duplicate key errors, though other problems may appear.
```

There is no simple one-answer-fits-all solution as the behaviour of MySQL and Triggers will differ based on various conditions.

- When using `ROW` Based Binary Logging, MySQL will log all data changes in the binary log, including any data changes performed as a result of a trigger firing
- When using `MIXED` Based Binary Logging...
  - if the Trigger is deemed to be non-deterministic then MySQL will behave based on the `ROW` Based Logging rules and log all data changes, including any data changes performed as a result of a trigger firing.
  - if the Tigger is deemed to be deterministic, then MySQL will behave based on `STATEMENT` Based Logging rules and ONLY log the statement issued by the client and NOT log any changes as a result of the trigger firing

The mixed behaviour outlined above presents challenges for Tungsten Replicator because MySQL does not flag transactions as being the result of a trigger firing or a client application. Therefore, it is not possible for the replicator to make a decision either.

This means, that if you are running with `MIXED` Based Binary Logging enabled, then there may be times when you would want the triggers on the target to fire, and times when you don't. Therefore the recommendations are as follows:

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- Switch to `ROW` Based Binary Logging, and either
  - Implement the `is_Primary()` function outlined below, or
  - Use the `replicate.ignore` filter to ignore data changes to tables altered by Triggers (ONLY suitable if the filtered tables are solely managed by the Trigger)

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- If source instance is running in `ROW` Based Binary Logging mode
  - Drop triggers on target. This is practical in fan-in topologies for reporting or other cases where you do not need to failover to the Replica at a later time. Optionally also implement the `dropddl.js` JavaScript filter (Available in Tungsten Replicator v6.1.2 onwards) to prevent CREATE/DROP TRIGGER DDL being replicated, or
  - Implement the `is_Primary()` function outlined below, or
  - Use the `replicate.ignore` filter to ignore data changes to tables altered by Triggers (ONLY suitable if the filtered tables are solely managed by the Trigger)
- If source instance is running in `MIXED` Based Binary Logging mode
  - Use the `replicate.ignore` filter to ignore data changes to tables altered by Triggers (ONLY suitable if the filtered tables are solely managed by the Trigger), or
  - Switch to `ROW` Based Binary Logging and follow recommendations above

The `is_Primary()` approach is simple to implement. First, create a function like the following that returns false if we are using the Tungsten user, as would be the case on a Replica.

```
create function is_Primary()
    returns boolean
    deterministic
    return if(substring_index(user(),'@',1) != 'tungsten',true, false);
```

Next add this to triggers that should not run on the Replica, as shown in the next example. This suppresses trigger action to insert into table bar except on the Primary.

```
delimiter //
create trigger foo_insert after insert on foo
  for each row begin
    if is_Primary() then
      insert into bar set id=NEW.id;
    end if;
  end;
//
```

As long as applications do not use the Tungsten account on the Primary, the preceding approach will be sufficient to suppress trigger operation.

Alternatively, if you are implementing the `is_Primary()` within a clustering deployment, you could check the database read_only parameter. In a clustered deployment, the Replica databases will be in read_only mode and therefore the trigger could be coded to only fire when the database read_only mode is OFF

C.5. Troubleshooting Timeouts

C.6. Troubleshooting Backups

- Operating system command failed

  Backup directory does not exist.

```
...
INFO | jvm 1 | 2013/05/21 09:36:47 | Process timed out: false
INFO | jvm 1 | 2013/05/21 09:36:47 | Process exception null
INFO | jvm 1 | 2013/05/21 09:36:47 | Process stderr: Error: »
    The directory '/opt/continuent/backups/xtrabackup' is not writeable
...
```

- Backup Retention

  The number of backups retained is set in the backup retention field. To set it at installation time, use the `--backup-retention=N` option where N is the number of backups to retain.

  You can check the number of currently retained backups by looking at the replicator.properties file and searching for the following property:

```
replicator.storage.agent.fs.retention=3
```

  The default is 3 backups retained at any given time.

C.7. Running Out of Diskspace

```
...
pendingError           : Event application failed: seqno=156847 »
    fragno=0 message=Unable to store event: seqno=156847
pendingErrorCode       : NONE
pendingErrorEventId    : mysql-bin.000025:0000000024735754;0
pendingErrorSeqno      : 156847
pendingExceptionMessage: Unable to store event: seqno=156847
...
```

The above indicates that the THL information could not be stored on disk. To recover from this error, make space available on the disk, or move the THL files to a different device with more space, then set the replicator service online again.

For more information on moving THL files to a different disk, see Section D.1.5.3, “Moving the THL File Location”; for information on moving the backup file location, see Section D.1.1.4, “Relocating Backup Storage”.

C.8. Troubleshooting SSH and tpm

When executing tpm, ssh is used to connect and install the software on other hosts in the cluster. If this fails, and the public key information is correct, there are a number of operations and settings that can be checked. Ensure that you have followed the Section B.2.2.2, “SSH Configuration” instructions.

- The most likely representation of this error will be when executing tpm during a deployment:

```
Error:
################################################################

Validation failed
################################################################
################################################################
Errors for host1
################################################################
ERROR>>host1>>Unable to SSH to host1 as root. (SSHLoginCheck)
Ensure that the host is running and that you can login as root via SSH using key authentication
tungsten-configure.log shows:
2012-05-23T11:10:37+02:00 DEBUG>>Execute `whoami` on host1 as root
2012-05-23T11:10:38+02:00 DEBUG>>RC: 0, Result: stdin: is not a tty
```

  Try running the following command:

```
shell> ssh tungsten@host1 sudo whoami
```

  If the SSH and sudo configurations have been configured correctly, it should return `root`. Any other value indicates a failure to configure the prerequisites properly.

- Check that none of the profile scripts [`.profile`, `.bash_profile`, `.bashrc`, etc.] do not contain a call to mesg n. This may fool the non-interactive ssh call; the call to this command should be changed to only be executed on interactive shells:

```
if `tty -s`; then
   mesg n
fi
```

- Check that firewalls and/or antivirus software are not blocking or preventing connectivity on port 22.

  If ssh has been enabled on a non-standard port, use the `--net-ssh-option=port` [405] option to specify the alternative port.

- Make sure that the user specified in the `--user` [471] to tpm is allowed to connect to your cluster nodes.

C.9. Troubleshooting Data Differences

It can sometimes become necessary to identify table and data differences due to unexpected behaviour or failures. There are a number of third party tools that can help identify and fix however a lot of them assume native replication is in place, the following explains the recommended methods for troubleshooting a Tungsten Environment based on MySQL as the source and target technologies.

C.9.1. Identify Structural Differences

If you suspect that there are differences to a table structure, a simple method to resolve this will be to compare schema DDL.

Extract DDL on the Primary node, specifying the schema in place of {DB}:

```
shell> mysqldump -u root -p --no-data -h localhost --databases {DB} >Primary.sql
```

Repeat the same on the Replica node:

```
shell> mysqldump -u root -p --no-data -h localhost --databases {DB} >Replica.sql
```

Now, using diff, you can compare the results

```
shell> diff Primary.sql Replica.sql
```

Using the output of diff, you can then craft the necessary SQL statements to re-align your structure

C.9.2. Identify Data Differences

It is possible to use pt-table-checksum from the Percona Toolkit to identify data differences, providing you use the syntax described below for bypassing the native replication checks. First of all, it is advisable to familiarise yourself with the product by reading through the providers own documentation here:

https://www.percona.com/doc/percona-toolkit/2.2/pt-table-checksum.html

Once you are ready, ensure you install the latest version to the persona toolkit on all nodes, next execute the following on the Primary node:

```
shell> pt-table-checksum --set-vars innodb_lock_wait_timeout=500 \
--recursion-method=none \
--ignore-databases=mysql \
--ignore-databases-regex=tungsten* \
h=localhost,u=tungsten,p=secret
```

On first run, this will create a database called percona, and within that database a table called checksums. The process will gather checksum information on every table in every database excluding the mysql and tungsten related schemas. You can now execute the following SQL Statement on the Replica to identify tables with data differences:

```
SELECT db, tbl, SUM(this_cnt) AS total_rows, COUNT(*) AS chunks
FROM percona.checksums
WHERE (
 master_cnt <> this_cnt
 OR master_crc <> this_crc
 OR ISNULL(master_crc) <> ISNULL(this_crc))
GROUP BY db, tbl;
```

This `SELECT` will return any tables that it detects are different, it won't show you the differences, or indeed how many, this is just a basic check. To identify and fix the changes, you could use pt-table-sync, however this product would by default assume native replication and also try and fix the problems for you. In a tungsten environment this would not be recommended, however by using the `--print` switch you can gather the SQL needed to be executed to fix the mistakes. You should run this, and review the output to determine whether you want to manually patch the data together or consider using tungsten_provision_slave to retrovision a node in the case of large quantities of differences.

To use pt-table-sync, first identify the tables with differences on each Replica, in this example, the SELECT statement above identified that there was a data difference on the departments table within the employees database on db2. Execute the pt-table-sync script on the Primary, passing in the database name, table name and the Replica host that the difference exists on:

```
shell> pt-table-sync --databases employees --tables departments --print h=db1,u=tungsten,p=secret,P=13306 h=db2
```

The first h= option should be the Primary, also the node you run the script from, the second h= option relates to the Replica that the difference exists on. Executing the script will output SQL statements that can be used to patch the data, for example the above statement produces the following output:

```
UPDATE `employees`.`departments`
SET `dept_name`='Sales'
WHERE `dept_no`='d007'
LIMIT 1
/*percona-toolkit src_db:employees src_tbl:departments src_dsn:P=13306,h=db1,p=...,u=tungsten
dst_db:employees dst_tbl:departments dst_dsn:P=13306,h=db2,p=...,u=tungsten
lock:0 transaction:1 changing_src:0 replicate:0 bidirectional:0 pid:24524 user:tungsten host:db1*/;
```

The UPDATE statements could now be issued directly on the Replica to correct the problem.

Warning

Generally, changing data directly on a Replica is not recommended, but every environment is different. before making any changes like this *always* ensure you have a FULL backup, and it would be recommended to shun the Replica node (if in a clustered environment) before making any changes so as not to cause any potential interruption to connected clients

C.10. Comparing Table Data

The Percona Toolkit includes a tool called pt-table-checksum that enables you to compare databases on different databases using a checksum comparison. This can be executed by running the checksum generation process on the Primary:

```
shell> pt-table-checksum --set-vars innodb_lock_wait_timeout=500 \
    --recursion-method=none \
    --ignore-databases=mysql \
    --ignore-databases-regex=tungsten* \
    h=localhost,u=tungsten,p=secret
```

Using MySQL, the following statement must then be executed to check the checksums generated on the Primary:

```
mysql> <userinput>SELECT db, tbl, SUM(this_cnt) AS total_rows, COUNT(*) AS chunks \
    FROM percona.checksums WHERE ( master_cnt <> this_cnt OR master_crc \
    <> this_crc OR ISNULL(master_crc) <> ISNULL(this_crc)) GROUP BY db, tbl;</userinput>
```

Any differences will be reported and will need to manually corrected.

C.11. Troubleshooting Memory Usage

Appendix D. Files, Directories, and Environment

D.1. The Tungsten Cluster Install Directory

Any Tungsten Cluster™ installation creates an installation directory that contains the software and the additional directories where active information, such as the transaction history log and backup data is stored. A sample of the directory is shown below, and a description of the individual directories is provided in Table D.1, "Continuent Tungsten Directory Structure".

```
shell> ls -al /opt/continuent
total 40
drwxr-xr-x 9 tungsten root     4096 Mar 21 18:47 .
drwxr-xr-x 3 root     root     4096 Mar 21 18:00 ..
drwxrwxr-x 2 tungsten tungsten 4096 Mar 21 18:44 backups
drwxrwxr-x 2 tungsten tungsten 4096 Mar 21 18:47 conf
drwxrwxr-x 3 tungsten tungsten 4096 Mar 21 18:44 relay
drwxrwxr-x 4 tungsten tungsten 4096 Mar 21 18:47 releases
drwxrwxr-x 2 tungsten tungsten 4096 Mar 21 18:47 service_logs
drwxrwxr-x 2 tungsten tungsten 4096 Mar 21 18:47 share
drwxrwxr-x 3 tungsten tungsten 4096 Mar 21 18:44 thl
lrwxrwxrwx 1 tungsten tungsten   62 Mar 21 18:47 tungsten -> /opt/continuent/releases/tungsten-clustering-5.4.1-41_pid31409
```

The directories shown in the table are relative to the installation directory, the recommended location is `/opt/continuent`. For example, the THL files would be located in `/opt/continuent/thl`.

Table D.1. Continuent Tungsten Directory Structure

Directory	Description
`backups`	Default directory for backup file storage
`conf`	Configuration directory with a copy of the current and past configurations
`relay`	Location for relay logs if relay logs have been enabled.
`releases`	Contains one or more active installations of the Continuent Tungsten software, referenced according to the version number and active process ID.
`service-logs`	Logging information for the active installation
`share`	Active installation information, including the active JAR for the MySQL connection
`thl`	The Transaction History Log files, stored in a directory named after each active service.
`tungsten`	Symbolic link to the currently active release in `releases`.

Some advice for the contents of specific directories within the main installation directory are described in the following sections.

D.1.1. The `backups` Directory

The `backups` directory is the default location for the data and metadata from any backup performed manually or automatically by Tungsten Cluster™. The backup data and metadata for each backup will be stored in this directory.

An example of the directory content is shown below:

```
shell> ls -al /opt/continuent/backups/
total 130788
drwxrwxr-x 2 tungsten tungsten      4096 Apr  4 16:09 .
drwxrwxr-x 3 tungsten tungsten      4096 Apr  4 11:51 ..
-rw-r--r-- 1 tungsten tungsten        71 Apr  4 16:09 storage.index
-rw-r--r-- 1 tungsten tungsten 133907646 Apr  4 16:09 store-0000000001-mysqldump_2013-04-04_16-08_42.sql.gz
-rw-r--r-- 1 tungsten tungsten       317 Apr  4 16:09 store-0000000001.properties
```

The `storage.index` contains the backup file index information. The actual backup data is stored in the GZipped file. The properties of the backup file, including the tool used to create the backup, and the checksum information, are location in the corresponding `.properties` file. Note that each backup and property file is uniquely numbered so that you can identify and restore a specific backup.

Different backups scripts and methods may place their backup information in a separate subdirectory. For example, xtrabackup stores backup data into `/opt/continuent/backups/xtrabackup`.

D.1.1.1. Automatically Deleting Backup Files

The Tungsten Replicator will automatically remove old backup files. This is controlled by the `--repl-backup-retention` [435] setting and defaults to 3. Use the tpm update command to modify this setting. Following the successful creation of a new backup, the number of backups will be

compared to the retention value. Any excess backups will be removed from the `/opt/continuent/backups` directory or whatever directory is configured for `--repl-backup-directory` [434].

The backup retention will only remove files starting with `store`. If you are using a backup method that creates additional information then those files may not be fully removed until the next backup process begins. This includes xtrabackup-full, xtrabackup-incremental and any snapshot based backup methods. You may manually clean these excess files if space is needed before the next backup method. If you delete information associated with an existing backup, any attempts to restore it will fail.

D.1.1.2. Manually Deleting Backup Files

If you no longer need one or more backup files, you can delete the files from the filesystem. You must delete both the SQL data, and the corresponding properties file. For example, from the following directory:

```
shell> ls -al /opt/continuent/backups
total 764708
drwxrwxr-x 2 tungsten tungsten      4096 Apr 16 13:57 .
drwxrwxr-x 3 tungsten tungsten      4096 Apr 16 13:54 ..
-rw-r--r-- 1 tungsten tungsten        71 Apr 16 13:56 storage.index
-rw-r--r-- 1 tungsten tungsten    517170 Apr 15 18:02 store-0000000004-mysqldump-1332463738918435527.sql
-rw-r--r-- 1 tungsten tungsten       311 Apr 15 18:02 store-0000000004.properties
-rw-r--r-- 1 tungsten tungsten    517170 Apr 15 18:06 store-0000000005-mysqldump-2284057977980000458.sql
-rw-r--r-- 1 tungsten tungsten       310 Apr 15 18:06 store-0000000005.properties
-rw-r--r-- 1 tungsten tungsten 781991444 Apr 16 13:57 store-0000000006-mysqldump-3081853249977885370.sql
-rw-r--r-- 1 tungsten tungsten       314 Apr 16 13:57 store-0000000006.properties
```

To delete the backup files for index 4:

```
shell> rm /opt/continuent/backups/alpha/store-0000000004*
```

See the information in Section D.1.1.3, “Copying Backup Files” about additional files related to a single backup. There may be additional files associated with the backup that you will need to manually remove.

Warning

Removing a backup should only be performed if you know that the backup is safe to be removed and will not be required. If the backup data is required, copy the backup files from the backup directory before deleting the files in the backup directory to make space.

D.1.1.3. Copying Backup Files

The files created during any backup can copied to another directory or system using any suitable means. Once the backup has been completed, the files will not be modified or updated and are therefore safe to be moved or actively copied to another location without fear of corruption of the backup information.

There are multiple files associated with each backup. The number of files will depend on the backup method that was used. All backups will use at least two files in the `/opt/continuent/backups` directory.

```
shell> cd /opt/continuent/backups
shell> scp store-[0]*6[\.-]* host3:$PWD/
store-0000000001-full_xtrabackup_2014-08-16_15-44_86                  100%   70     0.1KB/s   00:00
store-0000000001.properties                                           100%  314     0.3KB/s   00:00
```

Note

Check the ownership of files if you have trouble transferring files or restoring the backup. They should be owned by the Tungsten system user to ensure proper operation.

If xtrabackup-full method was used, you must transfer the corresponding directory from `/opt/continuent/backups/xtrabackup`. In this example that would be `/opt/continuent/backups/xtrabackup/full_xtrabackup_2014-08-16_15-44_86`.

```
shell> cd /opt/continuent/backups/xtrabackup
shell> rsync -aze ssh full_xtrabackup_2014-08-16_15-44_86 host3:$PWD/
```

If the xtrabackup-incremental method was used, you must transfer multiple directories. In addition to the corresponding directory from `/opt/continuent/backups/xtrabackup` you must transfer all xtrabackup-incremental directories since the most recent xtrabackup-full backup and then transfer that xtrabackup-full directory. See the example below for further explanation :

```
shell> ls -altr /opt/continuent/backups/xtrabackup/
total 32
drwxr-xr-x 7 tungsten tungsten 4096 Oct 16 20:55 incr_xtrabackup_2014-10-16_20-55_73
drwxr-xr-x 7 tungsten tungsten 4096 Oct 17 20:55 full_xtrabackup_2014-10-17_20-55_1
drwxr-xr-x 7 tungsten tungsten 4096 Oct 18 20:55 incr_xtrabackup_2014-10-18_20-55_38
drwxr-xr-x 7 tungsten tungsten 4096 Oct 19 20:57 incr_xtrabackup_2014-10-19_20-57_76
drwxr-xr-x 7 tungsten tungsten 4096 Oct 20 20:58 full_xtrabackup_2014-10-20_20-57_41
```

```
drwxr-xr-x 8 tungsten tungsten 4096 Oct 21 20:58 .
drwxr-xr-x 7 tungsten tungsten 4096 Oct 21 20:58 incr_xtrabackup_2014-10-21_20-58_97
drwxrwxr-x 3 tungsten tungsten 4096 Oct 21 20:58 ..
```

In this example there are two instances of xtrabackup-full backups and four xtrabackup-incremental backups.

- To restore either of the xtrabackup-full backups then they would be copied to the target host on their own.
- To restore `incr_xtrabackup_2014-10-21_20-58_97`, it must be copied along with `full_xtrabackup_2014-10-20_20-57_41`.
- To restore `incr_xtrabackup_2014-10-19_20-57_76`, it must be copied along with `incr_xtrabackup_2014-10-18_20-55_38` and `full_xtraback-up_2014-10-17_20-55_1`.

D.1.1.4. Relocating Backup Storage

If the filesystem on which the main installation directory is running out of space and you need to increase the space available for backup files without interrupting the service, you can use symbolic links to relocate the backup information.

Note

When using an NFS mount point when backing up with xtrabackup , the command must have the necessary access rights and permissions to change the ownership of files within the mounted directory. Failure to update the permissions and ownership will cause the xtrabackup command to fail. The following settings should be made on the directory:

- Ensure the `no_root_squash` option on the NFS export is not set.
- Change the group and owner of the mount point to the `tungsten` user and `mysql` group:

  ```
  shell> chown tungsten /mnt/backups
  shell> chgrp mysql /mnt/backups
  ```

  Owner and group IDs on NFS directories must match across all the hosts using the NFS mount point. Inconsistencies in the owner and group IDs may lead to backup failures.
- Change the permissions to permit at least owner and group modifications::

  ```
  shell> chmod 770 /mnt/backups
  ```
- Mount the directory:

  ```
  shell> mount host1:/exports/backups /mnt/backups
  ```

The backup directory can be changed using two different methods:

- Section D.1.1.4.1, “Relocating Backup Storage using Symbolic Links”
- Section D.1.1.4.2, “Relocating Backup Storage using Configuration Changes”

D.1.1.4.1. Relocating Backup Storage using Symbolic Links

To relocate the backup directory using symbolic links:

1. Ensure that no active backup is taking place of the current host. Your service does not need to be offline to complete this operation.
2. Create a new directory, or attach a new filesystem and location on which the backups will be located. You can use a directory on another filesystem or connect to a SAN, NFS or other filesystem where the new directory will be located. For example:

   ```
   shell> mkdir /mnt/backupdata/continuent
   ```
3. *Optional*

   Copy the existing backup directory to the new directory location. For example:

   ```
   shell> rsync -r /opt/continuent/backups/* /mnt/backupdata/continuent/
   ```
4. Move the existing directory to a temporary location:

   ```
   shell> mv /opt/continuent/backups /opt/continuent/old-backups
   ```
5. Create a symbolic link from the new directory to the original directory location:

   ```
   shell> ln -s /mnt/backupdata/continuent /opt/continuent/backups
   ```

The backup directory has now been moved. If you want to verify that the new backup directory is working, you can optionally run a backup and ensure that the backup process completes correctly.

D.1.1.4.2. Relocating Backup Storage using Configuration Changes

To relocate the backup directory by reconfiguration:

1. Ensure that no active backup is taking place of the current host. Your service does not need to be offline to complete this operation.
2. Create a new directory, or attach a new filesystem and location on which the backups will be located. You can use a directory on another filesystem or connect to a SAN, NFS or other filesystem where the new directory will be located. For example:

   ```
   shell> mkdir /mnt/backupdata/continuent
   ```
3. *Optional*

   Copy the existing backup directory to the new directory location. For example:

   ```
   shell> rsync -r /opt/continuent/backups/* /mnt/backupdata/continuent/
   ```
4. Following the directions for tpm update to apply the `--backup-directory=/mnt/backupdata/continuent` [434] setting.

The backup directory has now been moved. If you want to verify that the new backup directory is working, you can optionally run a backup and ensure that the backup process completes correctly.

D.1.2. The `releases` Directory

The `releases` directory contains a copy of each installed release. As new versions are installed and updated (through tpm update), a new directory is created with the corresponding version of the software.

For example, a number of releases are listed below:

```
shell> ll /opt/continuent/releases/
total 20
drwxr-xr-x  5 tungsten mysql 4096 May 23 16:19 ./
drwxr-xr-x  9 tungsten mysql 4096 May 23 16:19 ../
drwxr-xr-x 10 tungsten mysql 4096 May 23 16:19 tungsten-clustering-5.4.1-41_pid16184/
drwxr-xr-x 10 tungsten mysql 4096 May 23 16:19 tungsten-clustering-5.4.1-41_pid14577/
drwxr-xr-x 10 tungsten mysql 4096 May 23 16:19 tungsten-clustering-5.4.1-41_pid23747/
drwxr-xr-x 10 tungsten mysql 4096 May 23 16:19 tungsten-clustering-5.4.1-41_pid24978/
```

The latest release currently in use can be determined by checking the symbolic link, `tungsten` within the installation directory. For example:

```
shell> ll /opt/continuent
total 40
drwxr-xr-x 9 tungsten mysql 4096 May 23 16:19 ./
drwxr-xr-x 3 root     root  4096 Apr 29 16:09 ../
drwxr-xr-x 2 tungsten mysql 4096 May 30 13:27 backups/
drwxr-xr-x 2 tungsten mysql 4096 May 23 16:19 conf/
drwxr-xr-x 3 tungsten mysql 4096 May 10 19:09 relay/
drwxr-xr-x 5 tungsten mysql 4096 May 23 16:19 releases/
drwxr-xr-x 2 tungsten mysql 4096 May 10 19:09 service_logs/
drwxr-xr-x 2 tungsten mysql 4096 May 23 16:18 share/
drwxr-xr-x 3 tungsten mysql 4096 May 10 19:09 thl/
lrwxrwxrwx 1 tungsten mysql   63 May 23 16:19 tungsten -> /opt/continuent/releases/tungsten-clustering-5.4.1-41_pid24978/
```

If multiple services are running on the host, search for `.pid` files within the installation directory to determine which release directories are currently in use by an active service:

```
shell> find /opt/continuent -name "*.pid"
/opt/continuent/releases/tungsten-clustering-5.4.1-41_pid24978/tungsten-replicator/var/treplicator.pid
/opt/continuent/releases/tungsten-clustering-5.4.1-41_pid24978/tungsten-connector/var/tconnector.pid
/opt/continuent/releases/tungsten-clustering-5.4.1-41_pid24978/tungsten-manager/var/tmanager.pid
```

Directories within the `releases` directory that are no longer being used can be safely removed.

D.1.3. The `service_logs` Directory

The `service_logs` directory contains links to the log files for the currently active release. The directory contains the following links:

- `connector.log` — a link to the Tungsten Connector log.
- `tmsvc.log` — a link to the Tungsten Cluster manager log.
- `trepsvc.log` — a link to the Tungsten Replicator log.

D.1.4. The `share` Directory

The `share` directory contains information that is shared among all installed releases and instances of Tungsten Cluster. Unlike other directories, the `share` directory is not overwritten or replaced during installation or update using tpm. This means that the directory can be used to hold information, such as filter configurations, without the contents being removed when the installation is updated.

D.1.5. The `thl` Directory

The transaction history log (THL) retains a copy of the SQL statements from each Primary host, and it is the information within the THL that is transferred between hosts and applied to the database. The THL information is written to disk and stored in the `thl` directory:

```
shell> ls -al /opt/continuent/thl/alpha/
total 2291984
drwxrwxr-x 2 tungsten tungsten      4096 Apr 16 13:44 .
drwxrwxr-x 3 tungsten tungsten      4096 Apr 15 15:53 ..
-rw-r--r-- 1 tungsten tungsten         0 Apr 15 15:53 disklog.lck
-rw-r--r-- 1 tungsten tungsten 100137585 Apr 15 18:13 thl.data.0000000001
-rw-r--r-- 1 tungsten tungsten 100134069 Apr 15 18:18 thl.data.0000000002
-rw-r--r-- 1 tungsten tungsten 100859685 Apr 15 18:26 thl.data.0000000003
-rw-r--r-- 1 tungsten tungsten 100515215 Apr 15 18:28 thl.data.0000000004
-rw-r--r-- 1 tungsten tungsten 100180770 Apr 15 18:31 thl.data.0000000005
-rw-r--r-- 1 tungsten tungsten 100453094 Apr 15 18:34 thl.data.0000000006
-rw-r--r-- 1 tungsten tungsten 100379260 Apr 15 18:35 thl.data.0000000007
-rw-r--r-- 1 tungsten tungsten 100294561 Apr 16 12:21 thl.data.0000000008
-rw-r--r-- 1 tungsten tungsten 100133258 Apr 16 12:24 thl.data.0000000009
-rw-r--r-- 1 tungsten tungsten 100293278 Apr 16 12:32 thl.data.0000000010
-rw-r--r-- 1 tungsten tungsten 100819317 Apr 16 12:34 thl.data.0000000011
-rw-r--r-- 1 tungsten tungsten 100250972 Apr 16 12:35 thl.data.0000000012
-rw-r--r-- 1 tungsten tungsten 100337285 Apr 16 12:37 thl.data.0000000013
-rw-r--r-- 1 tungsten tungsten 100535387 Apr 16 12:38 thl.data.0000000014
-rw-r--r-- 1 tungsten tungsten 100378358 Apr 16 12:40 thl.data.0000000015
-rw-r--r-- 1 tungsten tungsten 100198421 Apr 16 13:32 thl.data.0000000016
-rw-r--r-- 1 tungsten tungsten 100136955 Apr 16 13:34 thl.data.0000000017
-rw-r--r-- 1 tungsten tungsten 100490927 Apr 16 13:41 thl.data.0000000018
-rw-r--r-- 1 tungsten tungsten 100684346 Apr 16 13:41 thl.data.0000000019
-rw-r--r-- 1 tungsten tungsten 100225119 Apr 16 13:42 thl.data.0000000020
-rw-r--r-- 1 tungsten tungsten 100390819 Apr 16 13:43 thl.data.0000000021
-rw-r--r-- 1 tungsten tungsten 100418115 Apr 16 13:43 thl.data.0000000022
-rw-r--r-- 1 tungsten tungsten 100388812 Apr 16 13:44 thl.data.0000000023
-rw-r--r-- 1 tungsten tungsten  38275509 Apr 16 13:47 thl.data.0000000024
```

THL files are created on both the Primary and Replicas within the cluster. THL data can be examined using the thl command.

The THL is written into individual files, which are by default, no more than 1 GByte in size each. From the listing above, you can see that each file has a unique file index number. A new file is created when the file size limit is reached, and given the next THL log file number. To determine the sequence number that is stored within log, use the thl command:

```
shell> thl index
LogIndexEntry thl.data.0000000001(0:106)
LogIndexEntry thl.data.0000000002(107:203)
LogIndexEntry thl.data.0000000003(204:367)
LogIndexEntry thl.data.0000000004(368:464)
LogIndexEntry thl.data.0000000005(465:561)
LogIndexEntry thl.data.0000000006(562:658)
LogIndexEntry thl.data.0000000007(659:755)
LogIndexEntry thl.data.0000000008(756:1251)
LogIndexEntry thl.data.0000000009(1252:1348)
LogIndexEntry thl.data.0000000010(1349:1511)
LogIndexEntry thl.data.0000000011(1512:1609)
LogIndexEntry thl.data.0000000012(1610:1706)
LogIndexEntry thl.data.0000000013(1707:1803)
LogIndexEntry thl.data.0000000014(1804:1900)
LogIndexEntry thl.data.0000000015(1901:1997)
LogIndexEntry thl.data.0000000016(1998:2493)
LogIndexEntry thl.data.0000000017(2494:2590)
LogIndexEntry thl.data.0000000018(2591:2754)
LogIndexEntry thl.data.0000000019(2755:2851)
LogIndexEntry thl.data.0000000020(2852:2948)
LogIndexEntry thl.data.0000000021(2949:3045)
LogIndexEntry thl.data.0000000022(3046:3142)
LogIndexEntry thl.data.0000000023(3143:3239)
LogIndexEntry thl.data.0000000024(3240:3672)
```

The THL files are retained for seven days by default, although this parameter is configurable. Due to the nature and potential size required to store the information for the THL, you should monitor the disk space and usage.

The purge is continuous and is based on the date the log file was written. Each time the replicator finishes the current THL log file, it checks for files that have exceeded the defined retention configuration and spawns a job within the replicator to delete files older than the retention policy. Old files are only removed when the current THL log file rotates.

D.1.5.1. Purging THL Log Information on a Replica

Warning

Purging the THL on a Replica node can potentially remove information that has not yet been applied to the database. Please check and ensure that the THL data that you are purging has been applied to the database before continuing.

The THL files can be explicitly purged to recover disk space, but you should ensure that the currently applied sequence no to the database is not purged, and that additional hosts are not reading the THL information.

To purge the logs on a Replica node:

1. Determine the highest sequence number from the THL that you want to delete. To purge the logs up until the latest sequence number, you can use trepctl to determine the highest applied sequence number:

```
shell> trepctl services
Processing services command...
NAME              VALUE
----              -----
appliedLastSeqno: 3672
appliedLatency  : 331.0
role            : slave
serviceName     : alpha
serviceType     : local
started         : true
state           : ONLINE
Finished services command...
```

2. Shun the Replica datasource and put the replicator into the offline state using cctrl:

```
shell> cctrl
[LOGICAL] /alpha > datasource host1 shun
[LOGICAL] /alpha > replicator host1 offline
```

Important

NEVER Shun the Primary datasource!

3. Use the thl command to purge the logs up to the specified transaction sequence number. You will be prompted to confirm the operation:

```
shell> thl purge -high 3670
WARNING: The purge command will break replication if you delete all events or »
   delete events that have not reached all slaves.
Are you sure you wish to delete these events [y/N]?
y
Deleting events where SEQ# <=3670
2013-04-16 14:09:42,384 [ - main] INFO  thl.THLManagerCtrl Transactions deleted
```

4. Recover the host back into the cluster:

```
shell> cctrl
[LOGICAL] /alpha > datasource host1 recover
```

You can now check the current THL file information:

```
shell> thl index
LogIndexEntry thl.data.0000000024(3240:3672)
```

For more information on purging events using thl, see Section 9.22.4, “thl purge Command”.

D.1.5.2. Purging THL Log Information on a Primary

Warning

Purging the THL on a Primary node can potentially remove information that has not yet been applied to the Replica databases. Please check and ensure that the THL data that you are purging has been applied to the database on all Replicas before continuing.

Important

If the situation allows, it may be better to switch the Primary role to a current, up-to-date Replica, then perform the steps to purge THL from a Replica on the old Primary host using Section D.1.5.1, “Purging THL Log Information on a Replica”.

Warning

Follow the below steps with great caution! Failure to follow best practices will result in Replicas unable to apply transactions, forcing a full re-provisioning. For those steps, please see Section 6.6.1.1, "Provision or Reprovision a Replica".

The THL files can be explicitly purged to recover disk space, but you should ensure that the currently applied sequence no to the database is not purged, and that additional hosts are not reading the THL information.

To purge the logs on a Primary node:

1. Determine the highest sequence number from the THL that you want to delete. To purge the logs up until the latest sequence number, you can use trepctl to determine the highest applied sequence number:

```
shell> trepctl services
Processing services command...
NAME              VALUE
----              -----
appliedLastSeqno: 3675
appliedLatency  : 0.835
role            : master
serviceName     : alpha
serviceType     : local
started         : true
state           : ONLINE
Finished services command...
```

2. Set the cluster to Maintenance mode and put the replicator into the offline state using cctrl:

```
shell> cctrl
[LOGICAL] /alpha > set policy maintenance
[LOGICAL] /alpha > replicator host1 offline
```

3. Use the thl command to purge the logs up to the specified transaction sequence number. You will be prompted to confirm the operation:

```
shell> thl purge -high 3670
WARNING: The purge command will break replication if you delete all events or »
   delete events that have not reached all slaves.
Are you sure you wish to delete these events [y/N]?
y
Deleting events where SEQ# <=3670
2013-04-16 14:09:42,384 [ - main] INFO  thl.THLManagerCtrl Transactions deleted
```

4. Set the cluster to Automatic mode and put the replicator online using cctrl:

```
shell> cctrl
[LOGICAL] /alpha > replicator host1 online
[LOGICAL] /alpha > set policy automatic
```

You can now check the current THL file information:

```
shell> thl index
LogIndexEntry thl.data.0000000024(3240:3672)
```

For more information on purging events using thl, see Section 9.22.4, "thl purge Command".

D.1.5.3. Moving the THL File Location

The location of the THL directory where THL files are stored can be changed, either by using a symbolic link or by changing the configuration to point to the new directory:

- Changing the directory location using symbolic links can be used in an emergency if the space on a filesystem has been exhausted. See Section D.1.5.3.1, "Relocating THL Storage using Symbolic Links"
- Changing the directory location through reconfiguration can be used when a permanent change to the THL location is required. See Section D.1.5.3.2, "Relocating THL Storage using Configuration Changes".t

D.1.5.3.1. Relocating THL Storage using Symbolic Links

In an emergency, the directory currently holding the THL information, can be moved using symbolic links to relocate the files to a location with more space.

Moving the THL location requires updating the location for a Replica by temporarily setting the Replica offline, updating the THL location, and re-enabling back into the cluster:

1. Shun the datasource and switch your node into the offline state using cctrl:

```
shell> cctrl -expert
  [LOGICAL:EXPERT] /alpha > datasource host1 shun
  [LOGICAL:EXPERT] /alpha > replicator host1 offline
```

2. Create a new directory, or attach a new filesystem and location on which the THL content will be located. You can use a directory on another filesystem or connect to a SAN, NFS or other filesystem where the new directory will be located. For example:

```
shell> mkdir /mnt/data/thl
```

3. Copy the existing THL directory to the new directory location. For example:

```
shell> rsync -r /opt/continuent/thl/* /mnt/data/thl/
```

4. Move the existing directory to a temporary location:

```
shell> mv /opt/continuent/thl /opt/continuent/old-thl
```

5. Create a symbolic link from the new directory to the original directory location:

```
shell> ln -s /mnt/data/thl /opt/continuent/thl
```

6. Recover the host back into the cluster :

```
shell> cctrl -expert
  [LOGICAL:EXPERT] /alpha > datasource host1 recover
```

To change the THL location on a Primary:

1. Manually promote an existing Replica to be the new Primary:

```
[LOGICAL] /alpha > switch to host2
SELECTED SLAVE: host2@alpha
PURGE REMAINING ACTIVE SESSIONS ON CURRENT MASTER 'host1@alpha'
PURGED A TOTAL OF 0 ACTIVE SESSIONS ON MASTER 'host1@alpha'
FLUSH TRANSACTIONS ON CURRENT MASTER 'host1@alpha'
PUT THE NEW MASTER 'host2@alpha' ONLINE
PUT THE PRIOR MASTER 'host1@alpha' ONLINE AS A SLAVE
RECONFIGURING SLAVE 'host3@alpha' TO POINT TO NEW MASTER 'host2@alpha'
SWITCH TO 'host2@alpha' WAS SUCCESSFUL
```

2. Update the THL location as provided in the previous sequence.

3. Switch the updated Replica back to be the Primary:

```
[LOGICAL] /alpha > switch to host1
SELECTED SLAVE: host1@alpha
PURGE REMAINING ACTIVE SESSIONS ON CURRENT MASTER 'host2@alpha'
PURGED A TOTAL OF 0 ACTIVE SESSIONS ON MASTER 'host2@alpha'
FLUSH TRANSACTIONS ON CURRENT MASTER 'host2@alpha'
PUT THE NEW MASTER 'host1@alpha' ONLINE
PUT THE PRIOR MASTER 'host2@alpha' ONLINE AS A SLAVE
RECONFIGURING SLAVE 'host3@alpha' TO POINT TO NEW MASTER 'host1@alpha'
SWITCH TO 'host1@alpha' WAS SUCCESSFUL
```

D.1.5.3.2. Relocating THL Storage using Configuration Changes

To permanently change the directory currently holding the THL information can by reconfigured to a new directory location.

To update the location for a Replica by temporarily setting the Replica offline, updating the THL location, and re-enabling back into the cluster:

1. Shun the datasource and switch your node into the offline state using cctrl:

```
shell> cctrl -expert
  [LOGICAL:EXPERT] /alpha > datasource host1 shun
  [LOGICAL:EXPERT] /alpha > replicator host1 offline
```

2. Create a new directory, or attach a new filesystem and location on which the THL content will be located. You can use a directory on another filesystem or connect to a SAN, NFS or other filesystem where the new directory will be located. For example:

```
shell> mkdir /mnt/data/thl
```

3. Copy the existing THL directory to the new directory location. For example:

```
shell> rsync -r /opt/continuent/thl/* /mnt/data/thl/
```

4. Change the directory location using tpm to update the configuration for a specific host:

```
shell> tpm update --thl-directory=/mnt/data/thl --host=host1
```

5. Recover the host back into the cluster :

```
shell> cctrl -expert
  [LOGICAL:EXPERT] /alpha > datasource host1 recover
```

To change the THL location on a Primary:

1. Manually promote an existing Replica to be the new Primary:

```
[LOGICAL] /alpha > switch to host2
SELECTED SLAVE: host2@alpha
PURGE REMAINING ACTIVE SESSIONS ON CURRENT MASTER 'host1@alpha'
PURGED A TOTAL OF 0 ACTIVE SESSIONS ON MASTER 'host1@alpha'
FLUSH TRANSACTIONS ON CURRENT MASTER 'host1@alpha'
PUT THE NEW MASTER 'host2@alpha' ONLINE
PUT THE PRIOR MASTER 'host1@alpha' ONLINE AS A SLAVE
RECONFIGURING SLAVE 'host3@alpha' TO POINT TO NEW MASTER 'host2@alpha'
SWITCH TO 'host2@alpha' WAS SUCCESSFUL
```

2. Update the THL location as provided in the previous sequence.

3. Switch the updated Replica back to be the Primary:

```
[LOGICAL] /alpha > switch to host1
SELECTED SLAVE: host1@alpha
PURGE REMAINING ACTIVE SESSIONS ON CURRENT MASTER 'host2@alpha'
PURGED A TOTAL OF 0 ACTIVE SESSIONS ON MASTER 'host2@alpha'
FLUSH TRANSACTIONS ON CURRENT MASTER 'host2@alpha'
PUT THE NEW MASTER 'host1@alpha' ONLINE
PUT THE PRIOR MASTER 'host2@alpha' ONLINE AS A SLAVE
RECONFIGURING SLAVE 'host3@alpha' TO POINT TO NEW MASTER 'host1@alpha'
SWITCH TO 'host1@alpha' WAS SUCCESSFUL
```

D.1.5.4. Changing the THL Retention Times

THL files are by default retained for seven days, but the retention period can be adjusted according the to requirements of the service. Longer times retain the logs for longer, increasing disk space usage while allowing access to the THL information for longer. Shorter logs reduce disk space usage while reducing the amount of log data available.

> **Note**
>
> The files are automatically managed by Tungsten Cluster. Old THL files are deleted only when new data is written to the current files. If there has been no THL activity, the log files remain until new THL information is written.

Use the tpm update command to apply the `--repl-thl-log-retention` [470] setting. The replication service will be restarted on each host with updated retention configuration.

D.1.6. The `tungsten` Directory

```
shell> ls -l /opt/continuent/tungsten/
total 72
drwxr-xr-x  9 tungsten mysql  4096 May 23 16:18 bristlecone
drwxr-xr-x  6 tungsten mysql  4096 May 23 16:18 cluster-home
drwxr-xr-x  4 tungsten mysql  4096 May 23 16:18 cookbook
-rw-r--r--  1 tungsten mysql   681 May 23 16:18 INSTALL
-rw-r--r--  1 tungsten mysql 19974 May 23 16:18 README.LICENSES
drwxr-xr-x  3 tungsten mysql  4096 May 23 16:18 tools
-rw-r--r--  1 tungsten mysql 19724 May 23 16:18 tungsten.cfg
drwxr-xr-x  9 tungsten mysql  4096 May 23 16:18 tungsten-connector
drwxr-xr-x 14 tungsten mysql  4096 May 23 16:18 tungsten-manager
drwxr-xr-x 11 tungsten mysql  4096 May 23 16:18 tungsten-replicator
```

Table D.2. Continuent Tungsten `tungsten` Sub-Directory Structure

Directory	Description
`bristlecone`	Contains the bristlecone load-testing tools.
`cluster-home`	Home directory for the main tools, configuration and libraries of the Tungsten Cluster installation.
`cookbook`	Cookbook installation and testing tools.
`INSTALL`	Text file describing the basic installation process for Tungsten Cluster

Directory	Description
README.LICENSES	Software license information.
tools	Directory containing the tools for installing and configuring Tungsten Cluster.
tungsten-connector	Installed directory of the Tungsten Connector installation.
tungsten-manager	Installed directory of the Tungsten Manager installation.
tungsten-replicator	Installed directory of the Tungsten Replicator installation.

D.1.6.1. The tungsten-connector Directory

This directory holds all of the files, libraries, configuration and other information used to support the installation of Tungsten Connector.

D.1.6.1.1. The tungsten-connector Directory

This directory holds library files specific to Tungsten Connector. When perform patches or extending functionality specifically for Tungsten Connector, JAR files can be placed into this directory.

D.1.6.2. The tungsten-manager Directory

This directory holds all of the files, libraries, configuration and other information used to support the installation of Tungsten Manager.

D.1.6.2.1. The tungsten-manager/lib Directory

This directory holds library files specific to Tungsten Manager. When perform patches or extending functionality specifically for Tungsten Manager, JAR files can be placed into this directory.

D.1.6.3. The tungsten-replicator Directory

This directory holds all of the files, libraries, configuration and other information used to support the installation of Tungsten Manager.

D.1.6.3.1. The tungsten-replicator/lib Directory

This directory holds library files specific to Tungsten Replicator. When perform patches or extending functionality specifically for Tungsten Replicator, for example when adding JDBC libraries for other databases, the JAR files can be placed into this directory.

D.1.6.3.2. The tungsten-replicator/scripts Directory

This directory contains scripts used to support Tungsten Replicator operation.

D.2. Log Files

Each component witin a cluster generates it's own log files. These log files are all written their own directory within the installation directory structure. In addition, symbolic links are generated for easier access to light weight logs more suited for general user use.

For example, this is the listing of the default log directory, /opt/continuent/service_logs:

```
connector.log -> /opt/continuent/tungsten/tungsten-connector/log/connector.log
connector-user.log -> /opt/continuent/tungsten/tungsten-connector/log/connector-user.log
manager-user.log -> /opt/continuent/tungsten/tungsten-manager/log/manager-user.log
mysqldump.log -> /opt/continuent/tungsten/tungsten-replicator/log/mysqldump.log
replicator-user.log -> /opt/continuent/tungsten/tungsten-replicator/log/replicator-user.log
tmsvc.log -> /opt/continuent/tungsten/tungsten-manager/log/tmsvc.log
trepsvc.log -> /opt/continuent/tungsten/tungsten-replicator/log/trepsvc.log
xtrabackup.log -> /opt/continuent/tungsten/tungsten-replicator/log/xtrabackup.log
```

As you can see, each log file is a symlink to the user-level log for each of the layers, the main detailed log for each component, along with logs for backups, if they exist.

D.3. Environment Variables

- $CONTINUENT_PROFILES

  This environment variable is used by tpm as the location for storing the deploy.cfg file that is created by tpm during a tpm configure or tpm install operation. For more information, see Section 10.3, “tpm Staging Configuration”.

- $REPLICATOR_PROFILES

When using tpm with Tungsten Replicator, `$REPLICATOR_PROFILES` is used for storing the `deploy.cfg` file during configuration and installation. If `$REPLICATOR_PROFILES` does not exist, then `$CONTINUENT_PROFILES` if it exists. For more information, see Section 10.3, "tpm Staging Configuration".

- `$CONTINUENT_ROOT`

  The `$CONTINUENT_ROOT` variable is created by the `env.sh` file that is created when installing Tungsten Cluster. When defined, the variable will contain the installation directory of the corresponding Tungsten Cluster installation.

  On hosts where multiple installations have been created, the variable can be used to point to different installations.

Appendix E. Terminology Reference

Tungsten Cluster involves a number of different terminology that helps define different parts of the product, and specific areas of the output information from different commands. Some of this information is shared across different tools and systems.

This appendix includes a reference to the most common terms and terminology used across Tungsten Cluster.

E.1. Transaction History Log (THL)

The Transaction History Log (THL) stores transactional data from different data servers in a universal format that is then used to exchange and transfer the information between replicator instances. Because the THL is stored and independently managed from the data servers that it reads and writes, the data can be moved, exchanged, and transmuted during processing.

The THL is created by any replicator service acting as a Primary, where the information is read from the database using the native format, such as the MySQL binary log, or Oracle Change Data Capture (CDC), writing the information to the THL. Once in the THL, the THL data can be exchanged with other processes, including transmission over the network, and then applied to a destination database. Within Tungsten Replicator, this process is handled through the pipeline stages that read and write information between the THL and internal queues.

Information stored in THL is recorded in a series of event records in sequential format. The THL therefore acts as a queue of the transactions. On a replicator reading data from a database, the THL represents the queue of transactions applied on the source database. On a replicator applying that information to a database, the THL represents the list of the transactions to be written. The THL has the following properties:

- THL is a sequential list of events
- THL events are written to a THL file through a single thread (to enforce the sequential nature)
- THL events can be read from individually or sequentially, and multiple threads can read the same THL at the same time
- THL events are immutable; once stored, the contents of the THL are never modified or individually deleted (although entire files may be deleted)
- THL is written to disk without any buffering to prevent software failure causing a problem; the operating system buffers are used.

THL data is stored on disk within the `thl` directory of your Tungsten Replicator installation. The exact location can configured using *`logDir`* parameter of the THL component. A sample directory is shown below:

```
total 710504
-rw-r--r-- 1 tungsten tungsten         0 May  2 10:48 disklog.lck
-rw-r--r-- 1 tungsten tungsten 100042900 Jun  4 10:10 thl.data.0000000013
-rw-rw-r-- 1 tungsten tungsten 101025311 Jun  4 11:41 thl.data.0000000014
-rw-rw-r-- 1 tungsten tungsten 100441159 Jun  4 11:43 thl.data.0000000015
-rw-rw-r-- 1 tungsten tungsten 100898492 Jun  4 11:44 thl.data.0000000016
-rw-rw-r-- 1 tungsten tungsten 100305613 Jun  4 11:44 thl.data.0000000017
-rw-rw-r-- 1 tungsten tungsten 100035516 Jun  4 11:44 thl.data.0000000018
-rw-rw-r-- 1 tungsten tungsten 101690969 Jun  4 11:45 thl.data.0000000019
-rw-rw-r-- 1 tungsten tungsten  23086641 Jun  5 21:55 thl.data.0000000020
```

The THL files have the format `thl.data.#########`, and the sequence number increases for each new log file. The size of each log file is controlled by the `--thl-log-file-size` [469] configuration parameter. The log files are automatically managed by Tungsten Replicator, with old files automatically removed according to the retention policy set by the `--thl-log-retention` [470] configuration parameter. The files can be manually purged or moved. See Section D.1.5.1, “Purging THL Log Information on a Replica”.

The THL can be viewed and managed by using the thl command. For more information, see Section 9.22, “The thl Command”.

E.1.1. THL Format

The THL is stored on disk in a specific format that combines the information about the SQL and row data, metadata about the environment in which the row changes and SQL changes were made (metadata), and the log specific information, including the source, database, and timestamp of the information.

A sample of the output is shown below, the information is taken from the output of the thl command:

```
SEQ# = 0 / FRAG# = 0 (last frag)
- TIME = 2013-03-21 18:47:39.0
- EPOCH# = 0
- EVENTID = mysql-bin.000010:0000000000000439;0
- SOURCEID = host1
- METADATA = [mysql_server_id=10;dbms_type=mysql;is_metadata=true;service=dsone;»
    shard=tungsten_firstcluster;heartbeat=MASTER_ONLINE]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
- OPTIONS = [##charset = ISO8859_1, autocommit = 1, sql_auto_is_null = 0, »
    foreign_key_checks = 1, unique_checks = 1, sql_mode = '', character_set_client = 8, »
    collation_connection = 8, collation_server = 8]
```

```
- SCHEMA = tungsten_dsone
- SQL(0) = UPDATE tungsten_dsone.heartbeat SET source_tstamp= '2013-03-21 18:47:39', salt= 1, »
    name= 'MASTER_ONLINE'  WHERE id= 1 /* ___SERVICE___ = [firstcluster] */
```

The sample above shows the information for the SQL executed on a MySQL server. The *EVENTID* [588] shows the MySQL binary log from which the statement has been read. The MySQL server has stored the information in the binary log using STATEMENT or MIXED mode; log events written in ROW mode store the individual row differences. A summary of the THL stored format information, including both hidden values and the information included in the thl command output is provided in Table E.1, "THL Event Format".

Table E.1. THL Event Format

Displayed Field	Internal Name	Data type	Size	Description
-	record_length	Integer	4 bytes	Length of the full record information, including this field
-	record_type	Byte	1 byte	Event record type identifier
-	header_length	Unsigned int	4 bytes	Length of the header information
SEQ# [587]	seqno	Unsigned long	8 bytes	Log sequence number, a sequential value given to each log entry
FRAG# [587]	fragno	Unsigned short	2 bytes	Event fragment number. An event can consist of multiple fragments of SQL or row log data
-	last_frag	Byte	1 byte	Indicates whether the fragment is the last fragment in the sequence
EPOCH# [587]	epoch_number	Unsigned long	8 bytes	Event epoch number. Used to identify log sections within the Primary THL
SOURCEID [588]	source_id	UTF-8 String	Variable (null terminated)	Event source ID, the hostname or identity of the dataserver that generated the event
EVENTID [588]	event_id	UTF-8 String	Variable (null terminated)	Event ID; in MySQL, for example, the binlog filename and position that contained the original event
SHARDID [589]	shard_id	UTF-8 String	Variable (null terminated)	Shard ID to which the event belongs
TIME [588]	tstamp	Unsigned long	8 bytes	Time of the commit that triggered the event
-	data_length	Unsigned int	4 bytes	Length of the included event data
-	event	Binary	Variable	Serialized Java object containing the SQL or ROW data
METADATA [588]	Part of event	-	-	Metadata about the event
TYPE [588]	Part of event	-	-	Internal storage type of the event
OPTIONS [588]	Part of event	-	-	Options about the event operation
SCHEMA [589]	Part of event	-	-	Schema used in the event
SQL [589]	Part of event	-	-	SQL statement or row data
-	crc_method	Byte	1 byte	Method used to compute the CRC for the event.
-	crc	Unsigned int	4 bytes	CRC of the event record (not including the CRC value)

- *SEQ#* [587] and *FRAG#* [587]

  Individual events within the log are identified by a sequential *SEQUENCE* [587] number. Events are further divided into individual fragments. Fragments are numbered from 0 within a given sequence number. Events are applied to the database wholesale, fragments are used to divide up the size of the statement or row information within the log file. The fragments are stored internally in memory before being applied to the database and therefore memory usage is directly affected by the size and number of fragments held in memory.

  The sequence number as generated during this process is unique and therefore acts as a global transaction ID across a cluster. It can be used to determine whether the Replicas and Primary are in sync, and can be used to identify individual transactions within the replication stream.

- *EPOCH#* [587]

  The *EPOCH* [587] value is used a check to ensure that the logs on the Replica and the Primary match. The *EPOCH* [587] is stored in the THL, and a new *EPOCH* [587] is generated each time a Primary goes online. The *EPOCH* [587] value is then written and stored in the THL along-

side each individual event. The *EPOCH* [587] acts as an additional check, beyond the sequence number, to validate the information between the Replica and the Primary. The *EPOCH* [587] value is used to prevent the following situations:

- In the event of a failover where there are events stored in the Primary log, but which did not make it to a Replica, the *EPOCH* [587] acts as a check so that when the Primary rejoins as the Replica, the *EPOCH* [587] numbers will not match the Replica and the new Primary. The trapped transactions be identified by examining the THL output.
- When a Replica joins a Primary, the existence of the *EPOCH* [587] prevents the Replica from accepting events that happen to match only the sequence number, but not the corresponding *EPOCH* [587].

Each time a Tungsten Replicator Primary goes online, the *EPOCH* [587] number is incremented. When the Replica connects, it requests the *SEQUENCE* [587] and *EPOCH* [587], and the Primary confirms that the requested *SEQUENCE* [587] has the requested *EPOCH* [587]. If not, the request is rejected and the Replica gets a validation error:

```
pendingExceptionMessage: Client handshake failure: Client response validation failed: »
    Log epoch numbers do not match: client source ID=west-db2 seqno=408129 »
    server epoch number=408128 client epoch number=189069
```

When this error occurs, the THL should be examined and compared between the Primary and Replica to determine if there really is a mismatch between the two databases. For more information, see Section 6.8, “Managing Transaction Failures”.

- *SOURCEID* [588]

  The *SOURCEID* [588] is a string identifying the source of the event stored in the THL. Typically it is the hostname or host identifier.

- *EVENTID* [588]

  The *EVENTID* [588] is a string identifying the source of the event information in the log. Within a MySQL installed, the *EVENTID* [588] contains the binary log name and position which provided the original statement or row data.

  > **Note**
  >
  > The event ID shown is the end of the corresponding event stored in the THL, not the beginning. When examining the mysqlbinlog for an sequence ID in the THL, you should check the EVENTID of the previous THL sequence number to determine where to start looking within the binary log.

- *TIME* [588]

  When the source information is committed to the database, that information is stored into the corresponding binary log (MySQL) or CDC (Oracle). That information is stored in the THL. The time recorded in the THL is the time the data was committed, *not* the time the data was recorded into the log file.

  The *TIME* [588] value as stored in the THL is used to compute latency information when reading and applying data on a Replica.

- *METADATA* [588]

  Part of the binary *EVENT* payload stored within the event fragment, the metadata is collected and stored in the fragment based on information generated by the replicator. The information is stored as a series of key/value pairs. Examples of the information stored include:

  - MySQL server ID
  - Source database type
  - Name of the Replicator service that generated the THL
  - Any 'heartbeat' operations sent through the replicator service, including those automatically generated by the service, such as when the Primary goes online
  - The name of the shard to which the event belongs
  - Whether the contained data is safe to be applied through a block commit operation

- *TYPE* [588]

  The stored event type. Replicator has the potential to use a number of different stored formats for the THL data. The default type is based on the `com.continuent.tungsten.replicator.event.ReplDBMSEvent`.

- *OPTIONS* [588]

  Part of the *EVENT* binary payload, the *OPTIONS* [588] include information about the individual event that have been extracted from the database. These include settings such as the autocommit status, character set and other information, which is used when the information is applied to the database.

There will be one *OPTIONS* [588] block for each *SQL* [589] statement stored in the event.

- *SCHEMA* [589]

  Part of the *EVENT* structure, the *SCHEMA* [589] provides the database or schema name in which the statement or row data was applied.

- *SHARDID* [589]

  When using parallel apply, provides the generated shard ID for the event when it is applied by the parallel applier thread. data.

- *SQL* [589]

  For statement based events, the SQL of the statement that was recorded. Multiple individual SQL statements as part of a transaction can be contained within a single event fragment.

  For example, the MySQL statement:

```
mysql> INSERT INTO user VALUES (null, 'Charles', now());
Query OK, 1 row affected (0.01 sec)
```

  Stores the following into the THL:

```
SEQ# = 3583 / FRAG# = 0 (last frag)
- TIME = 2013-05-27 11:49:45.0
- EPOCH# = 2500
- EVENTID = mysql-bin.000007:0000000625753960;0
- SOURCEID = host1
- METADATA = [mysql_server_id=1687011;dbms_type=mysql;service=firstrep;shard=test]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
- SQL(0) = SET INSERT_ID = 3
- OPTIONS = [##charset = ISO8859_1, autocommit = 1, sql_auto_is_null = 0, »
    foreign_key_checks = 1, unique_checks = 1, sql_mode = '', character_set_client = 8, »
    collation_connection = 8, collation_server = 8]
- SCHEMA = test
- SQL(1) = INSERT INTO user VALUES (null, 'Charles', now()) /* ___SERVICE___ = [firstrep] */
```

  For row based events, the information is further defined by the individual row data, including the action type (`UPDATE`, `INSERT` or `DELETE`), *SCHEMA* [589], *TABLE* [589] and individual ROW data. For each ROW, there may be one or more *COL* [589] (column) and identifying *KEY* [589] event to identify the row on which the action is to be performed.

  The same statement when recorded in *ROW* [589] format:

```
SEQ# = 3582 / FRAG# = 0 (last frag)
- TIME = 2013-05-27 11:45:19.0
- EPOCH# = 2500
- EVENTID = mysql-bin.000007:0000000625753710;0
- SOURCEID = host1
- METADATA = [mysql_server_id=1687011;dbms_type=mysql;service=firstrep;shard=test]
- TYPE = com.continuent.tungsten.replicator.event.ReplDBMSEvent
- SQL(0) =
 - ACTION = INSERT
 - SCHEMA = test
 - TABLE = user
 - ROW# = 0
  - COL(1: ) = 2
  - COL(2: ) = Charles
  - COL(3: ) = 2013-05-27 11:45:19.0
```

E.2. Generated Field Reference

When using any of the tools within Tungsten Cluster status information is output using a common set of fields that describe different status information. These field names and terms are constant throughout all of the different tools. A description of each of these different fields is provided below.

E.2.1. Terminology: Fields *masterConnectUri*

The URI being used to extract THL information. On a Primary, the information may be empty, or may contain the reference to the underlying extractor source where information is being read.

On a Replica, the URI indicates the host from which THL data is being read:

```
masterConnectUri : thl://host1:2112/
```

In a secure installation where SSL is being used to exchange data, the URI protocol will be `thls`:

```
masterConnectUri : thls://host1:2112/
```

E.2.2. Terminology: Fields *masterListenUri*

The URI on which the replicator is listening for incoming Replica requests. On a Primary, this is the URI used to distribute THL information.

```
masterListenUri : thls://host1:2112/
```

E.2.3. Terminology: Fields *accessFailures*

E.2.4. Terminology: Fields *active*

E.2.5. Terminology: Fields *activeSeqno*

E.2.6. Terminology: Fields *appliedLastEventId*

The event ID from the source database of the last corresponding event from the stage that has been applied to the database.

MySQL

When extracting from MySQL, the output from trepctl shows the MySQL binary log file and the byte position within the log where the transaction was extracted:

```
shell> trepctl status
Processing status command...
NAME VALUE
---- -----
appliedLastEventId : mysql-bin.000064:0000000002757461;0
...
```

Oracle CDC

When extracting from Oracle using the CDC method, the event ID is composed of the Oracle SCN number:

```
NAME VALUE
---- -----
appliedLastEventId : ora:16626156
```

Oracle Redo Reader

When extracting from Oracle using the Redo Reader method, the event ID is composed of a combination of Oracle SCN, transaction, and PLOG file numbers, separated by a hash symbol:

```
NAME VALUE
---- -----
appliedLastEventId : 8931871791244#0018.002.000196e1#LAST#8931871791237#100644
```

The format is:

```
COMMITSCN#XID#LCR#MINSCN#PLOGSEQ
```

- COMMITSCN

  Last committed Oracle System Change Number [SCN].

- XID

  Transaction ID.

- LCR

  Last committed record number.

- MINSCN

  Minimum stored Oracle SCN.

- PLOGSEQ

PLOG file sequence number.

E.2.7. Terminology: Fields *appliedLastSeqno*

The last sequence number for the transaction from the Tungsten stage that has been applied to the database. This indicates the last actual transaction information written into the Replica database.

```
appliedLastSeqno : 212
```

When using parallel replication, this parameter returns the minimum applied sequence number among all the channels applying data.

E.2.8. Terminology: Fields *appliedLatency*

The *appliedLatency* is the latency between the commit time of the source event and the time the last committed transaction reached the end of the corresponding pipeline within the replicator.

Within a Primary, this indicates the latency between the transaction commit time and when it was written to the THL. In a Replica, it indicates the latency between the commit time on the Primary database and when the transaction has been committed to the destination database. Clocks must be synchronized across hosts for this information to be accurate.

```
appliedLatency : 0.828
```

The latency is measure in seconds. Increasing latency may indicate that the destination database is unable to keep up with the transactions from the Primary.

In replicators that are operating with parallel apply, *appliedLatency* indicates the latency of the trailing channel. Because the parallel apply mechanism does not update all channels simultaneously, the figure shown may trail significantly from the actual latency.

E.2.9. Terminology: Fields *applier.class*

Classname of the current applier engine

E.2.10. Terminology: Fields *applier.name*

Name of the current applier engine

E.2.11. Terminology: Fields *applyTime*

E.2.12. Terminology: Fields *autoRecoveryEnabled*

Indicates whether autorecovery has been enabled by setting the `--auto-recovery-max-attempts` [433]. The field indicates the value as either `true` or `false` accordingly.

E.2.13. Terminology: Fields *autoRecoveryTotal*

A count of the number of times the replicator has used autorecovery to go back online since the replicator was started. This can be used to determine if autorecovery has been used. More details on autorecovery can be found in the `trepsvc.log` file.

The counter is reset when the replicator determines that the replicator has successfully gone online after an autorecovery.

E.2.14. Terminology: Fields *averageBlockSize*

E.2.15. Terminology: Fields *blockCommitRowCount*

E.2.16. Terminology: Fields *cancelled*

E.2.17. Terminology: Fields *channel*

E.2.18. Terminology: Fields *channels*

The number of channels being used to apply transactions to the target dataserver. In a standard replication setup there is typically only one channel. When parallel replication is in effect, there will be more than one channel used to apply transactions.

```
channels : 1
```

E.2.19. Terminology: Fields *clusterName*

The name of the cluster. This information is different to the service name and is used to identify the cluster, rather than the individual service information being output.

E.2.20. Terminology: Fields *commits*

E.2.21. Terminology: Fields *committedMinSeqno*

E.2.22. Terminology: Fields *criticalPartition*

E.2.23. Terminology: Fields *currentBlockSize*

E.2.24. Terminology: Fields *currentEventId*

Event ID of the transaction currently being processed

E.2.25. Terminology: Fields *currentLastEventId*

E.2.26. Terminology: Fields *currentLastFragno*

E.2.27. Terminology: Fields *currentLastSeqno*

E.2.28. Terminology: Fields *currentTimeMillis*

The current time on the host, in milliseconds since the epoch. This information can used to confirm that the time on different hosts is within a suitable limit. Internally, the information is used to record the time when transactions are applied, and may therefore the *appliedLatency* figure.

E.2.29. Terminology: Fields *dataServerHost*

E.2.30. Terminology: Fields *discardCount*

E.2.31. Terminology: Fields *doChecksum*

E.2.32. Terminology: Fields *estimatedOfflineInterval*

E.2.33. Terminology: Fields *eventCount*

E.2.34. Terminology: Fields *extensions*

E.2.35. Terminology: Fields *extractTime*

E.2.36. Terminology: Fields *extractor.class*

E.2.37. Terminology: Fields *extractor.name*

E.2.38. Terminology: Fields *filter.#.class*

E.2.39. Terminology: Fields *filter.#.name*

E.2.40. Terminology: Fields *filterTime*

E.2.41. Terminology: Fields *flushIntervalMillis*

E.2.42. Terminology: Fields *fsyncOnFlush*

E.2.43. Terminology: Fields *headSeqno*

E.2.44. Terminology: Fields *intervalGuard*

E.2.45. Terminology: Fields *lastCommittedBlockSize*

The *lastCommittedBlockSize* contains the size of the last block that was committed as part of the block commit procedure. The value is only displayed on appliers and defines the number of events in the last block. By comparing this value to the configured block commit size, the commit type can be determined.

For more information, see Section 12.1, "Block Commit".

E.2.46. Terminology: Fields *lastCommittedBlockTime*

The *lastCommittedBlockSize* contains the duration since the last committed block. The value is only displayed on appliers and defines the number of seconds since the last block was committed. By comparing this value to the configured block interval, the commit type can be determined.

For more information, see Section 12.1, "Block Commit".

E.2.47. Terminology: Fields *latestEpochNumber*

E.2.48. Terminology: Fields *logConnectionTimeout*

E.2.49. Terminology: Fields *logDir*

E.2.50. Terminology: Fields *logFileRetainMillis*

E.2.51. Terminology: Fields *logFileSize*

E.2.52. Terminology: Fields *maxChannel*

E.2.53. Terminology: Fields *maxDelayInterval*

E.2.54. Terminology: Fields *maxOfflineInterval*

E.2.55. Terminology: Fields *maxSize*

E.2.56. Terminology: Fields *maximumStoredSeqNo*

The maximum transaction ID that has been stored locally on the machine in the THL. Because Tungsten Replicator operates in stages, it is sometimes important to compare the sequence and latency between information being ready from the source into the THL, and then from the THL into the database. You can compare this value to the *appliedLastSeqno*, which indicates the last sequence committed to the database. The information is provided at a resolution of milliseconds.

```
maximumStoredSeqNo : 25
```

E.2.57. Terminology: Fields *minimumStoredSeqNo*

The minimum transaction ID stored locally in the THL on the host:

```
minimumStoredSeqNo : 0
```

The figure should match the lowest transaction ID as output by the thl index command. On a busy host, or one where the THL information has been purged, the figure will show the corresponding transaction ID as stored in the THL.

E.2.58. Terminology: Fields *name*

E.2.59. Terminology: Fields *offlineRequests*

Contains the specifications of one or more future offline events that have been configured for the replicator. Multiple events are separated by a semicolon:

```
shell> trepctl status
...
inimumStoredSeqNo : 0
offlineRequests : Offline at sequence number: 5262;Offline at time: 2014-01-01 00:00:00 EST
pendingError : NONE
```

E.2.60. Terminology: Fields *otherTime*

E.2.61. Terminology: Fields *pendingError*

E.2.62. Terminology: Fields *pendingErrorCode*

E.2.63. Terminology: Fields *pendingErrorEventId*

E.2.64. Terminology: Fields *pendingErrorSeqno*

The sequence number where the current error was identified

E.2.65. Terminology: Fields *pendingExceptionMessage*

The current error message that caused the current replicator offline

E.2.66. Terminology: Fields *pipelineSource*

The source for data for the current pipeline. On a Primary, the pipeline source is the database that the Primary is connected to and extracting data from. Within a Replica, the pipeline source is the Primary replicator that is providing THL data.

E.2.67. Terminology: Fields *processedMinSeqno*

E.2.68. Terminology: Fields *queues*

E.2.69. Terminology: Fields *readOnly*

E.2.70. Terminology: Fields *relativeLatency*

The relativeLatency is the latency between now and timestamp of the last event written into the local THL. This information gives an indication of how fresh the incoming THL information is. On a Primary, it indicates whether the Primary is keeping up with transactions generated on the Primary database. On a Replica, it indicates how up to date the THL read from the Primary is.

A large value can either indicate that the database is not busy, that a large transaction is currently being read from the source database, or from the Primary replicator, or that the replicator has stalled for some reason.

An increasing *relativeLatency* on the Replica may indicate that the replicator may have stalled and stopped applying changes to the dataserver.

E.2.71. Terminology: Fields *resourcePrecedence*

E.2.72. Terminology: Fields *rmiPort*

E.2.73. Terminology: Fields *role*

The current role of the host in the corresponding service specification. Primary roles are *master* and *slave*.

E.2.74. Terminology: Fields *seqnoType*

The internal class used to store the transaction ID. In MySQL replication, the sequence number is typically stored internally as a Java Long (`java.lang.Long`). In heterogeneous replication environments, the type used may be different to match the required information from the source database.

E.2.75. Terminology: Fields *serializationCount*

E.2.76. Terminology: Fields *serialized*

E.2.77. Terminology: Fields *serviceName*

The name of the configured service, as defined when the deployment was first created through tpm.

```
serviceName : alpha
```

A replicator may support multiple services. The information is output to confirm the service information being displayed.

E.2.78. Terminology: Fields *serviceType*

The configured service type. Where the replicator is on the same host as the database, the service is considered to be `local`. When reading or write to a remote dataserver, the service is `remote`.

E.2.79. Terminology: Fields *shard_id*

E.2.80. Terminology: Fields *simpleServiceName*

A simplified version of the *serviceName*.

E.2.81. Terminology: Fields *siteName*

E.2.82. Terminology: Fields *sourceId*

E.2.83. Terminology: Fields *stage*

E.2.84. Terminology: Fields *started*

E.2.85. Terminology: Fields *state*

E.2.86. Terminology: Fields *stopRequested*

E.2.87. Terminology: Fields *store.#*

E.2.88. Terminology: Fields *storeClass*

E.2.89. Terminology: Fields *syncInterval*

E.2.90. Terminology: Fields *taskCount*

E.2.91. Terminology: Fields *taskId*

E.2.92. Terminology: Fields *timeInCurrentEvent*

Shows the time that the replicator has been processing the current event. When processing very large transactions this can be used to determine whether the replicator has stalled or is still actively extracting or applying the information.

E.2.93. Terminology: Fields *timeInStateSeconds*

E.2.94. Terminology: Fields *timeoutMillis*

E.2.95. Terminology: Fields *totalAssignments*

E.2.96. Terminology: Fields *transitioningTo*

E.2.97. Terminology: Fields *uptimeSeconds*

E.2.98. Terminology: Fields *version*

Appendix F. Internals

Tungsten Cluster includes a number of different systems and elements to provide the core services and functionality. Some of these are designed only to be customer-configured. Others should be changed only on the advice of Continuent or Continuent support. This chapter covers a range of different systems hat are designated as internal features and functionality.

This chapter contains information on the following sections of Tungsten Cluster:

- Section F.1, "Extending Backup and Restore Behavior" — details on how the backup scripts operate and how to write custom backup scripts.
- Section F.2, "Character Sets in Database and Tungsten Cluster" — covers how character sets affect replication and command-line tool output.
- Section F.4, "Memory Tuning and Performance" — information on how the memory is used and allocated within Tungsten Cluster.

F.1. Extending Backup and Restore Behavior

The backup and restore system within Tungsten Cluster is handled entirely by the replicator. When a backup is initiated, the replicator on the specified datasource is asked to start the backup process.

The backup and restore system both use a modular mechanism that is used to perform the actual backup or restore operation. This can be configured to use specific backup tools or a custom script.

F.1.1. Backup Behavior

When a backup is requested, the Tungsten Replicator performs a number of separate, discrete, operations designed to perform the backup operation.

The backup operation performs the following steps:

1. Tungsten Replicator identifies the filename where properties about the backup will be stored. The file is used as the primary interface between the underlying backup script and Tungsten Replicator.
2. Tungsten Replicator executes the configured backup/restore script, supplying any configured arguments, and the location of a properties file, which the script updates with the location of the backup file created during the process.
3. If the backup completes successfully, the file generated by the backup process is copied into the configured Tungsten Cluster directory (for example `/opt/continuent/backups`.
4. Tungsten Replicator updates the property information with a CRC value for the backup file and the standard metadata for backups, including the tool used to create the backup.

A log is created of the backup process into a file according to the configured backup configuration. For example, when backing up using mysqldump the log is written to the log directory as `mysqldump.log`. When using a custom script, the log is written to `script.log`.

As standard, Tungsten Replicator supports two primary backup types, mysqldump and xtrabackup. A third option is based on the incremental version of the xtrabackup tool. The use of external backup script enables additional backup tools and methods to be supported.

To create a custom backup script, see Section F.1.3, "Writing a Custom Backup/Restore Script" for a list of requirements and samples.

F.1.2. Restore Behavior

The restore operation operates in a similar manner to the backup operation. The same script is called (but supplied with the `-restore` command-line option).

The restore operation performs the following steps:

1. Tungsten Replicator creates a temporary properties file, which contains the location of the backup file to be restored.
2. Tungsten Replicator executes the configured backup/restore script in restore mode, supplying any configured arguments, and the location of the properties file.
3. The script used during the restore process should read the supplied properties file to determine the location of the backup file.
4. The script performs all the necessary steps to achieve the restore process, including stopping the dataserver, restoring the data, and restarting the dataserver.

5. The replicator will remain in the `OFFLINE` state once the restore process has finished.

F.1.3. Writing a Custom Backup/Restore Script

The synopsis of the custom script is as follows:

`SCRIPT` {`-backup-restore`} -properties `FILE` -options `OPTIONS`

Where:

- `-backup` — indicates that the script should work in the backup mode and create a backup.
- `-restore` — indicates that the scrip should work in the restore mode and restore a previous backup.
- `-properties` — defines the name of the properties file. When called in *backup* mode, the properties file should be updated by the script with the location of the generated backup file. When called in *restore* mode, the file should be examined by the script to determine the backup file that will be used to perform the restore operation.
- `-options` — specifies any unique options to the script.

The custom script must support the following:

- The script must be capable of performing both the backup and the restore operation. Tungsten Replicator selects the operation by providing the `-backup` or `-restore` option to the script on the command-line.
- The script must parse command-line arguments to extract the operation type, properties file and other settings.
- Accept the name of the properties file to be used during the backup process. This is supplied on the command-line using the format:

  ```
  -properties FILENAME
  ```

  The properties file is used by Tungsten Replicator to exchange information about the backup or restore.
- Must parse any additional options supplied on the command-line using the format:

  ```
  -options ARG1=VAL1&ARG2=VAL2
  ```
- Must be responsible for executing whatever steps are required to create a consistent snapshot of the dataserver
- Must place the contents of the database backup into a single file. If the backup process generates multiple files, then the contents should be packaged using tar or zip.

  The script has to determine the files that were generated during the backup process and collect them into a single file as appropriate.
- Must update the supplied properties with the name of the backup file generated, as follows:

  ```
  file=BACKUPFILE
  ```

  If the file has not been updated with the information, or the file cannot be found, then the backup is considered to have failed.

  Once the backup process has completed, the backup file specified in the properties file will be moved to the configured backup location (for example `/opt/continuent/backups`).
- Tungsten Replicator will forward all `STDOUT` and `STDERR` from the script to the log file `script.log` within the log directory. This file is recreated each time a backup is executed.
- Script should have an exit (return) value of 0 for success, and 1 for failure. The script is responsible for handling any errors in the underlying backup tool or script used to perform the backup, but it must then pass the corresponding success or failure condition using the exit code.

A sample Ruby script that creates a simple text file as the backup content, but demonstrates the core operations for the script is shown below:

```
#!/usr/bin/env ruby
require "/opt/continuent/tungsten/cluster-home/lib/ruby/tungsten"
require "/opt/continuent/tungsten/tungsten-replicator/lib/ruby/backup"
class MyCustomBackupScript < TungstenBackupScript
  def backup
    TU.info("Take a backup with arg1 = #{@options[:arg1]} and myarg = #
{@options[:myarg]}")
    storage_file = "/opt/continuent/backups/backup_" +
Time.now.strftime("%Y-%m-%d_%H-%M") + "_" + rand(100).to_s()
    # Take a backup of the server and store the information to
storage_file
    TU.cmd_result("echo 'my backup' > #{storage_file}")
```

```
    # Write the filename to the final storage file
    TU.cmd_result("echo \"file=#{storage_file}\" > #
{@options[:properties]}")
end
  def restore
    storage_file = TU.cmd_result(". #{@options[:properties]}; echo
$file")
    TU.info("Restore a backup from #{storage_file} with arg1 = #
{@options[:arg1]} and myarg = #{@options[:myarg]}")
    # Process the contents of storage_file to restore into the database
server
end
```

An alternative script using Perl is provided below:

```
#!/usr/bin/perl

use strict;
use warnings;
use Getopt::Long;
use IO::File;

my $argstring = join(' ',@ARGV);

my ($backup,$restore,$properties,$options) = (0,0,'','');

my $result = GetOptions("backup" => \$backup,
   "restore" => \$restore,
   "properties=s" => \$properties,
   "options=s" => \$options,
    );

if ($backup)
{
    my ($sec,$min,$hour,$mday,$mon,$year,$wday,$yday,$isdst) = localtime(time);
    my $backupfile = sprintf('mcbackup.%04d%02d%02d-%02d%02d%02d-%02d.dump',
        ($year+1900),$mon,$mday,$hour,$min,$sec,$$);

    my $out = IO::File->new($backupfile,'w') or die "Couldn't open the backup file: $backupfile";

# Fake backup data

    print $out "Backup data!\n";

    $out->close();

# Update the properties file
    my $propfile = IO::File->new($properties,'w') or die "Couldn't write to the properties file";
    print $propfile "file=$backupfile\n";
    $propfile->close();
}

if ($restore)
{
    warn "Would be restoring information using $argstring\n";
}

exit 0;
```

F.1.4. Enabling a Custom Backup Script

To enable a custom backup script, the installation must be updated through tpm to use the script backup method. To update the configuration:

1. Create or copy the backup script into a suitable location, for example `/opt/continuent/share`.
2. Copy the script to each of the datasources within your dataservice.
3. Update the configuration using tpm. The `--repl-backup-method` [434] should be set to *`script`*, and the directory location set using the `--repl-backup-script` [435] option:

   ```
   shell> ./tools/tpm update --repl-backup-method=script \
       --repl-backup-script=/opt/continuent/share/mcbackup.pl \
       --repl-backup-online=true
   ```

   The `--repl-backup-online` [435] option indicates whether the backup script operates in online or offline mode. If set to false, replicator must be in the offline state because the backup process is started.

   To pass additional arguments or options to the script, use the *`replicator.backup.agent.script.options`* property to supply a list of ampersand separate key/value pairs, for example:

```
--property=replicator.backup.agent.script.options="arg1=val1&myarg=val2"
```

These are the custom parameters which are supplied to the script as the value of the `-options` parameter when the script is called.

Once the backup script has been enabled within the configuration it can be used when performing a backup through the standard backup or restore interface:

For example, within cctrl:

```
[LOGICAL:EXPERT] /alpha > datasource host2 backup script
```

> **Note**
>
> Note that the name of the backup method is `script`, not the actual name of the script being used.

F.2. Character Sets in Database and Tungsten Cluster

Character sets within the databases and within the configuration for Java and the wrappers for Tungsten Cluster must match to enable the information to be extracted and viewed.

For example, if you are extracting with the UTF-8 character set, the data must be applied to the target database using the same character set. In addition, the Tungsten Replicator should be configured with a corresponding matching character set. For installations where replication is between identical database flavours (for example, MySQL and MySQL) no explicit setting should be made. For heterogeneous deployments, the character set should be set explicitly.

When installing and using Tungsten Cluster, be aware of the following aspects when using character sets:

- When installing Tungsten Cluster, use the `--java-file-encoding` [452] to tpm to configure the character set.
- When using the thl command, the character set may need to be explicitly stated to view the content correctly:

```
shell> thl list -charset utf8
```

For more information on setting character sets within your database, see your documentation for the database:

- MySQL

For more information on the character set names and support within Java, see:

- Java 8 SE

F.3. Understanding Replication of Date/Time Values

- Replicator processes default to UTC internally by setting the Java VM default time zone to UTC. This default can be changed by setting the replicator.time_zone property in the replicator services.propertiesx file but is not recommended other than for problem diagnosis or specialized testing.
- Replicas store a time zone on statements and row changes extracted from MySQL.
- Replicators use UTC as the session time zone when applying to MySQL replicas.
- Replicators similarly default to UTC when applying transactions to data warehouses like Hadoop, Vertica, or Amazon Redshift.
- The thl utility prints time-related data using the default GMT time zone. This can be altered using the `-timezone` option.

Best Practices

We recommend the following steps to ensure successful replication of time-related data.

- Standardize all DBMS server and host time zones to UTC. This minimizes time zone inconsistencies between applications and data stores. The recommendation is particularly important when replicating between different DBMS types, such as MySQL to Hadoop.
- Use the default time zone settings for Tungsten replicator. Do not change the time zones unless specifically recommended by Continuent support.
- If you cannot standardize on UTC at least ensure that time zones are set consistently on all hosts and applications.

Arbitrary time zone settings create a number of corner cases for database management beyond replication. Standardizing on UTC helps minimize them, hence is strongly recommended.

F.4. Memory Tuning and Performance

Different areas of Tungsten Cluster use memory in different ways, according to the operation and requirements of the component. Specific information on how memory is used by different components and how it is used is available below:

- Tungsten Replicator — Memory performance and tuning options.
- Tungsten Connector — Memory usage requirements and tuning options.

F.4.1. Understanding Tungsten Replicator Memory Tuning

Replicators are implemented as Java processes, which use two types of memory: stack space, which is allocated per running thread and holds objects that are allocated within individual execution stack frames, and heap memory, which is where objects that persist across individual method calls live. Stack space is rarely a problem for Tungsten as replicators rarely run more than 200 threads and use limited recursion. The Java defaults are almost always sufficient. Heap memory on the other hand runs out if the replicator has too many transactions in memory at once. This results in the dreaded Java OutOfMemory exception, which causes the replicator to stop operating. When this happens you need to look at tuning the replicator memory size.

To understand replicator memory usage, we need to look into how replicators work internally. Replicators use a "pipeline" model of execution that streams transactions through 1 or more concurrently executing stages. As you can can see from the attached diagram, a Replica pipeline might have a stage to read transactions to the Primary and put them in the THL, a stage to read them back out of the THL into an in-memory queue, and a stage to apply those transactions to the Replica. This model ensures high performance as the stages work independently. This streaming model is quite efficient and normally permits Tungsten to transfer even exceedingly large transactions, as the replicator breaks them up into smaller pieces called transaction fragments.

The pipeline model has consequences for memory management. First of all, replicators are doing many things at one, hence need enough memory to hold all current objects. Second, the replicator works fastest if the in-memory queues between stages are large enough that they do not ever become empty. This keeps delays in upstream processing from delaying things at the end of the pipeline. Also, it allows replicators to make use of block commit. Block commit is an important performance optimization in which stages try to commit many transactions at once on Replicas to amortize the cost of commit. In block commit the end stage continues to commit transactions until it either runs out of work (i.e., the upstream queue becomes empty) or it hits the block commit limit. Larger upstream queues help keep the end stage from running out of work, hence increase efficiency.

Bearing this in mind, we can alter replicator behavior in a number of ways to make it use less memory or to handle larger amounts of traffic without getting a Java OutOfMemory error. You should look at each of these when tuning memory:

- Property wrapper.java.memory in file `wrapper.conf`. This controls the amount of heap memory available to replicators. 1024 MB is the minimum setting for most replicators. Busy replicators, those that have multiple services, or replicators that use parallel apply should consider using 2048 MB instead. If you get a Java OutOfMemory exception, you should first try raising the current setting to a higher value. This is usually enough to get past most memory-related problems. You can set this at installation time as the `--repl-java-mem-size` [452] parameter.

  If you set the heap memory to a very large value (e.g. over 3 GB), you should also consider enabling concurrent garbage collection. Java by default uses mark-and-sweep garbage collection, which may result in long pauses during which network calls to the replicator may fail. Concurrent garbage collection uses more CPU cycles and reduces on-going performance a bit but avoids periods of time during which the replicator is non-responsive. You can set this using the `--repl-java-enable-concurrent-gc` [451] parameter at installation time.)

- Property *`replicator.global.buffer.size`*.. This controls two things, the size of in-memory queues in the replicator as well as the block commit size. If you still have problems after increasing the heap size, try reducing this value. It reduces the number of objects simultaneously stored on the Java heap. A value of 2 is a good setting to try to get around temporary problems. This can be set at installation time as the `--repl-buffer-size` [436] parameter.

- Property replicator.stage.q-to-dbms.blockCommitRowCount in the replicator properties file. This parameter sets the block commit count in the final stage in a Replica pipeline. If you reduce the global buffer size, it is a good idea to set this to a fixed size, such as 10, to avoid reducing the block commit effect too much. Very low block commit values in this stage can cut update rates on Replicas by 50% or more in some cases. This is available at installation time as the `--repl-svc-applier-buffer-size` parameter.

- Property replicator.extractor.dbms.transaction_frag_size in the `replicator.properties` file. This parameter controls the size of fragments for long transactions. Tungsten automatically breaks up long transactions into fragments. This parameter controls the number of bytes of binlog per transaction fragment. You can try making this value smaller to reduce overall memory usage if many transactions are simultaneously present. Normally however this value has minimal impact.

Finally, it is worth mentioning that the main cause of out-of-memory conditions in replicators is large transactions. In particular, Tungsten cannot fragment individual statements or row changes, so changes to very large column values can also result in OutOfMemory conditions. For now the best approach is to raise memory, as described above, and change your application to avoid such transactions.

F.4.2. Connector Memory Management

The memory model within the Tungsten Connector works as follows:

- Memory consumption consists of the core memory, plus the buffered memory used for each connection.
- Each connection uses the maximum size of an `INSERT`, `UPDATE` or `SELECT`, up to the configured size of the MySQL `max_allowed_packet` parameter.

For example, with 1000 concurrent connections, and a result or insert size of 1 MB, the memory usage will be 1 GB.

The default setting for the Tungsten Connector memory size is 256 MB. The memory allocation can be increased using tpm and the `--conn-java-mem-size` [437] option:

For example, during installation:

```
shell> tpm install ... --conn-java-mem-size=1024
```

Or to update using tpm update:

```
shell> tpm update ... --conn-java-mem-size=1024
```

F.5. Tungsten Replicator Pipelines and Stages

A pipeline (or service) acts upon data.

Pipelines consist of a variable number of stages.

Every stage's workflow consists of three (3) actions, which are:

- Extract: the source for extraction could be the mysql server binary logs on a Primary, and the local THL on disk for a Replica
- Filter: any configured filters are applied here
- Apply: the apply target can be THL on disk on a Primary, and the database server on a Replica

Stages can be customized with filters, and filters are invoked on a per-stage basis.

By default, there are two pipeline services defined:

- Primary replication service, which contains two (2) stages:
  - binlog-to-q: reads information from the MySQL binary log and stores the information within an in-memory queue.
  - q-to-thl: in-memory queue is written out to the THL file on disk.
- Replica replication service, which contains three (3) stages:
  - remote-to-thl: remote THL information is read from a Primary datasource and written to a local file on disk.
  - thl-to-q: THL information is read from the file on disk and stored in an in-memory queue.
  - q-to-dbms: data from the in-memory queue is written to the target database.

F.6. Tungsten Cluster Schemas

Appendix G. Frequently Asked Questions (FAQ)

The following sections provide the questions and answers to questions often asked by customers and in forums.

G.1. General Questions

G.1.1. On a Tungsten Replicator Replica, how do I set both the local Replica THL listener port and the upstream Primaries THL listener port?

You need to specify two options: `thl-port` [470] to set the Replica THL listener port and `master-thl-port` [454] to define the upstream Primary THL listener port. Otherwise `thl-port` [470] alone sets BOTH.

G.1.2. How do I update the IP address of one or more hosts in the cluster?

To update the IP address used by one or more hosts in your cluster, you must perform the following steps:

1. If possible, switch the node into SHUNNED mode.
2. Reconfigure the IP address on the machine.
3. Update the hostname lookup, for example, by editing the IP configuration in `/etc/hosts`.
4. Restart the networking to reconfigure the service.
5. On the node that has changed IP address, run:

   ```
   shell> tpm update
   ```

   The above updates the configuration, but does not restart the individual services, which may still have the old, incorrect, IP address information for the host cached.
6. Restart the node services:

   ```
   shell> tpm restart
   ```
7. On each other node within the cluster:
   a. Update the hostname lookup for the new node, for example, by updating the IP configuration in `/etc/hosts`.
   b. Update the configuration, using tpm:

      ```
      shell> tpm update
      ```
   c. Restart the services:

      ```
      shell> tpm restart
      ```

G.1.3. How do I fix the mysql-connectorj to drizzle MySQL driver bug which prevents my application from connecting through the Connector?

When upgrading from version 2 to v4+, or simply just moving away from the mysql-connectorj driver to the Drizzle driver, the update process doesn't correctly remove all the connectorJ properties, causing a mismatch when connectors that did get the update try to make a connection to the cluster.

This is a known issue logged as CT-7

As yet, a fix has not been found, but the following workaround will correct the issue by hand:

To properly identify this issue, check the extended output of cctrl for the active driver. There will be one line of output for each node in the local cluster. Repeat once per cluster, on which node does not matter.

```
shell> echo ls -l | cctrl -expert| grep driver: | awk '{print $3}'
```

For example, for a three-node cluster, you may see something like this:

```
com.mysql.jdbc.Driver
com.mysql.jdbc.Driver
com.mysql.jdbc.Driver
```

If any line on any node in any cluster shows the `com.mysql.jdbc.Driver`, please use the workaround below:

> **Warning**
>
> If you have multiple clusters, either MSMM, CMM or Composite HA/DR, always ensure you check ALL clusters. Especially in Composite clusters, the Primary cluster, and especially the Primary node, must be checked and corrected if necessary.

Ensure the tpm update was done with the `--replace-release` option.

Review the tpm reverse output and analyze based on the following:

- `--mysql-driver=drizzle` [458] should exist in the defaults section
- You may (or may not) see the old `--mysql-connectorj-path` [458] entry within each service definition or in the defaults
- If none of the above appear in the output, then the default drizzle driver will be active by default as of v4.0.0.

Repeat the following steps for all clusters, one by one:

1. Place the cluster into Maintenance Mode using the cctrl command:

```
cctrl> set policy maintenance
```

2. Stop all managers on all nodes within the single cluster:

```
shell> manager stop
Stopping Tungsten Manager Service...
Waiting for Tungsten Manager Service to exit...
Stopped Tungsten Manager Service.
```

3. On all nodes within the single cluster, remove all files from the `/opt/continuent/tungsten/cluster-home/conf/cluster/{local_service-name}/datasource/` directory.

   Only delete the files from the local cluster service name directory, do not touch the composite service directory if there is one.

4. Start all managers on all nodes within the single cluster,starting with the Primary:

```
shell> manager start
Starting Tungsten Manager Service...
Waiting for Tungsten Manager Service.........
running: PID:24819
```

5. Place the cluster back into Automatic Mode

```
shell> echo set policy automatic | cctrl -expert
Tungsten Clustering 6.0.3 build 608
alpha: session established, encryption=false, authentication=false
[LOGICAL:EXPERT] /alpha > set policy automatic
policy mode is now AUTOMATIC
[LOGICAL:EXPERT] /alpha >
Exiting...
```

Once the above has been completed, confirm that the procedure has worked as follows:

```
shell> echo ls -l | cctrl -expert| grep driver: | awk '{print $3}'
org.drizzle.jdbc.DrizzleDriver
org.drizzle.jdbc.DrizzleDriver
org.drizzle.jdbc.DrizzleDriver
```

G.1.4. How do I update the password for the replication user in the cluster?

If you need to change the password used by Tungsten Cluster to connect to a dataserver and apply changes, the password can be updated first by changing the information within the your dataserver, and then by updating the configuration using tpm update. The new password is not checked until the Tungsten Replicator process is starting. Changing the password and then updating the configuration will keep replication from failing.

1. Within cctrl set the maintenance policy mode:

```
cctrl> set policy maintenance
```

2. Within MySQL, update the password for the user, allowing the change to be replicated to the other datasources:

```
mysql> SET PASSWORD FOR tungsten@'%' = PASSWORD('new_pass');
```

3. Follow the directions for tpm update to apply the `--datasource-password=new_pass` [463] setting.

4. Set the policy mode in cctrl back to *AUTOMATIC*:

```
cctrl> set policy automatic
```

G.1.5. One of my hosts is regularly a number of seconds behind my other Replicas?

The most likely culprit for this issue is that the time is different on the machine in question. If you have ntp or a similar network time tool installed on your machine, use it to update the current time across *all* the hosts within your deployment:

```
shell> ntpdate pool.ntp.org
```

Once the command has been executed across all the hosts, trying sending a heartbeat on the Primary to Replicas and checking the latency:

```
shell> trepctl heartbeat
```

G.1.6. Does the replicate filter (i.e. replicate.do and replicate.ignore) address both DML and DDL?

Both filters replicate.do and replicate.ignore will either do or ignore both DML and DDL

DDL is currently ONLY replicated for MySQL to MySQL or Oracle to Oracle topologies, or within MySQL Clusters, although it would be advisable not to use ignore/do filters in a clustered environment where data/structural integrity is key.

With replicate.do, all DML and DDL will be replicated ONLY for any database or table listed as part of the do filter.

With replicate.ignore, all DML and DDL will be replicated except for any database or table listed as part of the ignore filter.

G.1.7. How do you change the replicator heap size after installation?

You can change the configuration by running the following command from the staging directory:

```
shell> ./tools/tpm --host=host1 --java-mem-size=2048
```

G.2. Cloud Deployment and Management

G.2.1. Do we support a 3-node cluster spread across three AWS Availability Zones?

This is a normal deployment pattern for working in AWS reduce risk. A single cluster works quite well in this topology.

G.2.2. What are the best settings for the Tungsten connector intelligent proxy?

Standard settings work out of the box. Fine tuning can be done by working with the specific customer application during a Proof-Of-Concept or Production roll-out.

G.2.3. How do we use Tungsten to scale DB nodes up/down?

Currently a manual process. New puppet modules to aid this process are being developed, and will be included in the documentation when completed. Here is a link to the relevant procedure Section 3.5.1, “Adding Datasources to an Existing Deployment”.

G.2.4. Do you handle bandwidth/traffic management to the DB servers?

This is not something currently supported.

Appendix H. Ecosystem Support

In addition to the core utilities provided by Tungsten Cluster, additional tools and scripts are available that augment the core code with additional functionality, such as integrating with third-party monitoring systems, or providing additional functionality that is designed to be used and adapted for specific needs and requirements.

Different documentation and information exists for the following tools:

- Github — a selection of tools and utilities are provided in Github to further support and expand the functionality of Tungsten Cluster during deployment, monitoring, and management.
- logrotate — provides configuration information for users making use of the logrotate to manage Tungsten Cluster logs.
- Cacti — templates and scripts to enable monitoring through the Cacti environment.
- Nagios — templates and scripts to enable monitoring through the Nagios environment.

H.1. Continuent Github Repositories

In addition to the core product releases, Continuent also support a number of repositories within the Github system.

To access these repositories and use the tools and information within them, use the git command (available from git-scm.com). To copy the repository to a machine, use the clone command, specifying the repository URL:

Appendix I. Configuration Property Reference