MySQL Utilities

Abstract

This is the MySQL™ Utilities Reference Manual. It documents both the GPL and commercial editions of the MySQL Utilities 1.5 release series through 1.5.6.

If you have not yet installed MySQL Utilities please download your free copy from the download site. MySQL Utilities is available for Windows, OS X, and Linux variants.

For notes detailing the changes in each release, see the MySQL Utilities Release Notes.

For legal information, see the Legal Notices.

For help with using MySQL, please visit either the MySQL Forums or MySQL Mailing Lists, where you can discuss your issues with other MySQL users.

For additional documentation on MySQL products, including translations of the documentation into other languages, and downloadable versions in variety of formats, including HTML and PDF formats, see the MySQL Documentation Library.

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Preface

This is the User Manual for the MySQL Utilities.

MySQL Utilities is both a set of command-line utilities as well as a Python library for making common DevOps tasks easy to accomplish. The library is written entirely in Python, meaning that it is not necessary to have any other tools or libraries installed to make it work. It is currently designed to work with Python v2.6 or later and there is no support (yet) for Python v3.1.

Layout

This manual is arranged in an order designed to provide a quick reference for how to use MySQL Utilities. It begins with a brief introduction of MySQL Utilities then presents a list of common administration tasks with examples of how utilities can be used to perform the tasks. From there, the manual begins a deeper dive into the utilities starting with overviews of each utility leading to a detailed description of each via a manual page format. Thus, the manual provides a documentation solution for several needs.

How to Use This Manual

You can use this manual to get a quick solution to an administrative task complete with explanation of how to run the utilities involved and the options and parameters needed. See the tasks chapter for this information.

You can use the manual to learn what utilities exist and how each fits into your own administrative needs. See the utility overview chapter for this information.

You can also use the manual to get more information about each utility and what each option and parameter does via the manuals section.

The manual concludes with a look at extending the MySQL Utilities library, a look at the developer testing environment, and a list of frequently asked questions.

Legal Notices

Chapter 1 How to Install MySQL Utilities

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MySQL Utilities is available in a number of repository formats. Although you may not see your specific operating system or platform listed, we provide general repository formats for most platforms. If none of the available repositories are applicable to your platform, you can use the source code repository and install MySQL Utilities from the command line.

The latest MySQL Utilities downloads are available at http://dev.mysql.com/downloads/utilities/1.5.html. The following sections discuss each repository.

For information specific to Fabric, see Section 8.2, "Installing and Configuring MySQL Fabric".

1.1 Prerequisites

MySQL Utilities requires Python 2.6. All of the Python code is written to conform to this version of Python.

For connecting to MySQL, MySQL Utilities requires a MySQL Connector/Python General Availability (GA) release (version 2.0.4/2.1.2 or later). If you do not have Connector/Python installed, see the download section for Connector/Python to download the appropriate repository.

1.2 Source Code

The source code repository for MySQL Utilities includes all of the utility code as well as the MySQL Utilities library and manual pages. It is available as an architecture independent distribution, in either Zip archive format (`.zip` file) or compressed `tar` archive format (`.tar.gz` file), or as a RPM package (`.rpm` file).

You can use this repository to install on any platform that has Python 2.6 installed. For example, you can use the `.tar.gz` version of the repository to install MySQL Utilities on OS X or Ubuntu. Choose "Linux - Generic" from the download page, and then the file name similar to `mysql-utilities-1.5.6.tar.gz`.

After you download and unpack the repository distribution, open a terminal window and navigate to the directory containing the file. Then unpack the file and install MySQL Utilities using the `setup.py` script as shown below.

```
shell> unzip mysql-utilities-1.5.6.zip
shell> cd mysql-utilities-1.5.6
shell> python ./setup.py build
shell> sudo python ./setup.py install
```

Note

Using this repository requires that you have Connector/Python installed or install it separately. For additional information, see Section 1.1, "Prerequisites".

The source code is also available as a .rpm package, which can be downloaded and uncompressed as follows. More specifically, we first unpack the .rpm package then unzip the resulting .zip file.

On Mac and some Unix systems, you can use these commands.

```
shell> tar -tzvf mysql-utilities-1.5.6-1.el7.src.rpm
shell> tar -xzvf mysql-utilities-1.5.6-1.el7.src.rpm
shell> unzip mysql-utilities-1.5.6.zip
```

On Linux systems without native .rpm support, you can use these commands. For example, you can install rpm2cpio then run that utility to extract the .zip file then unzip it.

```
shell> sudo apt-get install rpm2cpio
shell> rpm2cpio mysql-utilities-1.5.6-1.el7.src.rpm | cpio -i --make-directories
shell> unzip mysql-utilities-1.5.6.zip
```

If these commands do not work for your platform, check your platform documentation for ways to open and inspect .rpm files.

1.3 Oracle Linux and Red Hat Linux 6

This repository is available as an architecture-independent RPM package (`.rpm` file).

After you download the package, install it using the following command or similar depending on your platform configuration:

```
shell> sudo rpm -i mysql-utilities-1.5.6-el6.noarch.rpm
```

You can also use the RPM package manager that is part of your base operating system. See your operating system documentation for more details.

Note

MySQL Utilities requires Connector/Python to be installed. For additional information, see Section 1.1, "Prerequisites".

1.4 Debian Linux

The .deb repository is built for Debian 6 and is architecture independent. Although built expressly for Debian 6, it can be installed on various ports such as amd64, i386, etc.

Note

The repository does not work for Debian 7 because MySQL Utilities requires Python 2.6 and Debian 7 currently ships with Python 2.7. For Debian 7, use the source code repository to install MySQL Utilities.

After you download the file, install it using the following command or similar depending on your specific release or version of Debian:

```
shell> sudo dpkg -i mysql-utilities-1.5.6-debian6.0_all.deb
```

Note

MySQL Utilities requires Connector/Python to be installed. For additional information, see Section 1.1, "Prerequisites".

1.5 Microsoft Windows

Either install MySQL Utilities using the MySQL Installer for Windows (a system that manages installations and updates for all MySQL products on Windows), or download and execute the standalone file. The download links are as follows:

- **MySQL Installer**: Download and execute the MySQL Installer MSI file. Select the MySQL Utilities product and then proceed with the installation. This is the recommended approach, and automatically selects and installs the required prerequisites. See the MySQL Installer manual for additional details.
- **Standalone**: Download and execute the MySQL Utilities standalone MSI file.

Note

MySQL Utilities requires Connector/Python to be installed. For additional information, see Section 1.1, "Prerequisites".

1.6 OS X

The `.dmg` file available for OS X is built for x84-64 bit platforms, and supports OS X version 10.7 (Lion) and newer.

After you download the `.dmg` file, install MySQL Utilities by opening it and double clicking the `.pkg` file.

Note

MySQL Utilities requires Connector/Python to be installed. For additional information, see Section 1.1, "Prerequisites".

Chapter 2 Introduction

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This chapter introduces MySQL Utilities and presents information on how to access and download MySQL Utilities. It also includes the basics of how to use the account login option common to all utilities.

2.1 Introduction to MySQL Utilities

What are the MySQL Utilities?

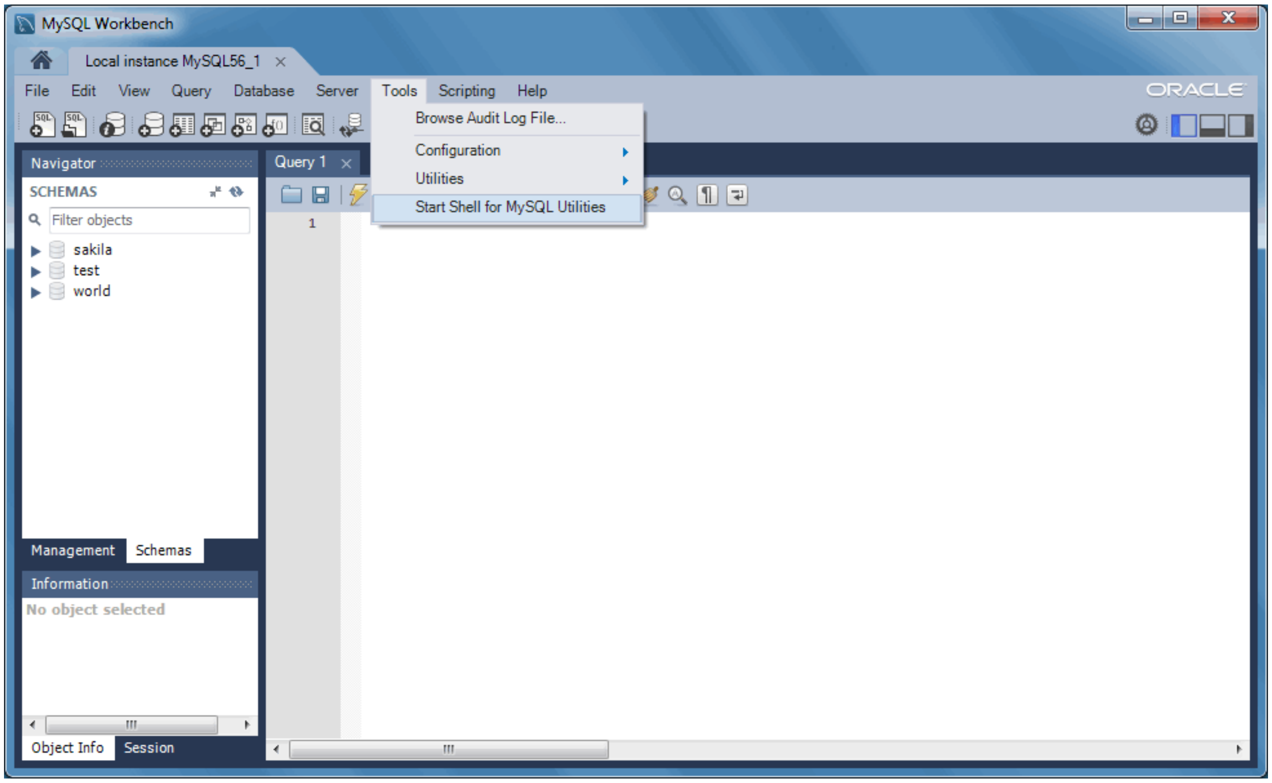
It is a package of utilities that are used for maintenance and administration of MySQL servers. These utilities encapsulate a set of primitive commands, and bundles them so they can be used to perform macro operations with a single command.

The utilities are written in Python, available under the GPLv2 license, and are extensible using the supplied library. They are designed to work with Python versions 2.6 or later and there is no support (yet) for Python v3.1.

How do we access the MySQL Utilities?

The MySQL Utilities are command line scripts, which by default are available in your system's PATH. Alternatively, if both MySQL Utilities and MySQL Workbench are installed, you can access their location from MySQL Workbench by selecting **Tools** from the main menu, and then **Start Shell for MySQL Utilities**. This opens a terminal/shell window in the `mysqluc` utility shell. Type "help" to list the available commands.

Figure 2.1 Starting MySQL Utilities from Workbench



You can launch any of the utilities listed by typing the name of the command. To find out what options are available, use the option, or read the appropriate manual page.

The utilities are designed to work on MySQL systems with grants enabled but can also operate on servers started with the `--skip-grant-tables` startup option. However, this practice is strongly discouraged and should be used only in situations where it is appropriate or deemed a last resort.

2.2 Connecting to MySQL Servers

This section describes the ways you can connect to a MySQL server via a MySQL Utility or via the MySQL Utilities library methods.

2.2.1 Connection Parameters

To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

- Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
- Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
- Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

2.2.1.1 Use login-paths (.mylogin.cnf)

The best way to specify server connection information is with your `.mylogin.cnf` file. Not only is this file encrypted, but any logging of the utility execution does not expose the connection information. Thus, no user names, passwords, ports, etc. are visible in the log. This is the preferred method for using MySQL Utilities to connect to servers.

Utilities support the use of login-paths in the connection string provided they use the following format `login-path-name[:port][:socket]` where the port and socket parameters are optional. If used, these optional parameters override the respective options from the specified login-path file.

When using login-paths, there are no default values except on Posix systems when specifying a socket. In this case, the host option defaults to localhost on port 3306. This means that combining the values specified in the login-path with the two optional values port and socket, one needs to specify at least a user, a hostname and a port or socket.

Use the mysql_config_editor tool (http://dev.mysql.com/doc/en/mysql-config-editor.html) to add the connection information as follows.

```
shell> mysql_config_editor set --login-path=instance_13001 --host=localhost --user=root --port=13001 --pass
Enter password: <Password is prompted to be inserted in a more secure way>
```

Next, use the following command to confirm that the login-path data was correctly added to `.mylogin.cnf` (the encrypted file):

```
shell> mysql_config_editor print --login-path=instance_13001
[instance_13001]
user = root
password = *****
host = localhost
port = 13001
```

Once your `.mylogin.cnf` file is configured, you need only specify the section of the `.mylogin.cnf` file for the server connection. For example, the section created in the previous example is 'instance_13001'. Thus, we use --server=instance_13001. The following shows the execution of a utility specifying the login-path section.

```
shell> mysqlserverinfo --server=instance_13001 --format=vertical

# Source on localhost: ... connected.
*************************       1. row *************************
server: localhost:13001
config_file: /etc/my.cnf, /etc/mysql/my.cnf
binary_log: clone-bin.000001
binary_log_pos: 341
relay_log:
relay_log_pos:
version: 5.6.17-log
datadir: /Volumes/Source/source/temp_13001/
basedir: /Volumes/Source/source/git/mysql-5.6
plugin_dir: /Volumes/Source/source/git/mysql-5.6/lib/plugin/
general_log: OFF
general_log_file:
general_log_file_size:
log_error:
log_error_file_size:
slow_query_log: OFF
slow_query_log_file:
slow_query_log_file_size:
```

```
1 row.
#...done.
```

See the online MySQL Reference Manual for more information about login-paths, the `.mylogin.cnf` file, and the `mysql_config_editor` client.

Note

If you have an installation where the MySQL Server version is older (before 5.6.25 or 5.7.8) and my_print_defaults is newer, then the Utilities cannot access the passwords in the `.login-path` file because the newer versions of my_print_defaults mask the passwords, but older versions do not.

2.2.1.2 Use a Configuration File

MySQL Utilities can also accept a configuration path and section for the server connection data. This allows you to store one or more sections with connection information. Saving the data in configuration files is more secure than specifying the data on the command-line but since the file is text, the data can still be read by anyone who can access the file.

To reference the configuration file, specify the path and file name followed by a section name in square brackets. The path is optional. If you do not specify it, the utility attempts to use your local configuration file (for example, my.cnf) if available.

For example, if you wanted to create a configuration file in /dev/env/test1/my.cnf and you created a section named server1, you would specify it as --server=/dev/env/test1/my.cnf[server1]. The corresponding section in the configuration file may look like the following.

```
[server1]
port=3308
user=root
password=other-pass
host=localhost
```

The following shows the execution of a utility using a configuration file.

```
shell> mysqlserverinfo.py --server=/dev/env/test1/my.cnf[server1] --format=vertical

# Source on localhost: ... connected.
*************************       1. row *************************
server: localhost:13001
config_file: /etc/my.cnf, /etc/mysql/my.cnf
binary_log: clone-bin.000001
binary_log_pos: 341
relay_log:
relay_log_pos:
version: 5.6.17-log
datadir: /Volumes/Source/source/temp_13001/
basedir: /Volumes/Source/source/git/mysql-5.6
plugin_dir: /Volumes/Source/source/git/mysql-5.6/lib/plugin/
general_log: OFF
general_log_file:
general_log_file_size:
log_error:
log_error_file_size:
slow_query_log: OFF
slow_query_log_file:
slow_query_log_file_size:
1 row.
#...done.
```

2.2.1.3 Command-line Options

The least secure way to provide connection information for MySQL servers is to specify the data on the command-line. This is least secure because the data is visible on the command-line and is also visible in any log or redirection of the execution.

In this case, we specify the data in the following order: *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*] where the passwd, port, and socket are optional. Each item is described in more detail below.

- user

  The name of the user to connect.

- passwd

  The password to use when connecting. The default if no password is supplied is the empty password.

- host

  The domain name of the host or the IP address. This field accepts host names, and IPv4 and IPv6 addresses. It also accepts quoted values which are not validated and passed directly to the calling methods. This enables users to specify host names and IP addresses that are outside of the supported validation mechanisms.

- port

  The port to use when connecting to the server. The default if no port is supplied is 3306 (which is the default port for the MySQL server as well).

- unix_socket

  The socket to connect to (instead of using the host and port parameters).

The following demonstrates executing a utility using command-line options for connecting to a server.

```
shell> mysqlserverinfo.py --server=root:other-pass@localhost:3308 --format=vertical
# Source on localhost: ... connected.
*************************       1. row *************************
server: localhost:13001
config_file: /etc/my.cnf, /etc/mysql/my.cnf
binary_log: clone-bin.000001
binary_log_pos: 341
relay_log:
relay_log_pos:
version: 5.6.17-log
datadir: /Volumes/Source/source/temp_13001/
basedir: /Volumes/Source/source/git/mysql-5.6
plugin_dir: /Volumes/Source/source/git/mysql-5.6/lib/plugin/
general_log: OFF
general_log_file:
general_log_file_size:
log_error:
log_error_file_size:
slow_query_log: OFF
slow_query_log_file:
slow_query_log_file_size:
1 row.
#...done.
```

As of MySQL Utilities 1.4.4, this deprecated connection method issues a warning if you use this connection method.

2.2.2 Specifying Connections in Python Library

If you build your own utilities using the MySQL Utilities library, there are various methods for connecting to MySQL servers. Methods that deal with connecting to servers can accept the following mechanisms for supplying the data.

- As a Python dictionary containing the connection parameters.
- As a connection specification string containing the connection parameters.
- As a Server instance.

The dictionary lists the values by name as described above. For example, you would create code like the following.

```
# Set connection values
dest_values = {
    "user" : "root",
    "passwd" : "secret",
    "host" : "localhost",
    "port" : 3308,
    "unix_socket" : None,
}
```

The connection specification is a string the form *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*] where the passwd, port, and socket are optional. This string is parsed using the options.parse_connection function.

You can also specify an existing instance of the Server class. In this case, the new class copies the connection information.

2.2.2.1 Specifying Secure Socket Layer (SSL) Options

Security is a big concern and MySQL Utilities is prepared to use a secure connection to MySQL server secure-connections using an encrypted connection with SSL. This section shows you how to use SSL when connecting to MySQL servers from any utility. All of the utilities use the same mechanism for establishing an SSL connection and include the following options.

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

In order to use SSL connections, the MySQL server must be configure using the `--ssl-ca` `--ssl-cert` and `--ssl-key` options with a specific SSL certificate. The `--ssl` option is used to enforce an SSL option. That is, if an SSL connection cannot be made, do not fall back to a normal connection. This option is not needed unless you want to enforce an SSL connection.

Note

If you are uncertain of how to create the SSL certificates, please following the steps indicated on Creating SSL and RSA Certificates and Keys.

Each utility permits the user to specify the `--ssl-ca`, `--ssl-cert`, `--ssl-key`, and `--ssl` options to create a SSL connection to a MySQL server. Simply specify the same options used when the server was started.

For example, if we wanted to get the information about a server that supports SSL connections, we first identify the SSL certificate authority (`--ssl-ca`), SSL certificate (`--ssl-cert`), and SSL key (`--ssl-key`). We want the connection to default to a normal connection if an SSL connection cannot be made, thus we omit the `--ssl` option.

Thus, we use the values from the server SSL configuration with the corresponding options for the utility. The following is an example of the running the serverinfo command with an SSL connection.

```
shell> mysqlserverinfo --server=root:pass@localhost:3307 \
          --ssl-ca=C:/newcerts/cacert.pem \
          --ssl-cert=C:/newcerts/client-cert.pem \
          --ssl-key=C:/newcerts/client-key.pem \
          --format=vertical
# Source on localhost: ... connected.
*************************       1. row *************************
                   server: localhost:3307
              config_file:
               binary_log:
           binary_log_pos:
                relay_log:
            relay_log_pos:
                  version: 5.6.15
                  datadir: C:\MySQL\instance_3307\
                  basedir: C:\MySQL\mysql-5.6.15-winx64
               plugin_dir: C:\MySQL\mysql-5.6.15-winx64\lib\plugin\
              general_log: OFF
         general_log_file:
    general_log_file_size:
                log_error: C:\MySQL\instance_3307\clone.err
      log_error_file_size: 1569 bytes
           slow_query_log: OFF
      slow_query_log_file:
 slow_query_log_file_size:
1 row.
#...done.
```

Chapter 3 MySQL Utilities Administrative Tasks

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MySQL Utilities provides a command-line set of tools for working with MySQL Servers and databases. MySQL Utilities fully supports MySQL Server versions 5.1 and above. It is also compatible with MySQL Server 5.0, but not every feature of 5.0 may be supported. It does not support MySQL Server versions 4.x.

In this section, we present a number of example administrative tasks introduced by an example "How do I?" question. Included in each is a description of the need, objective, goals, example execution, and a discussion about the specific options and techniques illustrated. Also included is a description of the specific permissions required to execute the utilities demonstrated and tips for using the utility.

These task descriptions are not a substitute for the full manual of each utility, rather, they represent examples of how you can use the utility. For a complete description of the utility and all of its options and arguments, see the manual page for that utility elsewhere in this manual.

3.1 Database Operations

The tasks described in this section relate to those that are performed on or with one or more databases.

3.1.1 How do you provision a slave?

When working with replication, one of the most frequent maintenance tasks is adding a new slave for scale out. Although adding a new slave has been simplified with utilities like `mysqlreplicate`, provisioning the slave (copying data and getting replication started properly) can be a challenge (or at least tedious) if done manually.

Fortunately, we have two utilities - `mysqldbexport` and `mysqldbimport` - that have been designed to work with replication so that when the export is generated, you can include the proper replication control statements in the output stream.

Objectives

Perform slave provisioning using `mysqldbexport` and `mysqldbimport`.

Example Execution

```
shell> mysqldbexport --server=root:root@localhost:13001 --all --export=both --rpl=master --rpl-user=rpl:rpl >
shell> mysqldbimport --server=root:root@localhost:13002 data.sql

# Source on localhost: ... connected.
# Importing definitions from data.sql.
ERROR: The import operation contains GTID statements that require the global gtid_executed
system variable on the target to be empty (no value). The gtid_executed value must be reset
by issuing a RESET MASTER command on the target prior to attempting the import operation.
Once the global gtid_executed value is cleared, you may retry the import.

shell> mysql -uroot -proot -h 127.0.0.1 --port=13002 -e "RESET MASTER"
shell> mysqldbimport --server=root:root@localhost:13002 data.sql

# Source on localhost: ... connected.
# Importing definitions from data.sql.
CAUTION: The following 1 warning messages were included in the import file:
# WARNING: A partial export from a server that has GTIDs enabled will by default include
the GTIDs of all transactions, even those that changed suppressed parts of the database.
If you don't want to generate the GTID statement, use the --skip-gtid option. To export all
databases, use the --all and --export=both options.
#...done.
```

Discussion

There are several operations listed here. The first one we see is the execution of the `mysqldbexport` utility to create a file that includes an export of all databases as designated with the `--all` option. We add the '--export=both' option to ensure we include the definitions as well as the data.

We also add the `--rpl=master` option which instructs `mysqldbexport` to generate the replication commands with respect to the source server being the master. Lastly, we include the replication user and password to be included in the CHANGE MASTER command.

Next, we see an attempt to run the import using `mysqldbimport` but we see there is an error. The reason for the error is the `mysqldbimport` utility detected a possible problem on the slave whereby there were global transaction identifiers (GTIDs) recorded from the master. You can see this situation if you setup replication prior to running the import. The way to resolve the problem is to run the RESET MASTER command on the slave as shown in the next operation.

We then see a rerun of the import and in this case it succeeds. We see a warning that is issued any time there are replication commands detected in the input stream whenever GTIDs are enabled.

Permissions Required

The user used to read data from the master must have the SELECT privilege on all databases exported. The user on the slave must have the SUPER privilege to start replication.

Tips and Tricks

The warning issued during the import concerning GTIDs is to ensure you are aware that the process for gathering the proper GTIDs to execute on the slave include transactions from all databases. Thus, if you ran a partial export that includes the replication commands and you have GTIDs enabled, you should use the `--skip-rpl` option to skip the replication commands and restart replication manually.

Should your data be large enough to make the use of `mysqldbexport` impractical, you can use `mysqldbexport` to generate the correct replication commands anyway by using the `--export=definitions` option. This generates the SQL statements for the objects but not the data. You can then use the replication commands generated with your own backup and restore tools.

You can use the option `--rpl=slave` to generate a output stream that considers the source server a slave and uses the source servers master settings for generating the CHANGE MASTER command.

If you need to copy users, we can use the `mysqluserclone` to copy user accounts.

3.1.2 How do you make a copy of a database on the same server?

If you are working with a database and want to experiment with changes to objects or data either from direct manipulation (SQL commands) or as a result of interaction with an application, it is prudent to always have a copy to fall back to if something should go wrong.

Naturally, a full backup is key for any production server but what if you just want to do something as a test or as a prototype? Sure, you can restore from your backup when the test is complete but who has the time for that? Why not just make a copy of the database in question and use it in the experiment/test?

Objectives

The goal is to make a copy of a database and rename it to another name. We want to do this on a single database server without resorting to messy file copies and/or stopping the server.

In this case, we want to copy the world database in its entirety and rename the copy to world_clone.

The utility of choice here is named `mysqldbcopy` and it is capable of copying databases from server to another or on the same server. The following is an example of using the utility.

Example Execution

```
shell> mysqldbcopy --source=root:root@localhost \
          --destination=root:root@localhost world:world_clone
# Source on localhost: ... connected.
# Destination on localhost: ... connected.
# Copying database world renamed as world_clone
# Copying TABLE world.city
# Copying TABLE world.country
# Copying TABLE world.countrylanguage
# Copying data for TABLE world.city
# Copying data for TABLE world.country
# Copying data for TABLE world.countrylanguage
#...done.
```

```
shell> mysql -uroot -p -e "SHOW DATABASES"
+--------------------+
| Database           |
+--------------------+
| information_schema |
| employees          |
| mysql              |
| world              |
| world_clone        |
+--------------------+
```

Discussion

Notice we specified the source of the database we wanted to copy as well as the destination. In this case, they are the same server. You must specify it this way so that it is clear we are operating on the same server.

Notice how we specified the new name. We used the `old_name`:`new_name` syntax. You can do this for as many databases as you want to copy. That's right - you can copy multiple databases with a single command renaming each along the way.

To copy a database without renaming it (if the destination is a different server), you can omit the :`new_name` portion.

Permissions Required

The user must have SELECT privileges for the database(s) on the source server and have CREATE, INSERT, UPDATE on the destination server.

Tips and Tricks

You can copy all of the databases on a source server to the destination by using the `--all` option, although this option does not permit rename actions. To rename, you must specify the databases one at a time using the `old_name`:`new_name` syntax.

You can specify certain objects to exclude (skip) in the copy. Use the `--skip` option to omit the type of objects. For example, you may want to exclude copying of triggers, procedures, and functions. In this case, use the option '--skip=TRIGGERS,PROCEDURES,FUNCTIONS'. The values are case-insensitive and written in uppercase for emphasis.

The copy is replication and GTID aware and takes actions to preserve the binary log events during the copy.

You can set the locking type with the `--locking` option. Possible values include: *no-locks* = do not use any table locks, *lock-all* = use table locks but no transaction and no consistent read, and *snapshot* (default): consistent read using a single transaction.

Risks

Should the copy fail in the middle, the destination databases may be incomplete or inconsistent. Should this occur, drop (delete) the destination database in question, repair the cause of the failure, and restart the copy.

3.1.3 How can you make a copy of a database and change the storage engine?

Sometimes you may have need to create a copy of a database but want to change the storage engine of all tables to another engine.

For example, if you are migrating your database to InnoDB (a wise choice), you can copy the database to a new database on a new server and change the storage engine to InnoDB for all of the tables. For this, we can use the `mysqldbcopy` utility.

Objectives

In this example, we want to make a copy of the world database but change the storage engine to InnoDB and rename the database accordingly.

You can cause all tables in the destination databases to use a different storage engine with the `--new-storage-engine` option.

Example Execution

```
shell> mysqldbcopy --source=root:root@localhost:3306 \
--destination=root:root@localhost:3307 --new-storage-engine=InnoDB \
world:world_innodb
# Source on localhost: ... connected.
# Destination on localhost: ... connected.
# Copying database world renamed as world_innodb
# Replacing ENGINE=MyISAM with ENGINE=InnoDB for table `world_innodb`.city.
# Copying TABLE world_innodb.city
# Replacing ENGINE=MyISAM with ENGINE=InnoDB for table `world_innodb`.country.
# Copying TABLE world_innodb.country
# Replacing ENGINE=MyISAM with ENGINE=InnoDB for table `world_innodb`.countrylanguage.
# Copying TABLE world_innodb.countrylanguage
# Copying data for TABLE world_innodb.city
# Copying data for TABLE world_innodb.country
# Copying data for TABLE world_innodb.countrylanguage
#...done.

shell> mysql -uroot -proot -h 127.0.0.1 --port=3307 -e "SHOW DATABASES"
+--------------------+
| Database           |
+--------------------+
| information_schema |
| mysql              |
| sakila             |
| world              |
| world_innodb       |
+--------------------+

shell> mysql -uroot -p -h 127.0.0.1 --port=3307 -e "SHOW CREATE TABLE world_innodb.countrylanguage\G"
*************************** 1. row ***************************
       Table: countrylanguage
Create Table: CREATE TABLE `countrylanguage` (
  `CountryCode` char(3) NOT NULL DEFAULT '',
  `Language` char(30) NOT NULL DEFAULT '',
  `IsOfficial` enum('T','F') NOT NULL DEFAULT 'F',
  `Percentage` float(4,1) NOT NULL DEFAULT '0.0',
  PRIMARY KEY (`CountryCode`,`Language`),
  KEY `CountryCode` (`CountryCode`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1
```

Discussion

Notice here we created a copy of the database and changed all tables in the destination database to use the InnoDB storage engine with the `--new-storage-engine` option.

We show proof of the change by displaying the CREATE statement for one of the tables on the destination server.

Notice we also renamed the database by using the *old_name*:*new_name* syntax.

Permissions Required

The user must have SELECT privileges for the database(s) on the source server and have CREATE, INSERT, UPDATE on the destination server.

Tips and Tricks

You can exclude specific options by using the `--exclude` option specifying an SQL pattern expression. For example, to exclude objects that start with xy, use '--exclude=xy%'.

You can use REGEXP patterns in the `--exclude` option by specifying `--regexp` in addition to the `--exclude` option.

Risks

Should the copy fail in the middle, the destination databases may be incomplete or inconsistent. Should this occur, drop the destination database in question, repair the cause of the failure, and restart the copy.

If you are changing the storage engine from InnoDB, you may encounter warnings or errors if the tables contain foreign keys and the new storage engine does not support foreign keys.

3.1.4 How do you tell if a table on server A has the same structure as the same table on server B?

Multiple database servers that are kept synchronized manually or are compartmentalized for security purposes but are by practice kept up-to-date manually are prone to unintentional (and sometimes intentional) divergence.

For example, you may maintain a production server and a development server. The development server may have the same databases with the same structures as the production server (but maybe not the same data). However, the natural course of development, administrative tasks, and maintenance can sometimes leave the development server behind.

When this happens, you need to have a way to quickly check the schema for a table on the production server to see if the development server has the same structure. The utility of choice for this operation is `mysqldiff`.

Objectives

The goal is to compare a table schema on one server to another and show they differ.

Example Execution

```
shell> mysqldiff --server1=root:root@localhost \
--server2=root:root@localhost:3307 world.city:world.city --changes-for=server2
# server1 on localhost: ... connected.
# server2 on localhost: ... connected.
# Comparing world.city to world.city                                [FAIL]
# Object definitions differ. (--changes-for=server2)
#

--- world.city
+++ world.city
@@ -4,6 +4,7 @@
   `CountryCode` char(3) NOT NULL DEFAULT '',
   `District` char(20) NOT NULL DEFAULT '',
   `Population` int(11) NOT NULL DEFAULT '0',
+  `Climate` enum('tropical','dry','mild','continental','polar') DEFAULT NULL,
   PRIMARY KEY (`ID`),
   KEY `CountryCode` (`CountryCode`),
   CONSTRAINT `city_ibfk_1` FOREIGN KEY (`CountryCode`) REFERENCES `Country` (`Code`)
Compare failed. One or more differences found.
```

Discussion

Notice to accomplish this task, we simply specified each server with `--server1` and `--server2` then specified the database objects to compare with the *`db.object:db.object`* syntax.

Permissions Required

The user must have SELECT privileges for both objects on both servers as well as SELECT on the mysql database.

Tips and Tricks

You can set the direction of the compare by using the `--changes-for` option. For example, to see the changes for server1 as the target, use '--changes-for=server1'.

3.1.5 How do you synchronize a table on two servers where neither is up-to-date?

When working with servers that are used in different networks or are compartmentalized, or simply intentionally manually redundant (they do not use replication), or perhaps through some crisis, you may encounter a situation where a table (or an entire database) diverge.

We don't simply want to know which rows differ, rather, we need to know the SQL statements needed to bring the tables into synchronization. Furthermore, we aren't sure which table is most out of date so we'd like to see the transformation statements for both directions.

In this case, it would be very helpful to know exactly how the tables differ. For this, we use the `mysqldbcompare` utility.

Objectives

The goal is to generate the SQL transformation statements to synchronize the tables.

Example Execution

```
shell> mysqldbcompare --server1=root:root@localhost:13001 --server2=root:root@localhost:13002 \
          menagerie -a --difftype=SQL --show-reverse --quiet
# Checking databases menagerie on server1 and menagerie on server2
#

#
# Row counts are not the same among `menagerie`.`pet` and `menagerie`.`pet`.
#
# Transformation for --changes-for=server1:
#

DELETE FROM `menagerie`.`pet` WHERE `pet_num` = '10';
DELETE FROM `menagerie`.`pet` WHERE `pet_num` = '12';
INSERT INTO `menagerie`.`pet` (`pet_num`, `name`, `owner`, `species`, `sex`, `birth`, `death`)
  VALUES('11', 'Violet', 'Annette', 'dog', 'f', '2010-10-20', NULL);

#
```

```
# Transformation for reverse changes (--changes-for=server2):
#
# DELETE FROM `menagerie`.`pet` WHERE `pet_num` = '11';
# INSERT INTO `menagerie`.`pet` (`pet_num`, `name`, `owner`, `species`, `sex`, `birth`, `death`)
#   VALUES('10', 'JonJon', 'Annette', 'dog', 'm', '2010-10-20', '2012-07-01');
# INSERT INTO `menagerie`.`pet` (`pet_num`, `name`, `owner`, `species`, `sex`, `birth`, `death`)
#   VALUES('12', 'Charlie', 'Annette', 'dog', 'f', '2010-10-20', NULL);
#
```

Discussion

In the example above, we connected to two servers and compare the database named menagerie. We enabled the transformation statements using a combination of options as follows.

The `--difftype=SQL` option instructs the utility to generate the SQL statements.

The `--show-reverse` option instructs the utility to generate the differences in both direction. That is, from the perspective of server1 as compared to server2 and server2 as compared to server1. By convention, the second set is commented out should you wish to pipe the output to a consumer.

Lastly, the `--quiet` option simply turns off the verbosity of print statements that normally occur for communicating progress.

Permissions Required

The user must have the SELECT privilege for the databases on both servers.

Tips and Tricks

You can change the direction using the `--changes-for` option. For example, '--changes-for=server1' is the default direction and '--changes-for=server2' is the reverse. In the second case, the `--show-reverse` displays the perspective of server1 commented out for convenience and to make it easier to determine which is the alternative direction.

3.2 General Operations

The tasks described in this section include general tasks such as reporting information about a server and searching for objects or processes on a server.

3.2.1 How do you know how much space your data uses?

When preparing to create a backup or when performing maintenance on a server, it is often the case we need to know how much space is used by our data and the logs the server maintains. Fortunately, there is a utility for that.

Objectives

Show the disk space used by the databases and all logs using the `mysqldiskusage` utility.

Example Execution

```
shell> sudo env PYTHONPATH=$PYTHONPATH mysqldiskusage \
--server=root:root@localhost --all
# Source on localhost: ... connected.
# Database totals:
+-----------------+--------------+
| db_name         |       total  |
+-----------------+--------------+
| oltp2           | 829,669      |
| bvm              | 15,129        |
| db1              | 9,895         |
| db2              | 11,035        |
| employees        | 206,117,692   |
| griots           | 14,415        |
| mysql            | 995,722       |
| oltp1            | 177,393       |
| room_temp        | 9,847         |
| sakila           | 791,727       |
| test             | 647,911       |
| test_arduino     | 9,999         |
| welford_kindle   | 72,032        |
| world            | 472,785       |
| world_innodb     | 829,669       |
+------------------+--------------+

Total database disk usage = 210,175,251 bytes or 200.44 MB

# Log information.
+---------------------+--------------+
| log_name            |        size  |
+---------------------+--------------+
| host123.log         | 957,282,265  |
| host123-slow.log    |     123,647  |
| host123.local.err   | 321,772,803  |
+---------------------+--------------+

Total size of logs = 1,279,178,715 bytes or 1.19 GB

# Binary log information:
Current binary log file = my_log.000287
+-----------------+---------+
| log_file        | size    |
+-----------------+---------+
| my_log.000285   | 252208  |
| my_log.000286   | 256     |
| my_log.000287   | 3063    |
| my_log.index    | 48      |
+-----------------+---------+

Total size of binary logs = 255,575 bytes or 249.58 KB

# Server is not an active slave - no relay log information.
# InnoDB tablespace information:
+---------------+--------------+
| innodb_file   |        size  |
+---------------+--------------+
| ib_logfile0   |   5,242,880  |
| ib_logfile1   |   5,242,880  |
| ibdata1       | 815,792,128  |
| ibdata2       |  52,428,800  |
+---------------+--------------+

Total size of InnoDB files = 889,192,448 bytes or 848.00 MB

InnoDB freespace = 635,437,056 bytes or 606.00 MB
```

Discussion

To see all of the logs, we use the `--all` option which shows all logs and the InnoDB disk usage.

Notice we used elevated privileges to allow for reading of all of the files and databases in the data directory. In this case, the data directory is owned by the mysql user and a normal user account does not have read access.

The `--all` option instructs the utility to list all databases even if they contain no data.

Permissions Required

The user must have permissions to read the data directory or use an administrator or super user (sudo) account as shown in the example.

Tips and Tricks

You can run `mysqldiskusage` without privileges to read the data directory but in this case you may see an estimate of the disk usage rather than actual bytes used. You may also not be able to see a list of the logs if you run the utility remotely.

3.2.2 How do you recover the CREATE statement from a damaged or offline server?

When things go wrong badly enough that your server is down or cannot be restarted, but you can still access the data on disk, you may find yourself faced with a number of complex recovery tasks.

One of those is the need to discover the structure of a particular table or set of tables. Perhaps this is needed for an emergency recovery, a redeployment, or setup for a forensic investigation. Whatever the case, without a running MySQL server it is not possible to know the structure of a table unless you keep meticulous notes and/or use some form of high availability (redundancy) or source control for your database schemas.

Fortunately, there is a utility for situations like this. The `mysqlfrm` utility can be used to discover the structure of a table directly from the .frm files.

Objectives

With a downed or offline server, discover the structure of a table. More specifically, generate the CREATE TABLE SQL command.

Example Execution

```
shell> sudo env PYTHONPATH=$PYTHONPATH mysqlfrm --basedir=/usr/local/mysql \
          --port=3333 --user=user /usr/local/mysql/data/welford_kindle/books.frm

# Spawning server with --user=user.
# Starting the spawned server on port 3333 ... done.
# Reading .frm files
#
# Reading the books.frm file.
#
# CREATE statement for /usr/local/mysql/data/kindle/books.frm:
#

CREATE TABLE `welford_kindle`.`books` (
  `ISBN` char(32) NOT NULL PRIMARY KEY,
  `title` char(128) DEFAULT NULL,
  `purchase_date` date DEFAULT NULL,
  `cost` float(10,2) DEFAULT NULL
) ENGINE=MyISAM DEFAULT CHARSET=latin1

#...done.
```

Discussion

For this example, we used three required parameters; the base directory for the offline server (basedir), a new port to use for the spawned server (port), and a user name to use to run the spawned server (port).

The later is necessary since we must launch the `mysqlfrm` utility as root (sudo) in order to be able to read (copy) files from the protected data directory of the host server.

The `--port` option is always required for running the utility in default mode (it is not needed for diagnostic mode). You must supply a valid unused port. The utility checks to see if the port is in use and if so produces an error. The port is used to spawn a temporary instance of a MySQL server in order to attempt to recover the .frm file. This instance is shutdown at the end of the process and is not used for diagnostic mode.

We use the `--basedir` option instead of the `--server` option because we were faced with a situation where the original server was offline (down). Note that you can use the `--basedir` option for a running server if you do not want the utility to connect to the original server in any way.

Permissions Required

The permissions for using `mysqlfrm` vary and depend entirely on how you use it. If you use the utility to read .frm files in a protected folder like the example above (in either mode), you must have the ability to run the spawned server with privileges that allow you to read the protected files. For example, you could use a user account that has root-level privileges.

If you use the utility with a server connection, the user you use to connect must have the ability to read system variables at a minimum including read access to the mysql database.

You should never use the root user to spawn the server nor should you use the mysql user when spawning the server or running the utility.

Tips and Tricks

The utility is designed to work on the host where the .frm files reside. It does not permit connecting to a remote host to read .frm files.

If something goes wrong during the spawning of the server, use the verbosity option three times (-vvv) to turn on maximum depth debug statements. This ensures you see all of the messages from the start of the spawned server from bootstrap onward. Look for errors in these statements as to why the spawned server did not start.

If you do not want to permit the utility to launch a temporary instance of a MySQL server, you should use the diagnostic mode instead. However, the diagnostic mode may not recover all of the options for a table.

Risks

The utility performs a best effort approximation of the CREATE statement when run in diagnostic mode. As such, if you read a `.frm` file that uses character sets or collations other than the default and you do not use a `--server` option to connect to a server to read the character sets, this can result in miscalculated column sizes.

For example, suppose your default character set is latin1 which uses 1 byte per character. Let us also suppose you are attempting to read a .frm file that uses a character set that uses 3 bytes per character. Furthermore, we have no server to connect. In this case, the column sizes may be off by a factor of 3. A case in point would be a field such as col_a char(3) would appear in the output of the `mysqlfrm` utility as col_a char(9).

To mitigate risks such as this and to produce the most accurate CREATE statement in diagnostic mode, always use the `--server` option.

3.2.3 How do you create a new user with the same privileges as another user?

The MySQL privilege system permits you to create a set of permissions for each user. Sometimes the set of permissions are complex and may require multiple `GRANT` statements to effect. Other times, the user may acquire privileges over time.

Regardless of how it came about, you may find yourself needing to create a new user that has the same privileges as another user.

Objectives

The goal is to create one or more users whose permissions are identical to an original user on a single server.

Rather than discover what those privileges are using a SHOW GRANTS FOR statement, copy them into a script, modify it, copy and paste again for each user, etc., etc., we can use a single command to copy one user to a list of new users. We can even set different passwords for each user as we go.

Let's assume we have a user, joe@localhost, who has a long list of permissions. We need to create a clone of his user account for two new users, sally and john. Each of these users requires a new password.

Example Execution

```
shell> mysqluserclone --source=root@localhost \
          --destination=root@localhost \
          joe@localhost sally:secret1@localhost john:secret2@localhost
# Source on localhost: ... connected.
# Destination on localhost: ... connected.
# Cloning 2 users...
# Cloning joe@localhost to user sally:secret1@localhost
# Cloning joe@localhost to user john:secret2@localhost
# ...done.
```

Discussion

In the above example, we see the use of the `mysqluserclone` utility to clone the joe user to two new user accounts.

Notice we used the `--source` option to connect to the original server and `--destination` for the same server.

After that, we simply list the user we want to clone and the new users we want to create. In this case we use the format username:password@host to specify the user account name, password (optional), and host.

When the utility finishes, you have two new user accounts that have the same privileges as the original user; joe@localhost.

Permissions Required

On the source server, the user must have the SELECT privilege for the mysql database.

On the destination server, the user must have the global CREATE USER privilege or the INSERT privilege for the mysql database as well as the GRANT OPTION privilege, and the privileges that the original user has (you grant a privilege you do not have yourself).

Tips and Tricks

You can use `--destination` option to specify a different server to copy a user account to another server.

Use the `--dump` option with only the `--source` option to see all user accounts.

Use the `--include-global-privileges` option to include GRANT statements that the user@host combination matches. This is useful for copying user accounts from one server to another where there are global privileges in effect.

3.2.4 Is there an easy way to know what options are used with each utility?

There are many utilities and it is not always easy to remember all of the options and parameters associated with each. Sometimes we need to run several utilities using nearly the same options. For example, you may want to run several utilities logging into a particular server. Rather than retype the connection information each time, you would like to save the option value some way and reuse it.

Fortunately, the `mysqluc` utility does this and more. It is named the MySQL Users' Console and provides type completion for options, utility names, and even user-defined variables for working with common option values. Not only that, it also provides the ability to get help for any utility supported.

Objectives

Discover what utilities exist and find the options for certain utilities.

Run several utilities with the same server using the type completion feature to make using the suite of utilities easier.

Example Execution

Note

In the example below, keystrokes are represented using square brackets. For example, [TAB] indicates the tab key was pressed. Similarly, portions in the commands specific with angle brackets are values you would replace with actual values. For example, <user> indicates you would place the user's login name here.

```
shell> mysqluc
Launching console ...

Welcome to the MySQL Utilities Client (mysqluc) version 1.5.2
Copyright (c) 2010, 2015 Oracle and/or its affiliates. All rights reserved.
This is a release of dual licensed MySQL Utilities. For the avoidance of
doubt, this particular copy of the software is released
under the version 2 of the GNU General Public License.
MySQL Utilities is brought to you by Oracle.

Type 'help' for a list of commands or press TAB twice for list of utilities.

mysqluc> help
Command                 Description
----------------------  ---------------------------------------------------
help utilities          Display list of all utilities supported.
help <utility>          Display help for a specific utility.
show errors             Display errors captured during the execution of the
                        utilities.
clear errors            clear captured errors.
show last error         Display the last error captured during the
                        execution of the utilities
help | help commands    Show this list.
exit | quit             Exit the console.
set <variable>=<value>  Store a variable for recall in commands.
show options            Display list of options specified by the user on
                        launch.
```

```
show variables          Display list of variables.
<ENTER>                 Press ENTER to execute command.
<ESCAPE>                Press ESCAPE to clear the command entry.
<DOWN>                  Press DOWN to retrieve the previous command.
<UP>                    Press UP to retrieve the next command in history.
<TAB>                   Press TAB for type completion of utility, option,
                        or variable names.
<TAB><TAB>              Press TAB twice for list of matching type
                        completion (context sensitive).

mysqluc> help utilities
Utility           Description
----------------  ---------------------------------------------------------
mysqlauditadmin   audit log maintenance utility
mysqlauditgrep    audit log search utility
mysqldbcompare    compare databases for consistency
mysqldbcopy       copy databases from one server to another
mysqldbexport     export metadata and data from databases
mysqldbimport     import metadata and data from files
mysqldiff         compare object definitions among objects where the
                  difference is how db1.obj1 differs from db2.obj2
mysqldiskusage    show disk usage for databases
mysqlfailover     automatic replication health monitoring and failover
mysqlfrm          show CREATE TABLE from .frm files
mysqlindexcheck   check for duplicate or redundant indexes
mysqlmetagrep     search metadata
mysqlprocgrep     search process information
mysqlreplicate    establish replication with a master
mysqlrpladmin     administration utility for MySQL replication
mysqlrplcheck     check replication
mysqlrplms        establish multi-source replication
mysqlrplshow      show slaves attached to a master
mysqlrplsync      replication synchronization checker utility
mysqlserverclone  start another instance of a running server
mysqlserverinfo   show server information
mysqluserclone    clone a MySQL user account to one or more new users


mysqluc> help mysqldb[TAB][TAB]
Utility         Description
--------------  -----------------------------------------------------------
mysqldbcompare  compare databases for consistency
mysqldbcopy     copy databases from one server to another
mysqldbexport   export metadata and data from databases
mysqldbimport   import metadata and data from files


mysqluc> mysqlrplshow --m[TAB][TAB]

Option                 Description
---------------------  ----------------------------------------------------
--master=MASTER        connection information for master server in the
                       form: <user>[:<password>]@<host>[:<port>][:<socket>]
                       or <login-path>[:<port>][:<socket>].
--max-depth=MAX_DEPTH  limit the traversal to this depth. Valid only with
                       the --recurse option. Valid values are non-negative
                       integers.

mysqluc> mysqlrplshow --mast[TAB]er=<user>:<password>@localhost:13001

The console has detected that the utility 'mysqlrplshow' ended with an error code.
You can get more information about the error by running the console command 'show last error'.

mysqluc> show last error
Execution of utility: mysqlrplshow --master=<user>:<password>@localhost:13001
returned errorcode: 2 with error message:
Usage: mysqlrplshow.py --master=root@localhost:3306
```

```
mysqlrplshow.py: error: The --discover-slaves-login is required to test slave connectivity.

mysqluc> mysqlrplshow --master=<user>:<password>@localhost:13001 \
            --discover-slaves-login=<user>:<password>
# master on localhost: ... connected.
# Finding slaves for master: localhost:13001

# Replication Topology Graph
localhost:13001 (MASTER)
   |
   +--- localhost:13002 - (SLAVE)
   |
   +--- localhost:13003 - (SLAVE)
   |
   +--- localhost:13004 - (SLAVE)
   |
   +--- localhost:13005 - (SLAVE)


mysqluc>
```

Discussion

There is a lot going on here in this example! Let's look through the command entries as they occur in the text.

The first command, `mysqluc`, starts the users' console. Once the console starts, a welcome banner is displayed followed by a simple prompt, `mysqluc>`. No additional options or parameters are necessary. However, it should be noted that you can pass commands to the console to execute on start. For a complete list of options, see MySQL Users' Console manual page.

The next command, help, shows the help for the users' console itself. As you can see, there are a number of options available. You can set user defined variables, discover the help for other utilities, display the latest error, and see the options used to start the console.

The help utilities command shows you a list of the available utilities and a short description of each.

Next, we decide we want to get help for one of the database utilities but we do not remember the name. We know it starts with mysqldb but we are not sure of the rest. In this case, if we type mysqldb then hit TAB twice, the users' console shows us a list of all of the utilities that begin with mysqldb.

Now let's say we want to see a graph of our replication topology but we are not sure what the option for specifying the master. In this case, we type the command to launch the `mysqlrplshow` utility and type the start of the option, '--m', then press TAB twice. What we see is there are two options that match that prefix. Notice we also see a short description (help) for each. This is a real time saving feature for the users' console.

Notice in the next segment we do not have to type the entire name of the option. In this case we typed '--mast[TAB]' which the users' console completed with '--master='. This is tab completion for option names.

Notice the result of the command we entered, `mysqlrplshow` '--master=*`user`*:*`password`*@localhost:13001'. There was an error here. We can see the error with the show errors command. We see in the error we failed to provide any connection information for the slaves.

Once we correct that omission, the last command shows how the users' console executes a utility and displays the results in the same stream as the console - much like the `mysql` client command-line tool.

Permissions Required

There are no special permissions required to run `mysqluc` however, you must have the necessary privileges to execute the desired utilities.

3.2.5 How do you find redundant or duplicate indexes and know which ones to drop?

MySQL allows its users to create several indexes that might be the same (duplicate indexes) or partially similar (redundant indexes) in its structure. Although duplicate indexes have no advantages, there are some cases where redundant indexes might be helpful. However, both have disadvantages. Duplicate and redundant indexes slow down update and insert operations. As a result it is usually a good idea to find and remove them.

Doing this manually would be a time consuming task, especially for big databases or databases with lots of tables and that is why there is a utility to automate this type of task: `mysqlindexcheck`.

Objectives

Our goal is to use the `mysqlindexcheck` utility to help us find duplicate and redundant indexes. For that we are going to use the following table as an example:

```
CREATE TABLE `test_db`.`indexcheck_test`(
       `emp_id` INT(11) NOT NULL,
       `fiscal_number` int(11) NOT NULL,
       `name` VARCHAR(50) NOT NULL,
       `surname` VARCHAR (50) NOT NULL,
       `job_title` VARCHAR (20),
       `hire_date` DATE default NULL,
       `birthday` DATE default NULL,
       PRIMARY KEY (`emp_id`),
       KEY `idx_fnumber`(`fiscal_number`),
       UNIQUE KEY `idx_unifnumber` (`fiscal_number`),
       UNIQUE KEY `idx_uemp_id` (`emp_id`),
       KEY `idx_full_name` (`name`, `surname`),
       KEY `idx_full_name_dup` (`name`, `surname`),
       KEY `idx_name` (`name`),
       KEY `idx_surname` (`surname`),
       KEY `idx_reverse_name` (`surname`,`name`),
       KEY `idx_id_name` (`emp_id`, `name`),
       KEY `idx_id_hdate` (`emp_id`, `hire_date`),
       KEY `idx_id_bday` (`emp_id`, `birthday`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8
```

Example Execution

```
shell> mysqlindexcheck --server=test_user@localhost:13010 test_db.indexcheck_test
# Source on localhost: ... connected.
# The following indexes are duplicates or redundant for table test_db.indexcheck_test:
#
CREATE INDEX `idx_uemp_id` ON `test_db`.`indexcheck_test` (`emp_id`) USING BTREE
#     may be redundant or duplicate of:
ALTER TABLE `test_db`.`indexcheck_test` ADD PRIMARY KEY (`emp_id`)
#
CREATE INDEX `idx_fnumber` ON `test_db`.`indexcheck_test` (`fiscal_number`) USING BTREE
#     may be redundant or duplicate of:
CREATE INDEX `idx_unifnumber` ON `test_db`.`indexcheck_test` (`fiscal_number`) USING BTREE
#
```

```
CREATE INDEX `idx_full_name_dup` ON `test_db`.`indexcheck_test` (`name`, `surname`) USING BTREE
#     may be redundant or duplicate of:
CREATE INDEX `idx_full_name` ON `test_db`.`indexcheck_test` (`name`, `surname`) USING BTREE
#
CREATE INDEX `idx_name` ON `test_db`.`indexcheck_test` (`name`) USING BTREE
#     may be redundant or duplicate of:
CREATE INDEX `idx_full_name` ON `test_db`.`indexcheck_test` (`name`, `surname`) USING BTREE
#
CREATE INDEX `idx_surname` ON `test_db`.`indexcheck_test` (`surname`) USING BTREE
#     may be redundant or duplicate of:
CREATE INDEX `idx_reverse_name` ON `test_db`.`indexcheck_test` (`surname`, `name`) USING BTREE
#
ALTER TABLE `test_db`.`indexcheck_test` ADD PRIMARY KEY (`emp_id`)
#     may be redundant or duplicate of:
CREATE INDEX `idx_id_name` ON `test_db`.`indexcheck_test` (`emp_id`, `name`) USING BTREE
#
CREATE INDEX `idx_id_hdate` ON `test_db`.`indexcheck_test` (`emp_id`, `hire_date`) USING BTREE
#     may be redundant or duplicate of:
CREATE INDEX `idx_id_name` ON `test_db`.`indexcheck_test` (`emp_id`, `name`) USING BTREE
#
CREATE INDEX `idx_id_bday` ON `test_db`.`indexcheck_test` (`emp_id`, `birthday`) USING BTREE
#     may be redundant or duplicate of:
CREATE INDEX `idx_id_name` ON `test_db`.`indexcheck_test` (`emp_id`, `name`) USING BTREE
# The following indexes for table test_db.indexcheck_test contain the clustered index and
# might be redundant:
#
CREATE INDEX `idx_uemp_id` ON `test_db`.`indexcheck_test` (`emp_id`) USING BTREE
#
CREATE INDEX `idx_id_name` ON `test_db`.`indexcheck_test` (`emp_id`, `name`) USING BTREE
#
CREATE INDEX `idx_id_hdate` ON `test_db`.`indexcheck_test` (`emp_id`, `hire_date`) USING BTREE
#
CREATE INDEX `idx_id_bday` ON `test_db`.`indexcheck_test` (`emp_id`, `birthday`) USING BTREE
```

Discussion

As we can see, the utility first points out that neither the idx_uemp_id index nor the idx_fnumber are necessary and it points out why. The first, idx_uemp_id, is redundant because the primary key already ensures that emp_id values have to be unique. As for idx_fnumber, it is also redundant because of idx_ufnumber, a UNIQUE type index which also works as a regular index. Then it points out that idx_full_name_dup is also not necessary. In this case it is a duplicate of the idx_full_name index since it contains the exact same columns on the same order.

Notice that it also indicates that idx_name, idx_surname and even the PRIMARY INDEX on emp_id might be redundant. This happens because we are dealing with BTREE type indexes and for this type of indexes an index X is redundant to an index Y if and only if the first n columns in X also appear in Y.

Given that we are using InnoDB engine, it also warns us that `idx_uemp_id`, `ìdx_id_name`, `idx_id_hdate` and `idx_id_bday` might not be needed. This happens because, in InnoDB, secondary indexes contain the primary key columns for the row that are not in the secondary index.

Note

The indexes identified are just indications of redundant and duplicate indexes. They must not be followed blindly because redundant indexes can be useful depending on how you use (query) your tables.

Permissions Required

Regarding the privileges needed to run this utility, the test_user needs SELECT privilege on the mysql database as well as for the databases which tables are being checked.

Tips and Tricks

You can use the -d option to generate the SQL drop statements needed to remove the indexes.

The `--stats` option can be used alone or together with either `--best` or `--worst` to show statistics about the indexes.

Use the `--show-indexes` option to show each table together with its indexes.

3.2.6 How do you find all objects that start with a given name prefix?

One of the challenges for database administrators who manage servers with thousands of objects is the task of finding an object by name. Sometimes all you have to go on is the name of a table or perhaps an obscure reference to a partial name. This can come about through a diagnosis of a problem connection, application, or via an incomplete description from a defect report.

It is also possible you need to simply check to see if certain things exist. For example, suppose among your databases are parts or inventory data and you want to check to see if there are any functions or procedures that operate on a column named 'cost'. Moreover, you want to see anything related that has 'cost' as part of its name.

Whatever the case, it would be a big time saver if you could search through all of the database objects and see a list of the objects whose name matches a prefix (or pattern). Fortunately, the `mysqlmetagrep` utility can get this done.

Objectives

Find all objects whose name begins with a known prefix. More specifically, find any mention of the word 'cost'.

Example Execution

```
shell> mysqlmetagrep --server=root:root@localhost --body --pattern='%cost%'
+------------------------+--------------+-------------+----------+-------------+------------------+
| Connection             | Object Type  | Object Name | Database | Field Type  | Matches          |
+------------------------+--------------+-------------+----------+-------------+------------------+
| root:*@localhost:3306  | FUNCTION     | adjust_cost | griots   | ROUTINE     | adjust_cost      |
| root:*@localhost:3306  | TABLE        | supplies    | griots   | COLUMN      | cost             |
| root:*@localhost:3306  | TABLE        | film        | sakila   | COLUMN      | replacement_cost |
+------------------------+--------------+-------------+-----------------+-------------+-------------+

shell> mysql -uroot -proot -e "SHOW CREATE FUNCTION griots.adjust_cost \G"
*************************** 1. row ***************************
            Function: adjust_cost
            sql_mode:
     Create Function: CREATE DEFINER=`root`@`localhost` FUNCTION `adjust_cost`(cost double)
     RETURNS double DETERMINISTIC
return cost * 1.10
character_set_client: latin1
collation_connection: latin1_swedish_ci
  Database Collation: latin1_swedish_ci
```

Discussion

In this example, we see the use of the database pattern '%cost%' to find objects that have 'cost' anywhere in their name. We also see the use of the `--body` option to instruct the utility to look inside procedures and functions. This can be very handy to locate routines that manipulate data as you can see.

Notice once we found a routine that had 'cost' mentioned, we can examine its body via the SHOW CREATE FUNCTION command to see just how it is using the column 'cost'. In this case, we see someone has written a function to adjust the cost by 10%'.

Therefore, not only can you find objects that have anything named 'cost', you can also discover any hidden logic that may operate on something named 'cost'.

Permissions Required

The user must have the SELECT privilege on the mysql database.

Tips and Tricks

If you are familiar with using regular expressions, you can use the `--regexp` option to use regular expressions instead of database patterns. For example, the regular expression for the search above would be `--pattern='^.*cost.*' --basic-regex`.

3.2.7 How do you run a process every night to kill certain connections?

Some database administrators use nightly routines to perform maintenance on their databases or servers. Sometimes these routines can be blocked by long running queries or applications that hang onto locks for longer than expected.

Naturally, priority is given to the application and maintenance routines are often canceled rather than interfere with an application. Should it happen that you subscribe to this notion and you have a routine that is still being blocked or for some reason hasn't completed by a certain time, you need a quick way to generate an event to kill the connection involved. This is where the `mysqlprocgrep` utility can help.

Objectives

The objective is to generate an event that kills all connections based on a user login ('msaladin') but only if that connection is trying to run a custom administration script named 'my_admin_thingy'.

Example Execution

```
shell> mysqlprocgrep --sql-body \
          --match-command='my_admin_thingy%' --match-user='msaladin%'  --kill-connection
DECLARE kill_done INT;
DECLARE kill_cursor CURSOR FOR
  SELECT
        Id, User, Host, Db, Command, Time, State, Info
      FROM
        INFORMATION_SCHEMA.PROCESSLIST
      WHERE
          COMMAND LIKE 'my_admin_thingy%'
        AND
          USER LIKE 'msaladin%'
OPEN kill_cursor;
BEGIN
   DECLARE id BIGINT;
   DECLARE EXIT HANDLER FOR NOT FOUND SET kill_done = 1;
   kill_loop: LOOP
      FETCH kill_cursor INTO id;
      KILL CONNECTION id;
   END LOOP kill_loop;
END;
CLOSE kill_cursor;
```

Discussion

Notice in the example above, we did not connect to any server to get this information. That is one of the great things about this utility - you can generate all manner of SQL statements for finding processes and try them out on a test system before incorporating them into your events, triggers, and routines.

We specified the user with the `--match-user` option using a wildcard in case the user is logged in from a different system. We also specified the name of the maintenance routine in the same manner in case it gets renamed with a version number or some such.

The output of this utility then is the SQL statement we need to use to find and kill the connections that meet these criteria. Armed with this, we can make a procedure we can call from an event and execute the SQL at a precise time every day.

Permissions Required

The user must have the SELECT permission on the mysql database.

Tips and Tricks

If you are familiar with using regular expressions, you can use the `--regexp` option to use regular expressions instead of database patterns.

3.3 High Availability Operations

The tasks described in this section include those for replication and general to specific high availability tasks such as automatic failover.

3.3.1 How do you setup and use replication?

MySQL has built-in support for several types of replication. Replication is usually employed with the purpose of increasing the performance and/or the fault-tolerance of the server and by extension the application. However, setting up replication can be a somewhat complicated and error prone process. But fear not, MySQL Utilities has tools that can help simplify and even automate several replication related tasks.

Consider a scenario where replication is used to obtain scalability, i.e. to increase the performance. Let us imagine an online shopping service. The shop started out small so a single server was enough to handle all the requests, however now it has become quite popular and as a result that single server is no longer able to handle all the requests. Being an online store, most of the operations are read operations (checking existing products, reviews, stock availability, etc).

Objectives

Our goal is to use replication in order to improve the throughput of the service by adding more servers which becomes replicas of the already existing server. These replicas allows scaling out of the service by taking up all the read requests, leaving the old server (now called the master) in charge of the writes. Rather than doing everything "by hand" with the mysql command line, we are going to setup this replication scenario using a single script, `mysqlreplicate` which does most of the hard work for us. We then check the result using the `mysqlrpladmin` utility.

Let us assume the existing server, Server1, is running on port 13001 on the local machine with IP 192.168.1.1 and that we want to add 2 new servers, Server2 running on 192.168.1.2:13001 and Server3 running on 192.168.1.3:3306.

Example Execution

```
shell> mysqlreplicate --master=m_account@192.168.1.1:13001 \
--slave=slave_acc1@192.168.1.2:13001 --rpl-user=repl:slavepass -b
# master on 192.168.1.1: ... connected.
# slave on 192.168.1.2: ... connected.
# Checking for binary logging on master...
# Setting up replication...
# ...done.

shell> mysqlreplicate --master=m_account@192.168.1.1:13001 \
          --slave=slave_acc2@192.168.1.3:3306 --rpl-user=repl:slavepass -b
# master on 192.168.1.1: ... connected.
# slave on 192.168.1.3: ... connected.
# Checking for binary logging on master...
# Setting up replication...
# ...done.

shell> mysqlrplcheck --master=m_account@192.168.1.1:13001 \
          --slave=slave_acc1@192.168.1.2:13001

# master on 192.168.1.1: ... connected.
# slave on 192.168.1.2: ... connected.
Test Description                                                     Status
---------------------------------------------------------------------------
Checking for binary logging on master                                [pass]
Are there binlog exceptions?                                         [pass]
Replication user exists?                                             [pass]
Checking server_id values                                            [pass]
Checking server_uuid values                                          [pass]
Is slave connected to master?                                        [pass]
Check master information file                                        [pass]
Checking InnoDB compatibility                                        [pass]
Checking storage engines compatibility                               [pass]
Checking lower_case_table_names settings                             [pass]
Checking slave delay (seconds behind master)                         [FAIL]

Slave is NNN seconds behind master.

# ...done.

shell> mysqlrplcheck --master=m_account@192.168.1.1:13001 \
          --slave=slave_acc2@192.168.1.3:3306

# master on 192.168.1.1: ... connected.
# slave on 192.168.1.3: ... connected.
Test Description                                                     Status
---------------------------------------------------------------------------
Checking for binary logging on master                                [pass]
Are there binlog exceptions?                                         [pass]
Replication user exists?                                             [pass]
Checking server_id values                                            [pass]
Checking server_uuid values                                          [pass]
Is slave connected to master?                                        [pass]
Check master information file                                        [pass]
Checking InnoDB compatibility                                        [pass]
Checking storage engines compatibility                               [pass]
Checking lower_case_table_names settings                             [pass]
Checking slave delay (seconds behind master)                         [FAIL]

Slave is N seconds behind master.

# ...done.
```

Discussion

In the above example we made use of the mysqlreplicate utility to setup a single tier replication topology, where the existing server is now the master for the two new servers which act as slaves. Notice how we used the address of the old existing server in the --master option and in the --slave option we used the addresses of the new servers. Also notice the use of the -b flag, this makes replication start from the first event recorded in the master's binary log.

Also notice how we used the mysqlrplcheck utility to check the health of the replication. In this case, the failing test "Check slave delay" is expected, since the slaves are catching up with the master. When the slaves have read and applied all the transactions from the master's binary log the "Check slave delay" test passes. Also, in case the slave wasn't properly configured and pointing to the master specified the "Is slave connect to master" test would notify us of that with a FAIL or WARN status.

Permissions Required

The m_account user needs the following privileges for the mysqlreplicate: SELECT and INSERT privileges on mysql database, REPLICATION SLAVE, REPLICATION CLIENT and GRANT OPTION. As for the slave_acc users, they need the SUPER privilege. The repl user, used as the argument for the --rpl-user option, is either created automatically or if it exists, it needs the REPLICATION SLAVE privilege.

Also, when using GTIDs, the slave_acc users must also have SELECT privilege over the mysql database in order to run the mysqlrplcheck utility successfully.

Tips and Tricks

In the mysqlreplicate utility we could have also used the --test-db option which creates a dummy database to test the replication setup. However, the mysqlrplcheck provides more detailed information in that regard.

As previously stated, the -b option tells the utility to start replication from the first event recorded in the master's binary log. Omitting this flag, in turn, makes the slaves replicate only what is stored in the master's binary log from the present moment onward.

Furthermore, using the --master-log-file and --master-log-pos options it is possible to specify respectively the master log file and the master log position from which the slave starts its replication process.

The -p flag can be used to ensure that the replication setup is only executed in case the storage engines match in both the master and the slave.

Regarding the mysqlrplcheck utility, we can use the -s option to check the output of the show slave status command. This can be useful for instance to check what might be causing the "Is slave connected" test to fail. We can also use the --master-log-file option to specify the name of the master information file to read.

Lastly, we can use the --verbose option in order to get more information about what is happening "under the hood".

3.3.2 How do you add new servers to an existing topology and change the master role?

We examine a scenario similar to the previous one where we want to make one of the two new slaves added the new master server (perhaps because it has better specs and is faster).

Objectives

Our goal in this example it create replication configuration with 3 servers, two new ones and an existing one, and we want to replicate all the information, but make one of the new servers the master server.

Like the previous example, lets assume that the existing server, Server1, is running on port 13001 on the local machine with IP 192.168.1.1 that the two new machines with mysql server instances are Server2 running on 192.168.1.2:13001 and Server3 running on 192.168.1.3:3306. We want to make Server2 the new master.

Example Execution

```
shell> mysqlreplicate --master=m_account@192.168.1.1:13001 \
          --slave=slave_acc1@192.168.1.2:13001 --rpl-user=repl:slavepass -b
# master on 192.168.1.1: ... connected.
# slave on 192.168.1.2: ... connected.
# Checking for binary logging on master...
# Setting up replication...
# ...done.

shell> mysqlreplicate --master=m_account@192.168.1.1:13001 \
          --slave=slave_acc2@192.168.1.3:3306 --rpl-user=repl:slavepass -b
# master on 192.168.1.1: ... connected.
# slave on 192.168.1.3: ... connected.
# Checking for binary logging on master...
# Setting up replication...
# ...done.

shell> mysqlrpladmin --master=m_account@192.168.1.1:13001 \
          --slaves=slave_acc1@192.168.1.2:13001,slave_acc2@192.168.1.3:3306 health

# Checking privileges.
#
# Replication Topology Health:
+--------------+--------+---------+--------+------------+------------------------------+
| host         | port   | role    | state  | gtid_mode  | health                       |
+--------------+--------+---------+--------+------------+------------------------------+
| 192.168.1.1  | 13001  | MASTER  | UP     | ON         | OK                           |
| 192.168.1.2  | 13001  | SLAVE   | UP     | ON         | Slave delay is NNN seconds   |
| 192.168.1.3  | 3306   | SLAVE   | UP     | ON         | Slave delay is NNN seconds   |
+--------------+--------+---------+--------+------------+------------------------------+
# ...done.

shell> mysqlrpladmin --master=m_account@192.168.1.1:13001 \
          --slaves=slave_acc1@192.168.1.2:13001,slave_acc2@192.168.1.3:3306 health

# Checking privileges.
#
# Replication Topology Health:
+--------------+--------+---------+--------+------------+---------+
| host         | port   | role    | state  | gtid_mode  | health  |
+--------------+--------+---------+--------+------------+---------+
| 192.168.1.1  | 13001  | MASTER  | UP     | ON         | OK      |
| 192.168.1.2  | 13001  | SLAVE   | UP     | ON         | OK      |
| 192.168.1.3  | 3306   | SLAVE   | UP     | ON         | OK      |
+--------------+--------+---------+--------+------------+---------+
# ...done.

shell> mysqlrpladmin --master=m_account@192.168.1.1:13001 \
          --slaves=slave_acc1@192.168.1.2:13001,slave_acc2@192.168.1.3:3306 \
          --new-master=slave_acc1@localhost:13002 --demote-master switchover
# Checking privileges.
# Performing switchover from master at 192.168.1.1:13001 to slave at 192.168.1.2:13001.
# Checking candidate slave prerequisites.
# Checking slaves configuration to master.
# Waiting for slaves to catch up to old master.
# Stopping slaves.
# Performing STOP on all slaves.
# Demoting old master to be a slave to the new master.
# Switching slaves to new master.
# Starting all slaves.
# Performing START on all slaves.
# Checking slaves for errors.
# Switchover complete.
#
# Replication Topology Health:
+--------------+--------+---------+--------+------------+---------+
| host         | port   | role    | state  | gtid_mode  | health  |
+--------------+--------+---------+--------+------------+---------+
| 192.168.1.2  | 13001  | MASTER  | UP     | ON         | OK      |
| 192.168.1.1  | 13001  | SLAVE   | UP     | ON         | OK      |
| 192.168.1.3  | 3306   | SLAVE   | UP     | ON         | OK      |
+--------------+--------+---------+--------+------------+---------+
```

Discussion

As with our previous scenario we used the `mysqlreplicate` utility to set up a replication topology between the existing server and the two new servers. Notice the use of the -b flag which this replication start from the first event recorded in the master's binary log.

After creating the replication topology, we made use of the `mysqlrpladmin` utility specifying both the master and slave servers and using the health command to check the status of the replication. Since our master server had lots of information, it is normal for the new slaves to take some time to catch up, thus the slave delay message on the health column of the output.

However, if all goes well, after some time the slaves eventually catch up, and when that happens, the `health` column shows an OK status.

Once this was established, we used the `mysqlrpladmin` utility yet again, this time with switchover command. Using the `--new-master` option, we specify the server that becomes the new master. We also used the `--demote-master` option, which turns the old master into a slave. If we left that option out, the old master would still behave as a master just without any slaves.

After the switchover, Server2 becomes the master server for both Server1 and Server3 which are now the slaves.

Permissions Required

The m_account user needs the following privileges for the `mysqlreplicate`: SELECT and INSERT privileges on mysql database, REPLICATION SLAVE, REPLICATION CLIENT and GRANT OPTION. As for the slave_acc users, they need the SUPER privilege. The repl user, used as the argument for the `--rpl-user` option, is either created automatically or if it exists, it needs the REPLICATION SLAVE privilege.

To run the `mysqlrpladmin` utility with the health command, the m_account used on the master needs an extra SUPER privilege.

As for the switchover command all the users need the following privileges: SUPER, GRANT OPTION, SELECT, RELOAD, DROP, CREATE and REPLICATION SLAVE

Tips and Tricks

We can use the `--discover-slaves-login` option for `mysqlrpladmin` in order to detect the slaves automatically instead of manually specifying the slaves.

The mysqlrpladmin utility allows users to specify a script to execute before and after the failover and switchover operations using the --exec-before and --exec-after options respectively. Note that the script specified using the exec-after option only runs in case the switchover/failover executes successfully.

We can use the mysqlrpladmin utility to start and stop all the slaves with the start/stop commands. Using the stop command only stops servers that are actually slaves of the specified master thus preventing us from stopping unwanted servers.

3.3.3 How do you setup and use automatic failover?

Once your replication topology is setup, it is important to consider the possible occurrences of failures in order to maintain the high availability level of your system. Several failures independently from their cause (network connection issue, hard drive crash, cosmic lightning, etc.) can stop the replication process by making the master no longer accessible by its slaves.

In this type of situation, it is desirable to promote one of the slaves to the master while the problem with the old master is resolved. It is better to have an application to monitor the replicate topology and perform failover automatically, minimizing downtime and keeping replication running smoothly. This is where the mysqlfailover utility shines.

Objectives

The goal is to start the mysqlfailover utility to monitor a replication topology and perform failover automatically when required.

When the current master fails, manually promoting a slave to the new master can be a very tedious and error prone task, as all the remaining slave have to be redirected to the new master and the new master needs to catch up with all the slaves to make sure that no transactions is lost.

Fortunately, the mysqlfailover utility is capable of executing this full process automatically and in a optimized way.

Let's assume that a replication topology with one master (server1:3311) and four slaves (server2:3312, server3:3313, server4:3314, server:3315) was previously setup.

Example Execution

Start the mysqlfailover utility (in console mode - default):

```
shell> mysqlfailover --master=root@server1:3311 \
--slaves=root@server2:3312,root@server3:3313,root@server4:3314,root@server5:3315 \
--log=log.txt --rpl-user=rpl:rpl
NOTE: Log file 'log.txt' does not exist. Will be created.
# Checking privileges.

MySQL Replication Failover Utility
Failover Mode = auto     Next Interval = Fri Jul 26 10:17:52 2013

Master Information
------------------
Binary Log File    Position  Binlog_Do_DB  Binlog_Ignore_DB
master-bin.000001  151

GTID Executed Set
None

Replication Health Status
+----------+-------+---------+--------+------------+---------+
| host     | port  | role    | state  | gtid_mode  | health  |
+----------+-------+---------+--------+------------+---------+
| server1  | 3311  | MASTER  | UP     | ON         | OK      |
| server2  | 3312  | SLAVE   | UP     | ON         | OK      |
| server3  | 3313  | SLAVE   | UP     | ON         | OK      |
| server4  | 3314  | SLAVE   | UP     | ON         | OK      |
| server5  | 3315  | SLAVE   | UP     | ON         | OK      |
+----------+-------+---------+--------+------------+---------+

Q-quit R-refresh H-health G-GTID Lists U-UUIDs L-log entries
```

Now imagine that the master crashed or is no longer reachable, then after a predefined time interval (by default 15 seconds) we can observe that the failover process starts automatically:

```
Failover starting in 'auto' mode...
# Candidate slave server2:3312 will become the new master.
# Checking slaves status (before failover).
# Preparing candidate for failover.
# Creating replication user if it does not exist.
# Stopping slaves.
# Performing STOP on all slaves.
# Switching slaves to new master.
# Disconnecting new master as slave.
# Starting slaves.
# Performing START on all slaves.
# Checking slaves for errors.
# Failover complete.

Failover console will restart in 5 seconds.

[...]

MySQL Replication Failover Utility
Failover Mode = auto     Next Interval = Fri Jul 26 10:25:17 2013

Master Information
------------------
Binary Log File    Position  Binlog_Do_DB  Binlog_Ignore_DB
master-bin.000001  151

GTID Executed Set
None

Replication Health Status
+----------+-------+---------+--------+------------+---------+
| host     | port  | role    | state  | gtid_mode  | health  |
+----------+-------+---------+--------+------------+---------+
| server2  | 3312  | MASTER  | UP     | ON         | OK      |
| server3  | 3313  | SLAVE   | UP     | ON         | OK      |
| server4  | 3314  | SLAVE   | UP     | ON         | OK      |
| server5  | 3315  | SLAVE   | UP     | ON         | OK      |
+----------+-------+---------+--------+------------+---------+


Q-quit R-refresh H-health G-GTID Lists U-UUIDs L-log entries
```

Discussion

The above example illustrates how to start the `mysqlfailover` utility to monitor the health of the replication topology and reconfigure the topology when failover occurs.

To setup this feature, we simply need to specify the master's connection with the `--master` option, the list of slaves with the `--slaves` option and the replication user (login and password) using the `--rpl-user` option. As an alternative to the `--slaves` options, you can use the `--discover-slaves-login` specifying a user and password (or login-path) to connect to the slaves. The utility attempts to discover all of the slaves connected with the master using the specified login and password. For the above example, '--discover-slaves-login=root' could be used.

The `--discover-slaves-login` can be very handy especially if there is a huge number of slaves in the topology, but bear in mind that the explicit specification of slaves is safer and that discovery can fail to find some servers. In particular, it is important to note that in order for slaves to be discovered, they must be started with the '--report-host' and '--report-port' options with the correct values and they must be connected to the master (I/O thread running) otherwise discovery fails.

It is also recommended to use the `--log` options to specify a file to register all events, warning and errors. This is useful to keep a record of what happened. For example, to determine when failover occurred and if the process completed without errors or warnings.

An important matter to discuss is the order in which the servers are select as candidates for failover. No distinction is made in terms of the number of transactions to select the most up-to-date slave to become the new master. The reason is very simple; this criteria is non-deterministic as many circumstances (i.e., network load, server maintenance operations) can temporarily influence the performance of a slave and could lead to an incorrect selection of the most appropriate candidate. For example, the slave with the best hardware should be in the long run the most appropriate candidate to become the new master, but for some unanticipated reason it might actually have fewer transactions than other servers when the master crashed. Therefore, a more deterministic criteria based on the order in which the servers are specified is used, allowing the user to control the order in which the candidates are selected. The first server that meets the required election criteria, consisting on simple sanity checks (server reachable and running with the required options: GTID ON and binary logging enabled), is chosen. More specifically, the selection of the new master follows this order: first, sequentially check the list of servers specified by the `--candidates` option, then the servers listed in the `--slaves` option, and finally check any discovered slaves in an unordered way.

Permissions Required

The user must have permissions to configure replication.

Tips and Tricks

In the above example the `mysqlfailover` utility was started in the default console mode, but it can also be executed as a daemon. For that purpose, the `--daemon` option needs to be used, more specifically simply add '--daemon=start' to the command line. When `mysqlfailover` is executed as a daemon, no output is displayed and all the information is logged to file specified for the `--log` option, which is mandatory in this case. To stop the execution of the `mysqlfailover` daemon, simply invoke the utility using the option '--daemon=stop'. No other options is required to stop the daemon unless a specific pidfile (which contains the process PID) was specified with the `--pidfile` option to start the daemon and in this case the same option value is also required to stop it.

Another useful feature is the possibility to run external scripts along the execution of the utility to perform customized actions. The following options can be used to execute different scripts at distinct moments of the `mysqlfailover` execution: `--exec-fail-check` to specify a script to run periodically at each predefined interval instead of the default check (i.e., master is reachable and alive) to detect the need to failover, `--exec-before` to specify a script to execute before starting failover, `--exec-after` to execute a script at the end of failover process, `--exec-post-failover` to run a script after completing the failover process (before displaying the health report).

3.3.4 How do you restore the previous master to service after failover?

After a successful failover, it is sometimes required to restore the initial topology and promote the crashed server to become the master again (or even a new server with distinctive hardware characteristics).

Sometimes failover can be triggered by a simple network issue (not affecting the health of the initial master server) and after being resolved, it may be desirable to put the old master back in the replication topology. We can do this with several of the high availability utilities.

Objectives

The goal of this task is simply to replace the new master of a replication topology with the previous one that might have been demoted as result of successful automatic failover execution. It is assumed that the server to be restored as master is healthy and any previous issue (that triggered failover) have been resolved.

Let's consider the previous topology after failover, now with a new master (server2:3312) and three slaves (server3:3313, server4:3314, server:3315), and that we want to promote the initial server (server1:3311) to master again.

Performing this task manually can be delicate as one wrong or missing step can lead to errors and errors in the replication topology or even to the lost of some transaction. Once more MySQL Utilities can provide a precious assistance to perform this task, in this case requiring the user to follow three simple steps to restore the initial topology as shown below.

Example Execution

There are several steps involved in solving this problem. We walk through each in turn.

You must first stop running the `mysqlfailover` utility instance and start the (old) master to be restored, i.e. server1:3311.

Next, set the old master (server1:3311) as a slave of the current new master (server2:3312):

```
shell> mysqlreplicate --master=root@server2:3312 --slave=root@server1:3311 -rpl-user=rpl:rpl
# master on localhost: ... connected.
# slave on localhost: ... connected.
# Checking for binary logging on master...
# Setting up replication...
# ...done.
```

Next, switchover to the previous master to restore the initial replication topology:

```
shell> mysqlrpladmin --master=root@server2:3312 \
          --slaves=root@server2:3313,root@server4:3314,root@server5:3315 \
          --rpl-user=rpl:rpl --new-master=root@server1:3311 --demote-master switchover
# Checking privileges.
# Performing switchover from master at server2:3312 to slave at server1:3311.
# Checking candidate slave prerequisites.
# Checking slaves configuration to master.
# Waiting for slaves to catch up to old master.
# Stopping slaves.
# Performing STOP on all slaves.
# Demoting old master to be a slave to the new master.
# Switching slaves to new master.
# Starting all slaves.
# Performing START on all slaves.
# Checking slaves for errors.
# Switchover complete.
#
# Replication Topology Health:
+----------+-------+---------+--------+------------+---------+
| host     | port  | role    | state  | gtid_mode  | health  |
+----------+-------+---------+--------+------------+---------+
| server1  | 3311  | MASTER  | UP     | ON         | OK      |
| server2  | 3312  | SLAVE   | UP     | ON         | OK      |
| server3  | 3313  | SLAVE   | UP     | ON         | OK      |
| server4  | 3314  | SLAVE   | UP     | ON         | OK      |
| server5  | 3315  | SLAVE   | UP     | ON         | OK      |
+----------+-------+---------+--------+------------+---------+
# ...done.
```

The initial replication topology is now restored and `mysqlfailover` can be restarted (but using --force) as initially:

```
shell> mysqlfailover --master=root@server1:3311 \
          --slaves=root@server2:3312,root@server3:3313,root@server4:3314,server5:3315 \
          --log=log.txt --rpl-user=rpl:rpl --force
# Checking privileges.

MySQL Replication Failover Utility
Failover Mode = auto     Next Interval = Sat Jul 27 02:17:12 2013

Master Information
------------------
Binary Log File    Position  Binlog_Do_DB  Binlog_Ignore_DB
master-bin.000002  151

GTID Executed Set
None

Replication Health Status
+----------+-------+---------+--------+------------+---------+
| host     | port  | role    | state  | gtid_mode  | health  |
+----------+-------+---------+--------+------------+---------+
| server1  | 3311  | MASTER  | UP     | ON         | OK      |
| server2  | 3312  | SLAVE   | UP     | ON         | OK      |
| server3  | 3313  | SLAVE   | UP     | ON         | OK      |
| server4  | 3314  | SLAVE   | UP     | ON         | OK      |
| server5  | 3315  | SLAVE   | UP     | ON         | OK      |
+----------+-------+---------+--------+------------+---------+

Q-quit R-refresh H-health G-GTID Lists U-UUIDs L-log entries
```

Discussion

The most important step is the execution of the switchover command with the `mysqlrpladmin` utility. The previous steps can be seen as a preparation for switchover. The first step simply makes sure that the server is running and that there is no `mysqlfailover` instance still running that could affect the correct execution of switchover. The second step sets the old master as a slave of the new master, because the switchover command can only be performed with slaves. This step also allows the old master to catch up with the new master. If many transaction have been performed on the new master it is recommended to wait a while to let the old master catch up before switchover, otherwise the switchover command might take longer.

As expected, the execution of the switchover command requires the specification of the current and new master with the `--master` and `--new-master` options as well as the list of slaves in the topology using the `--slaves` option (without need to list the new master). The replication user is specified with the `--rpl-user` option. In this specific example, the use of the option `--demote-master` is important, because without it the current master (server2:3312) is not be demoted and set as a slave of the new master (server1:3311).

The `mysqlrpladmin` utility executes and displays information about all required actions to perform switchover. After completing the switchover process, a health report is displayed that you can use to confirm the successful execution of the command and verify that the topology has changed as expected.

After completing these simple steps, the replication topology is back to its initial structure (before failover) with its old master. Therefore, `mysqlfailover` is ready to be executed again to monitor the topology and reestablish automatic failover.

Permissions Required

The user have permissions to configure replication.

Tips and Tricks

It is important to wait for the old master to catch up with the new master in order to ensure that no transactions are lost. Depending on the time the old master was down or not accessible it might take a considerable time for the old master to execute all missing transactions. MySQL Utilities provide tools that allow the visualizations of the slaves status, namely the 'health' command of the `mysqlrpladmin` utility.

An alternative set of steps could have been followed to perform the desired task, using the failover command from `mysqlrpladmin` instead of switchover. In this case, the old master should be specified in the candidates list using the option `--candidates` to be chosen as the preferred slave to become the new master (no need for the --master, --new-master and --demote-master options). However, an additional step are required to set the previous master (server2:3312) as a slave of the old master (server1:3311) using the `mysqlreplicate` utility because failover does not demote the previous master as it assumes that it is not available. Notice that unlike switchover that fails if the server specified by the `--new-master` option does not meet the requirements to become master, failover choses another server from the slaves list to become the new master if the one specified in by the `--candidates` option is not suitable. It is important to keep this behavior differences in mind when deciding which command to apply.

The `mysqlfailover` utility registers its execution on the servers in order to avoid concurrent executions of the utility, which may lead to errors and inconsistent state during failover. If the utility detects that another instance might be running, it is started in "fail" mode (not taking any action when it detects that the master failed). The `mysqlfailover` instance registration is cleared when the utility exits, and it is expected that registration process can fail on crashed or not accessible servers. The `--force` option overwrite the instance execution check allowing to surpass registration failure on (crashed) old masters, allowing the `mysqlfailover` utility to start in 'auto' mode.

3.3.5 How do you find all of the slaves attached to a master server?

When you have a topology that has grown over time - many slaves have been added from time-to-time - it may not be so easy to remember which servers are connected as slaves and even which are slaves to a given master.

Most often you want to know the state of those slaves at-a-glance. Rather than connect to each slave individually, it would be nice to know what the state of each slaves threads using a single command.

Objectives

Show a map of the slaves connected to a master including the state of each slaves threads (IO and SQL). We can do this with a single command using the `mysqlrplshow` utility.

Example Execution

```
shell> mysqlrplshow --master=root:root@localhost:13001 \
          --disco=root:root --verbosity
# master on localhost: ... connected.
# Finding slaves for master: localhost:13001
# Replication Topology Graph
localhost:13001 (MASTER)
   |
   +--- localhost:13002 [IO: Yes, SQL: Yes] - (SLAVE)
   |
   +--- localhost:13003 [IO: Yes, SQL: Yes] - (SLAVE)
   |
   +--- localhost:13004 [IO: Yes, SQL: Yes] - (SLAVE)
   |
   +--- localhost:13005 [IO: Yes, SQL: Yes] - (SLAVE)
```

Discussion

Notice the use of the `mysqlrplshow` utility. Not only did it show us the slaves attached to the master, it also displayed the state of the IO and SQL thread for each slave.

We used the master server for the `--master` option but for the slaves, we provided the option `--discover-slaves-login` which provides the user name and password for the account used to connect to each slave. Without this, we would not be able to determine if the slave is attached (currently) or the state of its threads.

The `--discover-slaves-login` option applies to all slaves. If you do not have the same user defined on all of your slaves, you can use the `--prompt` option to prompt for the user and password for each slave.

To get the state of the slave threads, use the `--verbose` option.

Permissions Required

The user connected to the master must have the REPLICATION SLAVE privilege.

The user specified with the `--discover-slaves-login` option that logs into each slave must have the REPLICATION CLIENT privilege.

Tips and Tricks

You can also display multiple tiered topologies by providing the `--recurse` option.

Notice in the example we used the option `--discover-slaves-login` but specified only --disco=. This is a shortcut feature built into every utility. If you type the first N letters of a utility that uniquely identifies it among the options for said utility, the utility accepts it as if you typed the entire string. For example, the full name of the option we used is `--discover-slaves-login`.

3.3.6 How Can you determine if data was replicated correctly?

Once the replication system is setup and running, it is not uncommon that one might want to verify if the data is being replicated correctly on the slaves. In normal circumstances, the same data is expected on the master and its slaves (excluding the use of filtering rules). Nevertheless, faults at the data level can introduce inconsistent changes on servers without raising any kind of error. These data inconsistencies can result from bugs, hardware malfunction, human errors, or unauthorized access.

It is desirable to detect these issues, in order to fix them and ultimately prevent them from happening again. Determining the cause of such issues might not be an easy task since it might be caused by byzantine failures at distinct levels. However, the first big step toward a solution to this kind of problem is being able to detect data inconsistency and make sure that the data among the replication servers is synchronized.

Objectives

The goal is to execute the `mysqlrplsync` utility to detect data consistency issues on an active replication system making sure that the master and its slaves are synchronized.

Executing this task manually on an active system is difficult and sometimes tedious since changes may be continuously happening on all servers (in an asynchronous way) and the same data needs to be compared between servers. Moreover, it can introduce an undesirable and uncontrolled impact on the system performance if you lock the tables or stop replication.

Fortunately, the `mysqlrplsync` utility allows us to perform this task in an easy and optimized way with a controlled impact on the running system (limiting the execution time of all operations).

Let's assume that a replication topology with one master (server1:3310) and two slaves (server2:3311, server3:3312) was previously setup and it is running without errors.

Example Execution

Start the `mysqlrplsync` utility, specifying the servers you want to check.

```
shell> mysqlrplsync --master=user:pass@localhost:3310 \
          --slaves=rpl:pass@localhost:3311,rpl:pass@localhost:3312
#
# GTID differences between Master and Slaves:
# - Slave 'localhost@3311' is 15 transactions behind Master.
# - Slave 'localhost@3312' is 12 transactions behind Master.
#
# Checking data consistency.
#
# Using Master 'localhost@3310' as base server for comparison.
# Checking 'test_rplsync_db' database...
# - Checking 't0' table data...
#   [OK] `test_rplsync_db`.`t0` checksum for server 'localhost@3311'.
#   [OK] `test_rplsync_db`.`t0` checksum for server 'localhost@3312'.
# - Checking 't1' table data...
#   [OK] `test_rplsync_db`.`t1` checksum for server 'localhost@3311'.
#   [OK] `test_rplsync_db`.`t1` checksum for server 'localhost@3312'.
# Checking 'test_db' database...
# - Checking 't0' table data...
#   [OK] `test_db`.`t0` checksum for server 'localhost@3311'.
#   [OK] `test_db`.`t0` checksum for server 'localhost@3312'.
# - Checking 't1' table data...
#   [OK] `test_db`.`t1` checksum for server 'localhost@3311'.
#   [OK] `test_db`.`t1` checksum for server 'localhost@3312'.
#
#...done.
#
# SUMMARY: No data consistency issue found.
#
```

Discussion

The above example illustrates how to start the `mysqlrplsync` utility to check if all data on the specified replication topology is synchronized.

To do this, we simply need to specify the master's connection with the `--master` option, and the list of slaves with the `--slaves` option. As an alternative to the `--slaves` option, one can use the `--discover-slaves-login` specifying a user and password (or login-path) to connect to the slaves and the utility attempts to discover all of the slaves connected to the master using the specified login. For example, '--discover-slaves-login=root:secret' is used to discover all of the slaves and login to each using the 'root' user id and the password 'secret'.

The `--discover-slaves-login` can be very handy especially if there is a huge number of slaves in the topology, but bear in mind that the explicit specification of slaves is safer and that discovery can fail to find some servers. In particular, it is important to note that in order for slaves to be discovered, they must be started with the '--report-host' and '--report-port' options with appropriate values and they must be correctly connected to the master (IO thread running) otherwise discovery may fail to identify the slave.

In the above example, no data consistency issues were found. In case any data difference are found, each is clearly identified by the '[DIFF]' prefix followed by concise information of where and what is the difference. Additionally, at the end the utility displays a summary of the number of issues found.

The utility also allows users to check consistency on the slaves without specifying the master. However, be advised that only checking the slaves does not guarantee that there is no data consistency issue between the master and the slaves. Also keep in mind that the results provided by the utility are valid at the time the checks are actually performed for each table. This is because in an active system with data continuously changing, inconstancy issues might be introduced in the immediate instance after the check is completed.

Permissions Required

The user for the master must have permissions to lock tables, perform the checksum, and get information about the master status. Specifically, the user used to connect to the master requires the following privileges: SUPER or REPLICATION CLIENT, LOCK TABLES and SELECT.

The user for the slaves must have permissions to start/stop the slave, perform the checksum, and get information about the slave status. More specifically, the login user to connect to slaves requires the following privileges: SUPER and SELECT.

Tips and Tricks

In the above example, the `mysqlrplsync` utility was used to check all the data on the servers. However, it is possible to check only specific databases and tables. For that purpose, the user only need specify the target database and tables as arguments when invoking the utility. It is also possible to exclude specific database and tables from the check using the `--exclude` option. For example, '--exclude=test_rplsync_db,test_db.t0' excludes the database 'test_rplsync_db' and table 'test_db.t0' from the check performed by the utility.

The utility provides important options to control the execution time of the checksum queries performed on each table and the waiting time for slaves to reach an established synchronization point, namely: the `--checksum-timeout` and `--rpl-timeout` options. A polling process is applied on each slave to periodically check if replication has caught up with the defined sync point (all transactions have been processed).

The periodic interval to perform this check can be adjusted with the `--interval` option. These options are fundamental to control the impact of the execution of the utility on the replication system allow you to limit the execution time of the checksum queries for large tables and the time slaves wait for replication to catch up. When the timeouts defined by those options are reached, the check is skipped. Nevertheless, the user can always execute the utility later only for the skipped tables using higher timeout values.

The utility provides the flexibility to be executed separately for different set of servers, only affecting different parts of the replication system at each time. For example, consider a heterogeneous system (where slaves have a different performance characteristics) with one master 'M' and three slaves 'S1', 'S2' and 'S3'. To minimize the impact on the master, the user can run the utility first for the master 'M' and the fastest slave 'S1', and then run it again only for the slaves 'S1', 'S2' and 'S3'. If no consistency issues are found in the first execution (M = S1) or in the second execution (S1 = S2 = S3), then by transitivity and due to the inclusion of the same server 'S1' in both checks, it can be said that there is no consistency issues in the topology (M = S1 = S2 = S3) at the time the first check was completed. This kind of execution must be performed sequentially and not concurrently, otherwise the synchronization process of each instance may affect the other and it may not work properly.

3.3.7 How do you fix errant transactions on the replication topology?

At some point in time, when performing some maintenance/administration operation or other task which verify your replication topology, you may discover the existence of errant transactions. Some utilities like `mysqlfailover` and `mysqlrpladmin` detects errant transactions and issues a warning or error before executing. This is done because errant transactions can lead to an unstable replication topology or introduce errors after a failover or switchover.

What are errant transactions? Errant transactions are transactions directly applied by a client on a slave that do not exist on the other slaves connected to the master. By nature, these transactions should not be replicated and can lead to replication errors if the slave that possesses them is promoted to the master. In practice, this can happen for example if the errant transaction corresponds to a data insert or delete on a table that only exists on that slave. These kind of transactions usually result from a mistake or poor practice with data being changed directly on the slave without turning off the binary log.

The best way to deal with errant transaction is to avoid them, making sure that every transaction on a slave, even if needed for example to add data for reporting or execute local administrative commands, must be applied with binary logging disabled. See SET sql_log_bin Syntax, for more information about how to control logging to the binary log. However, in case errant transaction are found we still need to be able to deal with them in a easy and quick way, skipping those transactions and avoiding them from being replicated if the slave becomes the new master.

Note

Always turn off the binary log when executing queries that change data on a slave. Use `sql_log_bin = 0` before the queries to turn off the binary log and `sql_log_bin = 1` after the query to turn it back on.

Objectives

The goal is to execute the `mysqlslavetrx` utility to skip errant transactions on slaves making sure that those transaction are replicated if the slave that originated them becomes the new master.

Skipping errant transactions is done by injecting an empty transaction for each corresponding GTID on every slave. This can be a very tedious task when performed manually, especially if many transactions need to be skipped.

Thankfully, the `mysqlslavetrx` utility allows us to skip multiple transactions on multiple slaves in a single step.

Let's assume that we have three slaves (slave1:3311, slave2:3312, and slave3:3313) and that one of the slaves (slave1:3311) has five errant transactions that need to be skipped on the other slaves. The GTID set of those transactions is ce969d18-7b10-11e4-aaae-606720440b68:1-5.

Example Execution

Execute the `mysqlslavetrx` utility, specifying the GTID set of the transaction to skip and the target slaves.

```
shell> mysqlslavetrx --gtid-set=ce969d18-7b10-11e4-aaae-606720440b68:1-5 \
          --slaves=dba:pass@slave2:3312,dba:pass@slave3:3313
WARNING: Using a password on the command line interface can be insecure.
#
# GTID set to be skipped for each server:
# - slave2@3312: ce969d18-7b10-11e4-aaae-606720440b68:1-5
# - slave3@3313: ce969d18-7b10-11e4-aaae-606720440b68:1-5
#
# Injecting empty transactions for 'slave2:3312'...
# Injecting empty transactions for 'slave3:3313'...
#
#...done.
#
```

Discussion

The above example illustrates how to execute the `mysqlslavetrx` utility to skip the transactions for the specified GTID set on all given slaves.

To achieve this task, we only need to specify the GTID set for the transactions to be skipped with the `--gtid-set` option, and the list of connection parameters for the target slaves with the `--slaves` option.

In the above example, all of the specific GTIDs were skipped on all target slaves injecting an empty transaction for each one of them. However, it might happen that some of the GTIDs cannot be skipped on some slaves. This can happen if a transaction with the same GTID was previously applied on the target slave. The reason is due to the purpose of GTIDs, which is to uniquely identify a transaction, therefore two distinct transactions cannot be applied with the same GTID, otherwise an error is issued. The `mysqlslavetrx` utility checks the transactions that can be effectively skipped on each slave at the beginning, excluding already executed GTIDs.

Permissions Required

The user for the slaves must have the required permissions to inject an empty transaction for a specific GTID, i.e. to set the `gtid_next` variable. More specifically, the login user to connect to slaves requires the SUPER privilege.

Tips and Tricks

The `mysqlslavetrx` provides a dry run mode that allows users to verify the GTID that would be skipped in each slave without actually injecting empty transactions. The `--dryrun` option must be specified to use this read-only mode.

3.4 Server Operations

The tasks described in this section are those used to perform server-wide operations such as cloning a server instance, determining what MySQL servers are running, etc.

3.4.1 How can you create a temporary copy (running instance) of a server for testing?

When diagnosing a problem or needing to experiment with a server for developing new features or testing modifications, you often need a duplicate of your running server so that you can ensure your solution works for the actual server. It would be really convenient if we had a process to make a copy of a running server for such processes.

Although it is possible and indeed popular to use replication to replicate all of your data to multiple slaves and use one of the slaves for these purposes, for cases where you are working with a particular server or if replication is not in use, you need some way to duplicate not only the data but also the server and its startup parameters.

Objectives

Create a new instance of a running server complete with the same options and the same data.

Example Execution

To meet this objective, we need to use several utilities. But before we get started, we need to know what specific options the host server is using. To do this, we use the `mysqlserverinfo` utility to discover the configuration file and the my_print_defaults tool to print the defaults. We can also show the process id to see what command-line options are being used. We get this from using the `--show-servers` option with `mysqlserverinfo`. On POSIX systems, we can use the `ps` command to find the command line options.

```
shell> mysqlserverinfo --server=root:root@localhost \
          --format=vertical --show-servers
#
# The following MySQL servers are active on this host:
#  Process id:   2377, Data path: /usr/local/mysql/data
#  Process id:   2478, Data path: /Volumes/Source/source/temp_13001
#  Process id:   2487, Data path: /Volumes/Source/source/temp_13002
#
# Source on localhost: ... connected.
*************************       1. row *************************
         server: localhost:3306
        version: 5.1.50-log
        datadir: /usr/local/mysql/data/
        basedir: /usr/local/mysql-5.1.50-osx10.6-x86_64/
     plugin_dir: /usr/local/mysql-5.1.50-osx10.6-x86_64/lib/plugin
    config_file: /etc/my.cnf
     binary_log: my_log.000287
 binary_log_pos: 106
      relay_log: None
  relay_log_pos: None
1 row.
#...done.

shell> my_print_defaults mysqld /etc/my.cnf
--port=3306
--basedir=/usr/local/mysql
--datadir=/usr/local/mysql/data
--server_id=5
--log-bin=my_log
--general_log
--slow_query_log
--innodb_data_file_path=ibdata1:778M;ibdata2:50M:autoextend

shell> ps -f 2377
  UID   PID  PPID   C STIME   TTY      TIME CMD
   74  2377  2300   0 10:56AM ??      0:02.04 /usr/local/mysql/bin/mysqld --basedir=/usr/local/mysql \
                                              --datadir=/usr/local/mysql/data --user=mysql \
                                              --log-error=/logs/me.local.err --pid-file=/logs/me.local.pid \
                                              --port=3306
```

Notice we now have all of the options from the configuration file as well as the startup options. We can now construct the proper options for creating a clone (a running instance) of this server using the `mysqlserverclone` utility. Specifically, we can set the following options using the `--mysqld` option:

- --log-bin=my_log
- --general_log

- --slow_query_log
- --user=mysql
- --log-error=*path*

Using these options and choosing a new data directory, we can create a new instance of the host server using the following command.

```
shell> mysqlserverclone --server=root:root@localhost \
          --new-data=/source/temp_clone --new-port=3307 --root=root --delete \
          --new-id=123 --mysqld="--log-bin=my_log --general-log --slow-query-log \
          --user=mysql --log-error=/source/temp_clone"
# Cloning the MySQL server running on localhost.
# Creating new data directory...
# Configuring new instance...
# Locating mysql tools...
# Setting up empty database and mysql tables...
# Starting new instance of the server...
# Testing connection to new instance...
# Success!
# Setting the root password...
# Connection Information:
#  -uroot -proot --socket=/source/temp_clone/mysql.sock
#...done.
```

Now that we have a running instance, we can export all of the data from the host to the clone.

```
shell> mysqldbexport --server=root:root@localhost:3306 --export=both --all > data.sql
shell> mysqldbimport --server=root:root@localhost:3307 --import=both data.sql
# Source on localhost: ... connected.
# Importing definitions and data from data.sql.
#...done.
```

Discussion

As you can see, this is a multiple step process. We saw examples of using the `mysqlserverinfo`, `mysqlserverclone`, `mysqldbexport`, and `mysqldbimport` utilities.

Notice in the example we used port 3307 for the clone which is reflected in the `mysqldbimport` utility `--server` option.

Permissions Required

The user must have permission to read all databases. Since we are using the root account for these examples (and you typically would), permissions are not generally a problem.

You also need permissions to create the new data directory and write data to it.

Tips and Tricks

If you want to copy all of the users and their permissions, check out the `mysqluserclone` utility.

3.4.2 How do you find what MySQL servers are running on a local machine?

One of the challenges for a database administrator or database developer when working with a development server that has multiple instances of MySQL running is knowing exactly how many are running and once you know that, which ones are no longer needed.

In some cases, this may have come about by accident but mostly having multiple instances of MySQL running is intentional. Whichever the case, it would be nice to be able to use a single command to find all of the MySQL processes.

Objectives

Use the `mysqlserverinfo` utility to locate all of the MySQL processes running on a host.

Example Execution

```
shell> mysqlserverinfo --show-servers --server=root:root@localhost \
          --format=vertical
#
# The following MySQL servers are active on this host:
#  Process id:   3007, Data path: /usr/local/mysql/data
#  Process id:   8191, Data path: /Volumes/Source/source/temp_13001
#  Process id:   8196, Data path: /Volumes/Source/source/temp_13002
#  Process id:   8201, Data path: /Volumes/Source/source/temp_13003
#  Process id:   8207, Data path: /Volumes/Source/source/temp_13004
#  Process id:   8212, Data path: /Volumes/Source/source/temp_13005
#
# Source on localhost: ... connected.
*************************       1. row *************************
         server: localhost:3306
        version: 5.1.50-log
        datadir: /usr/local/mysql/data/
        basedir: /usr/local/mysql-5.1.50-osx10.6-x86_64/
     plugin_dir: /usr/local/mysql-5.1.50-osx10.6-x86_64/lib/plugin
    config_file: /etc/my.cnf
     binary_log: my_log.000286
 binary_log_pos: 237
      relay_log: None
  relay_log_pos: None
1 row.
#...done.
```

Discussion

The `mysqlserverinfo` utility is normally used to find information about a particular server. We can see such results in the example above.

However, the utility also has an option, `--show-servers` that displays a list of all of the MySQL server process ids that are executing on the host. This quick glance can help diagnose problems with multiple instances on the same machine.

Permissions Required

The permissions required include the ability to read the mysql database and to have read access to the data directory.

Tips and Tricks

Notice the output shows the data directory for each server. You can use this information to examine the files in that folder to discern more information such as what databases exist and find and examine the binary log, etc.

On POSIX systems, you can discover the command-line arguments such as the port number the server is using with the "ps -f PID" command. For example, to discover the complete information for PID 2487, you can do the following.

```
shell> ps -f 2487
  UID   PID  PPID   C STIME   TTY           TIME CMD
  501  2487     1   0 10:58AM ttys001    0:00.41 /source/mysql-5.6/sql/mysqld --no-defaults \
                                                 --datadir=/source/temp_13002 --tmpdir=/source/temp_13002 \
                                                 --pid-file=/source/temp_13002/clone.pid --port=13002 \
                                                 --server-id=102 --basedir=/source/mysql-5.6 \
                                                 --socket=/source/temp_13002/mysql.sock --log-slave-updates
                                                 --gtid-mode=on --enforce-gtid-consistency --log-bin \
                                                 --master-info-repository=TABLE --report-port=13002 \
                                                 --report-host=localhost
```

3.4.3 How do you setup and use a secure (encrypted) connection between Utilities and a MySQL server?

Security is a big concern and MySQL Utilities is prepared to use a secure connection to MySQL server secure-connections using an encrypted connection with SSL. This section shows you how to use SSL when connecting to MySQL servers from any utility. All of the utilities use the same mechanism for establishing an SSL connection.

Objectives

Use the `mysqlserverclone` utility to create a new instance of your installed MySQL Server. This new instance is enabled for secure connections using SSL to establish a secure connection by using the SSL options. You can also use an options file to specify the SSL certificates needed for the secure connection.

Example Execution

To meet this objective, you need to supply values for the following options of `mysqlserverclone`:

- --basedir
- --new-port
- --new-data
- --mysqld
- --root-password

If you are unfamiliar with the previous options, you can find more info in the Section 5.20, "`mysqlserverclone` — Clone Existing Server to Create New Server" section.

In the --mysqld option you need to specify the --ssl-ca --ssl-cert and --ssl-key options with his respective SSL certificate for the new instance of the server. By doing this, the new server instance uses the given certificates to establish a secure connection. If you are uncertain of how to create the SSL certificates, please following the steps indicated on Creating SSL and RSA Certificates and Keys. The --ssl-ca --ssl-cert and --ssl-key options of `mysqlserverclone` are used to connect to an existing instance of MySQL in case you need to use ssl to connect to it and these options are not used to indicate the certificates to use by the new server instance. For that reason it is necessary to use the --mysqld option of `mysqlserverclone`.

The following is an example of the running command.

```
shell> mysqlserverclone --basedir=C:\MySQL\mysql-5.6.15-winx64 \
          --new-data=C:\MySQL\instance_3307 \
          --new-port=3307 --root-password=pass \
          --mysqld="--ssl-ca=C:/newcerts/cacert.pem \
          --ssl-cert=C:/newcerts/server-cert.pem \
          --ssl-key=C:/newcerts/server-key.pem"
# Cloning the MySQL server located at C:\MySQL\mysql-5.6.15-winx64.
# Creating new data directory...
# Configuring new instance...
# Locating mysql tools...
# Setting up empty database and mysql tables...
# Starting new instance of the server...
# Testing connection to new instance...
# Success!
# Setting the root password...
# Connection Information:
#  -uroot -ppass --port=3307
#...done.
```

Now we have a new MySQL server instance, and you can confirm the use of the given SSL certificates with the MySQL command-Line tool (also called the monitor or simply the MySQL client tool) by executing the command: "show variables like '%ssl%';".

```
shell> mysql -uroot -ppass --port=3307 -e"show variables like '%ssl%';"
+---------------+----------------------------+
| Variable_name | Value                      |
+---------------+----------------------------+
| have_openssl  | YES                        |
| have_ssl      | YES                        |
| ssl_ca        | C:/newcerts/cacert.pem     |
| ssl_capath    |                            |
| ssl_cert      | C:/newcerts/server-cert.pem |
| ssl_cipher    |                            |
| ssl_crl       |                            |
| ssl_crlpath   |                            |
| ssl_key       | C:/newcerts/server-key.pem  |
+---------------+----------------------------+
```

However, at this moment the root account is not using an encrypted ssl connection. You can see this using the MySQL command-Line tool running the "status;" command:

```
shell> mysql -uroot -ppass --port=3307 -e"status;"
--------------
mysql  Ver 14.14 Distrib 5.6.15, for Win64 (x86_64)

Connection id:          11
Current database:
Current user:           root@localhost
SSL:                    Not in use
...
--------------
```

You need to add the SSL options necessarily to establish an encrypted connection with SSL, this can be done in the following form:

```
shell> mysql -uroot -ppass --port=3307 --ssl-ca=C:/newcerts/cacert.pem \
          --ssl-cert=C:/newcerts/server-cert.pem \
          --ssl-key=C:/newcerts/server-key.pem -e"status;"
--------------
mysql  Ver 14.14 Distrib 5.6.15, for Win64 (x86_64)

Connection id:          13
Current database:
Current user:           root@localhost
SSL:                    Cipher in use is DHE-RSA-AES256-SHA
...
```

```
--------------
```

Note

To configure an account to only permit SSL-encrypted connections, the grants for that account must include the `REQUIRE SSL` clause in your GRANT Syntax statement.

In the same form that you use the SSL options with the MySQL Command-Line Tool, you can use the SSL options on each of the MySQL Utilities. The following is an example of `mysqlserverinfo` using SSL options:

```
shell> mysqlserverinfo --server=root:pass@localhost:3307 \
          --ssl-ca=C:/newcerts/cacert.pem \
          --ssl-cert=C:/newcerts/client-cert.pem \
          --ssl-key=C:/newcerts/client-key.pem \
          --format=vertical
# Source on localhost: ... connected.
*************************       1. row *************************
                   server: localhost:3307
              config_file:
               binary_log:
           binary_log_pos:
                relay_log:
            relay_log_pos:
                  version: 5.6.15
                  datadir: C:\MySQL\instance_3307\
                  basedir: C:\MySQL\mysql-5.6.15-winx64
               plugin_dir: C:\MySQL\mysql-5.6.15-winx64\lib\plugin\
              general_log: OFF
         general_log_file:
    general_log_file_size:
                log_error: C:\MySQL\instance_3307\clone.err
      log_error_file_size: 1569 bytes
           slow_query_log: OFF
      slow_query_log_file:
 slow_query_log_file_size:
1 row.
#...done.
```

Or you can indicate the SSL options by Using Option Files as is mentioned in the Section 2.2, “Connecting to MySQL Servers” documentation. This is an example of how it may look for a group with the options in an options file for the command used above.

```
[instance_3307]
port=3307
user=root
password=pass
host=localhost
ssl-ca=C:/newcerts/cacert.pem
ssl-cert=C:/newcerts/client-cert.pem
ssl-key=C:/newcerts/client-key.pem
```

In this case, the file is located at `C:\MySQL\instance-3307.cnf` and by indicating this path and the group name in the `--server` option, the options for the `mysqlserverinfo` of the previous example takes this form:

```
shell> mysqlserverinfo --server=c:\MySQL\instance-3307.cnf[instance_3307] \
          --format=vertical
```

```
# Source on localhost: ... connected.
*************************       1. row *************************
                   server: localhost:3307
              config_file:
               binary_log:
           binary_log_pos:
                relay_log:
            relay_log_pos:
                  version: 5.6.15
                  datadir: C:\MySQL\instance_3307\
                  basedir: C:\MySQL\mysql-5.6.15-winx64
               plugin_dir: C:\MySQL\mysql-5.6.15-winx64\lib\plugin\
              general_log: OFF
         general_log_file:
    general_log_file_size:
                log_error: C:\MySQL\instance_3307\clone.err
      log_error_file_size: 1569 bytes
           slow_query_log: OFF
      slow_query_log_file:
 slow_query_log_file_size:
1 row.
#...done.
```

Discussion

The SSL options (`--ssl-ca` `--ssl-cert` and `--ssl-key`) are available in the MySQL Utilities that requires a connection to a server or servers, as is in the case of the `--master` and `--slave` options.

Note

An options file can be used to store the connection values, and the MySQL Utilities can read the values stored in them as mentioned in the Section 2.2, "Connecting to MySQL Servers" documentation.

Permissions Required

Required permissions include the ability to read the SSL certificate files and the path where they are located regardless of the form these SSL certificate paths are given to the MySQL Utilities, in addition of the required permissions that each utility requires to accomplish its specific task.

Tips and Tricks

In the configuration file, different connection options can be stored and separated in groups. The desired group used by the MySQL Utilities can be expressed by indicating the group name in the form `config-path["["group-name"]"]`, such as `C:\MySQL\instances.cnf`:

```

[instance_3307]
port=3307
user=root
password=pass
host=localhost
ssl-ca=C:/newcerts/cacert.pem
ssl-cert=C:/newcerts/client-cert.pem
ssl-key=C:/newcerts/client-key.pem

[instance_3308]
port=3308
user=root
password=other-pass
host=localhost
ssl-ca=C:/newcerts/cacert_2.pem
ssl-cert=C:/newcerts/client-cert_2.pem
```

```
ssl-key=C:/newcerts/client-key_2.pem
```

```
shell> mysqlreplicate --master=c:\MySQL\instances.cnf[instance_3307] \
          --slave=C:\MySQL\instances.cnf[instance_3308]
```

3.5 Specialized Operations

The tasks described in this section relate to specific situations or configurations and may not apply in the general case. For example, some tasks require a specific commercial plugin such as those for use with the Audit Log Plugin.

3.5.1 How do you record only login events in the audit log?

The audit log plugin records MySQL servers activity. By default, it is set to write all audit events to the log file which can represent a considerable amount of information. Fortunately, it is possible to control the type of information that is written to the audit log file by changing the audit log plugin's policy. The policy should be set to log only the events of interest, avoiding wasting resources to log unnecessary events.

In particular, if the audit log plugin is only used to monitor access to the database server (for security purposes) then only the login events need to be recorded. The `mysqlauditadmin` utility allows us to perform such a change in a simple way (as well as changes to other settings).

Objectives

The goal is to set the audit log plugin to write the login events to the log file and no other events. It is assumed that the audit log plugin is enabled and running with the default settings (logging all audit events) on the localhost and default port (3306).

Example Execution

```
shell> mysqlauditadmin --server=root@localhost:3306 policy --value=LOGINS \
          --show-options
#
# Showing options before command.
#
# Audit Log Variables and Options
#
+---------------------------+---------------+
| Variable_name             | Value         |
+---------------------------+---------------+
| audit_log_buffer_size     | 1048576       |
| audit_log_file            | audit.log     |
| audit_log_flush           | OFF           |
| audit_log_policy          | ALL           |
| audit_log_rotate_on_size  | 0             |
| audit_log_strategy        | ASYNCHRONOUS  |
+---------------------------+---------------+

#
# Executing POLICY command.
#

#
# Showing options after command.
#
# Audit Log Variables and Options
#
+---------------------------+---------------+
| Variable_name             | Value         |
+--------------------------+---------------+
| audit_log_buffer_size     | 1048576       |
| audit_log_file            | audit.log     |
| audit_log_flush           | OFF           |
| audit_log_policy          | LOGINS        |
| audit_log_rotate_on_size  | 0             |
| audit_log_strategy        | ASYNCHRONOUS  |
+--------------------------+---------------+
```

Discussion

In order to change the type of events recorded to the audit log file, the policy settings must be changed. This is done with the `mysqlauditadmin` utility using the command 'policy' and specifying the desired policy value with the `--value` option. As expected the specification of the target server is also required using the `--server` option.

In the above example, the policy value was set to LOGINS to write only login events to the log file. Nevertheless, other values are also permitted to control the information written to the log file: *ALL* (write all events), *QUERIES* (write only query event), *NONE* (disable logging), *DEFAULT* (use the default policy).

Permissions Required

User must have the SELECT privilege for the mysql database. To view the log file, the user must have read access to the audit log file on the server.

Tips and Tricks

The policy value was specified using uppercase in this example, however uppercase and lowercase can be mixed to specify the policy value (such as "LoGiNs"). The values for this command are still read correctly independently of the used cases (case insensitive), but if an unsupported value is specified, an error is issued.

In the above example the `--show-options` option was used, but it is not required. This option simply displays the audit log settings (variables). However, when this option is combined with a command that changes one of the audit log variables, it displays the audit log settings before and after the execution of the command which can be very handy to confirm that the desired change was performed as expected.

3.5.2 How do you copy or move the audit log?

The audit log information can grow quickly and considerably depending on the type of information written and the activity of the MySQL server. Therefore, it might be a good idea to copy the audit log files to a different location and free some storage on the server.

The `mysqlauditadmin` utility also provides this useful functionality.

Objectives

The goal of this task is to copy an existing audit log file to a different location using the `mysqlauditadmin` utility.

It is assumed that the utility is executed on the destination host which must be a non-Windows system with the scp (Secure Copy) command line program, and that must have access to the MySQL remote server and its data directory with the provided credentials (user and password). It is also assumed that the specified audit log file exists and user has write privileges on the target directory.

Example Execution

```
shell> mysqlauditadmin --audit-log-name=/MySQL/SERVER/data/audit.log.13753706179878237 \
          copy --copy-to=/ARCHIVE/Audit_Logs --remote-login=user1:server1
# Copying file from server1:/MySQL/SERVER/data/audit.log.13753706179878237 to /ARCHIVE/Audit_Logs:
user1@server1's password:
audit.log.13753706179878237                   100% 4716     4.6KB/s   00:01
```

Discussion

The copy operation can be performed with the `mysqlauditadmin` utility using the 'copy' command requiring the following options: the `--audit-log-name` option to specify the path and filename of the audit log file to copy, the `--copy-to` option to indicate the destination folder, and the `--remote-login` option to specify the user and remote host where the file is located (a prompt for the user password is displayed).

The `--remote-login` option is not required if the source and destination location are on the same server where the utility is executed. Moreover, this option is not supported in Windows system where UNC paths should be used.

Permissions Required

The user must have permissions to read the audit log on disk and write the file to the remove location.

Tips and Tricks

The name of the audit log file (`audit.log`, by default) is defined by the `audit_log_file` variable displayed by `mysqlauditadmin` when using the `--show-options` option. Existing audit log files have a timestamp extension except the one that is currently in use. That being said, it might be useful to know that it is possible to get information about the existing audit log files using `mysqlrpladmin`. For instance, to determine which files need to be copied. To get this information use the `--file-stats` option and the `--audit-log-name` option specifying the full path of the current audit log file (i.e., without the timestamp extension). For example:

```
shell> mysqlauditadmin --file-stats --audit-log-name=/MySQL/SERVER/data/audit.log
+------------------------------+------------+---------------------------+---------------------------+
| File                         | Size       | Created                   | Last Modified             |
+------------------------------+------------+---------------------------+---------------------------+
| audit.log.13753706179878237  | 4716       | Thu Aug  1 16:23:37 2013  | Thu Aug  1 16:23:37 2013  |
| audit.log                    | 6062       | Thu Aug  1 16:24:26 2013  | Thu Aug  1 16:24:26 2013  |
| audit.log.13753705495049727  | 335142503  | Thu Aug  1 16:22:29 2013  | Thu Aug  1 16:22:29 2013  |
+------------------------------+------------+---------------------------+---------------------------+
```

Note

If an audit log file with the timestamp extension is specified in this example for the `--audit-log-name` option, only the information of the specified file is displayed, as opposed to the file statistics of all existing files.

3.5.3 How can you find the INSERT and UPDATE queries that failed in the audit log?

Over time, the audit log can contain a lot of useful information. However, how filtering this information and searching for specific events, for instance in order to determine the possible cause of a problem, can be very tedious if done manually.

For example, suppose that someone reported that some data changes are missing (and you suspect some INSERT or UPDATE queries failed) and you want to determine what might be the cause of those transaction failures. All queries are recorded to the audit log file, so you just need to get retrieve all queries of a given type that failed (with a MySQL error) and analyze them.

This can be achieved using common 'grep' command line tools, but likely involves the use of very complex regular expression to filter the desired data. Fortunately, the `mysqlauditgrep` utility allows to perform this kind of task in a much easier and simple way taking advantage of the knowledge of the structure and semantics of the audit log files.

Objectives

The goal is display all INSERT and UPDATE queries that failed (independently of error) from the current audit log file.

It is assumed that the `audit.log` file exists and is located in the directory `/MySQL/SERVER/data/`. The below example show how easy it is to perform the desired search with the `mysqlauditgrep` utility.

Example Execution

```
shell> mysqlauditgrep --query-type=INSERT,UPDATE --status=1-9999 /MySQL/SERVER/data/audit.log
+--------+---------------------+-------+-------------------------------------------------------+--------------
| STATUS | TIMESTAMP           | NAME  | SQLTEXT                                               | CONNECTION_ID
+--------+---------------------+-------+-------------------------------------------------------+--------------
| 1046   | 2013-08-01T18:20:46 | Query | INSERT INTO tbl_not_exist (a,b,c) VALUES(1,2,3)       | 37
| 1146   | 2013-08-01T18:21:03 | Query | INSERT INTO mysql.tbl_not_exist (a,b,c) VALUES(1,2,3) | 37
| 1054   | 2013-08-01T18:23:10 | Query | INSERT INTO test.t1 (a,b,not_col) VALUES(1,2,3)       | 37
| 1146   | 2013-08-01T18:26:14 | Query | UPDATE tbl_not_exist SET a = 1                        | 37
| 1054   | 2013-08-01T18:26:53 | Query | UPDATE test.t1 SET not_col = 1                        | 37
+--------+---------------------+-------+-------------------------------------------------------+--------------
```

Discussion

As expected, the use of the `mysqlauditgrep` utility requires the specification of the target audit log file to search and a few options corresponding to the needed search criteria. In this case, the `--query-type` option was used to restrict the displayed results to specific types of queries (i.e., only INSERT and UPDATE), and the `--status` option was used to specify the considered MySQL error codes (i.e., all ranging from 1 to 9999).

The `--query-type` option allows the specification of a comma separated list of different SQL statements. Apart from INSERT and UPDATE the list of supported values for this option also includes: CREATE, ALTER, DROP, TRUNCATE, RENAME, GRANT, REVOKE, SELECT, DELETE, COMMIT, SHOW, SET, CALL, PREPARE, EXECUTE, DEALLOCATE

The `--status` option accepts a comma-separated list of non-negative integers (corresponding to MySQL error codes) or intervals marked with a dash. For example: 1051,1100-1199,1146. In this particular case, the range value 1-9999 was used to include all MySQL error codes and display all unsuccessful commands. To retrieve only successful command (no errors) simply use the value 0 for the `--status` option.

Permissions Required

The user must have permissions to read the audit log on disk.

Tips and Tricks

The value specified for the `--query-type` option are case insensitive, therefore you can mix lowercase and uppercase to specify the list of query types. For example, 'insert,Update' produces the same result as using 'INSERT,UPDATE'. Of course the use of non-supported values raises an appropriate error.

Many other options and search criteria are provided by the `mysqlauditgrep` utility, check them in order to use the more appropriate one to meet your needs. Note that the utility provides the `--pattern` option to search entries in the audit log file using regular expressions, like common grep tools. By default, this option uses standard SQL pattern matching (used by 'LIKE' comparison operator), unless the `--regexp` option is used to allow more powerful standard regular expressions (POSIX extended).

3.5.4 How do you find connections by the user 'root' in the audit log and show the results in CSV format?

The audit log plugin can be used to record information about different type of events which one might need to monitor or keep a record in a different format. For example, a security record with the list of all logins performed to the database serve might need to be kept to later track the responsible for some change. Moreover, the retrieved information might need to be converted to a specific format (such as CSV) to feed another application.

Objectives

The goal of this task is to retrieve from the audit log the information of all the connections established by the root user to the MySQL Server, and display the resulting information in the comma-separated-value (CSV) format.

Besides the search/filter functionalities using different criteria, the `mysqlauditgrep` utility also provides a feature to display the resulting information in different formats (including CSV). This allows this task to be performed easily with in a single step.

It is assumed that the `audit.log` file exists and is located in the directory `/MySQL/SERVER/data/`.

Example Execution

```
shell> mysqlauditgrep --user=root --event-type=Connect \
          --format=CSV /MySQL/SERVER/data/audit.log

STATUS,NAME,TIMESTAMP,CONNECTION_ID,HOST,USER,PRIV_USER,IP
0,Connect,2013-08-01T15:24:26,33,localhost,root,root,127.0.0.1
0,Connect,2013-08-01T15:24:26,34,localhost,root,root,127.0.0.1
0,Connect,2013-08-01T15:24:26,35,localhost,root,root,127.0.0.1
0,Connect,2013-08-01T15:24:26,36,localhost,root,root,127.0.0.1
0,Connect,2013-08-01T18:18:43,37,localhost,root,root,127.0.0.1
0,Connect,2013-08-01T18:49:46,38,,root,root,192.168.1.104
1045,Connect,2013-08-01T19:18:08,39,localhost,root,,127.0.0.1
```

Discussion

To perform this operation the `mysqlauditgrep` utility requires the indication of the target audit log file as expected, two criteria search options, and one formatting option to convert the output to the desired format. In this case, the `--users` option was applied to search the records for the specified user (i.e., "root") and the `--event-type` option to retrieve only event of a specific type (i.e., "connect"). The `--format` option is the one used to define the output format of the obtained search results.

In this example, only the "Connect" value was used for the `--event-type` option which correspond to the logging in event (when a client connects). Nevertheless, this option accepts a comma separated list of event types with the following supported values (beside "Connect"): Audit, Binlog Dump, Change user, Close stmt, Out, Connect, Create DB, Daemon, Debug, Delayed, insert, Drop DB, Execute, Fetch, Field List, Init DB, Kill, Long Data, NoAudit, Ping, Prepare, Processlist, Query, Quit, Refresh, Register Slave, Reset stmt, Set option, Shutdown, Sleep, Statistics, Table Dump, Time.

In terms of output formats the following are supported beside CSV: *GRID* (used by default), *TAB*, *VERTICAL* and *RAW* (corresponding to the original XML format of the audit log file).

Permissions Required

The user must have permissions to read the audit log on disk.

Tips and Tricks

The values for the `--event-type` and `--format` options are case insensitive, therefore lowercase and uppercase can be mixed to specify these values as long as a supported event type name or format is used. Unlike them, the value specified for the `--users` option is case sensitive, so be careful not to mix upper and lower cases here.

It is possible to find some event type values with a space in the middle, for example like "Binlog Dump" or "Init DB". If one of such values needs to be specified for the `--event-type` option then it must be surrounded by double (") or single (') quotes depending on the operating system.

Chapter 4 Overview of MySQL Utilities

Table of Contents

This chapter presents an brief overview of each of the available utilities. The utilities are grouped into sections based on the type of administrative function that they perform.

4.1 Database Operations

These utilities are those designed to work at the database-level. They include utilities that can used to adminster databases on one or more servers.

- `mysqldbcompare`
  - Compare databases on two servers or the same server
  - Compare definitions and data
  - Generate a difference report
  - Generate SQL transformation statements
- `mysqldbcopy`
  - Copy databases between servers
  - Clone databases on the same server
  - Supports rename
- `mysqldbexport`
  - Export metadata and/or data from one or more databases
  - Formats: SQL, CSV, TAB, Grid, Vertical
- `mysqldbimport`
  - Import metadata and data from one or more files
  - Reads all formats from mysqldbexport
- `mysqldiff`
  - Compare object definitions
  - Generate a difference report

4.2 General Operations

These utilities are those designed to perform general operations such as reporting and searching.

- `mysqldiskusage`
  - Show disk usage for databases
  - Generate reports in SQL, CSV, TAB, Grid, Vertical
- `mysqlfrm`
  - Reads `.frm` files, optionally in byte-by-byte diagnostic mode
  - Generates `CREATE` statements from table definition data
- `mysqlindexcheck`
  - Read indexes for one or more tables
  - Check for redundant and duplicate indexes
  - Generate reports in SQL, CSV, TAB, Grid, Vertical
- `mysqlmetagrep`
  - Search metadata
  - Regexp, database search
  - Generate SQL statement for search query
- `mysqlprocgrep`
  - Search process information
  - Generate SQL statement for search
  - Kill processes that match query
- `mysqluserclone`
  - Clone a user account, to the same or different server
  - Show user grants
- `mysqluc`
  - Command line client for running MySQL Utilities
  - Allows a persistent connection to a MySQL Server
  - Tab completion for utility names and options
  - Allows calling the commands with shorter names, such as using "serverinfo" instead of `mysqlserverinfo`

4.3 High Availability Operations

These utilities are those designed to support replication and high availability operations for MySQL servers.

- `mysqlfailover`
  - Provides automatic failover on a replication topology
  - Uses Global Transaction Identifiers (GTID, MySQL Server 5.6.5+)
- `mysqlreplicate`
  - Setup replication
  - Start from beginning, current, specific binlog, pos
- `mysqlrplms`
  - Provides round-robin multi-source replication (a slave server continually cycles through multiple masters in order to store a consolidated data set)
  - Uses Global Transaction Identifiers (GTID, MySQL Server 5.6.9+)
- `mysqlrpladmin`
  - Administers the replication topology
  - Allows recovery of the master
  - Commands include elect, failover, gtid, health, start, stop, and switchover
- `mysqlrplcheck`
  - Check replication configuration
  - Tests binary logging on master
- `mysqlrplshow`
  - Show slaves attached to master
  - Can search recursively
  - Show the replication topology as a graph or list
- `mysqlrplsync`
  - Check data consistency between servers in a replicated setup
  - Uses Global Transaction Identifiers (GTID)
  - Requires MySQL Server 5.6.14 and higher

4.4 Server Operations

These utilities are used to perform server-wide operations.

- `mysqlserverclone`

    - Start a new instance of a running server

- `mysqlserverinfo`
    - Show server information
    - Can search for running servers on a host
    - Access online or offline servers

4.5 Specialized Operations

These utilities are designed to be used with a specific commercial extension. In this case, these utilities require the Audit Log Plugin.

- `mysqlauditadmin`
    - Monitor the audit log
    - Copy, rotate, and configure the audit log
- `mysqlauditgrep`
    - Search the audit log
    - Output results to different formats

Chapter 5 Manual Pages

Table of Contents

This chapter includes the manual pages for each of the utilities. Each manual page is formatted similar to a typical Unix man page.

5.1 `mysqlauditadmin` — Allows users to perform maintenance actions on the audit log

This utility allows you to maintain the audit log including the ability to view and modify a subset of audit log control variables, display the audit log file status, perform on-demand rotation of the log file, and copy files to other locations. These features enable you to easily monitor the audit log file growth and control its rotation (automatically based on the defined file size threshold, or manually by a on-demand command).

Rotation refers to the action of replacing the current audit log file by a new one for continuous use, renaming (with a timestamp extension) and copying the previously used audit log file to a defined location for archival purposes.

The available actions include the following:

- **copy**

  This command copies the audit log specified by `--audit-log-name` to the destination path specified by `--copy-to`. The `--remote-login` option can be used to copy log files from a remote location. Note: the destination path must be locally accessible by the current user.

- **policy**

The policy command is used to change the audit logging policy. The accepted values include the following, which are set using the `--value` option.

Note

The `--server` option is also required to execute this command.

Starting from MySQL server 5.6.20 and 5.7.5, the value is read only for the audit_log_policy variable. MySQL server 5.7.9 introduced two new variables: audit_log_connection_policy and audit_log_statement_policy whose values are determined based on the presence and value of the audit_log_policy startup variable. See the MySQL reference manual for more information about how the policy variables are set. These changes are supported starting from MySQL Utilities 1.5.2.

- `ALL`: log all events
- `NONE`: log nothing
- `LOGINS`: only log login events
- `QUERIES`: only log query events
- `DEFAULT`: sets the default log policy

- **rotate_on_size**

  This command sets the file size threshold for automatic rotation of the audit log (the `audit_log_rotate_on_size` variable). The value is set using the `--value` option, and must be in the range (0, 4294967295). This command also requires the `--server` option to be specified. Note: if the variable is set with a value that is not a multiple of 4096, then it is truncated to the nearest multiple.

- **rotate**

  This command is used to perform an on-demand audit log rotation, and only requires the `--server` option to be passed. Note: this command has no effect if the audit log file size is smaller than 4096, which is the minimum value allowed that is greater than 0 for the `audit_log_rotate_on_size` variable).

OPTIONS

`mysqlauditadmin` accepts the following command-line options:

- --audit-log-name=*`AUDIT_LOG_FILE`*

  Full path and filename for the audit log file. Used by the `--file-stats` option, and the *copy* command.

- --copy-to=*`COPY_DESTINATION`*

  The location to copy the specified audit log file. The path must be locally accessible for the current user.

- --file-stats

  Display the audit log file statistics.

- --help

Display a help message and exit.

- --license

  Display license information and exit.

- --remote-login=`REMOTE_LOGIN`

  User name and host to be used for the remote login, for copying log files. It is defined using the following format: `user`:`host or IP`. The utility displays a prompt for the password.

- --server=`SERVER`

  Connection information for the server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : `login-path`[:`port`][:`socket`]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : `configuration-file-path`[:`section`]
  - Specify the data on the command-line (unencrypted, visible). Example : `user`[:`passwd`]@`host`[:`port`][:`socket`]

- --show-options

  Display the audit log system variables.

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --value=`VALUE`

  Value used to set variables based on the specified commands, such as *policy* and *rotate_on_size*.

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

NOTES

This utility can only be applied to servers with the audit log plugin enabled. And the audit log plugin is available as of MySQL Server versions 5.5.28 and 5.6.10.

This utility requires Python version 2.6 or higher, but does not support Python 3.

The path to the MySQL client tools should be included in the `PATH` environment variable in order to use the authentication mechanism with login-paths. This allows the utility to use the `my_print_defaults` tools, which is required to read the login-path values from the login configuration file (`.mylogin.cnf`). This feature exists as of MySQL Server 5.6.6, see `mysql_config_editor` — MySQL Configuration Utility.

Changes to MySQL Enterprise Audit are not documented here, so your output might be different than the examples shown. For example, a new (or removed) MySQL Enterprise Audit option might affect the output.

LIMITATIONS

The `--remote-login` option is not supported on Microsoft Windows platforms. For Microsoft Windows, use `UNC` paths and perform a local copy operation, omitting the `--remote-login` option.

EXAMPLES

To display the audit log system variables, run the following command:

```
shell> mysqlauditadmin --show-options --server=root@localhost:3310

#
# Showing options after command.
#
# Audit Log Variables and Options
#
+-------------------------------+---------------+
| Variable_name                 | Value         |
+-------------------------------+---------------+
| audit_log_buffer_size         | 1048576       |
| audit_log_connection_policy   | NONE          |
| audit_log_current_session     | ON            |
| audit_log_exclude_accounts    |               |
| audit_log_file                | audit.log     |
| audit_log_flush               | OFF           |
| audit_log_format              | OLD           |
| audit_log_include_accounts    |               |
| audit_log_policy              | ALL           |
| audit_log_rotate_on_size      | 0             |
| audit_log_statement_policy    | ALL           |
| audit_log_strategy            | ASYNCHRONOUS  |
+-------------------------------+---------------+
```

To perform a (manual) rotation of the audit log file, use the following command:

```
shell> mysqlauditadmin --server=root@localhost:3310 rotate

#
```

```
# Executing ROTATE command.
#
```

To display the audit log file statistics, run the following command:

```
shell> mysqlauditadmin --file-stats --audit-log-name=../SERVER/data/audit.log

  +------------------------------+--------+--------------------------+--------------------------+
  | File                         | Size   | Created                  | Last Modified            |
  +------------------------------+--------+--------------------------+--------------------------+
  | audit.log                    | 3258   | Wed Sep 26 11:07:43 2012 | Wed Sep 26 11:07:43 2012 |
  | audit.log.13486539046497235  | 47317  | Wed Sep 26 11:05:04 2012 | Wed Sep 26 11:05:04 2012 |
  +------------------------------+--------+--------------------------+--------------------------+
```

To change the audit log policy to log only query events, and show the system variables before and after the execution of the *policy* command, use the following command:

```
shell> mysqlauditadmin --show-options --server=root@localhost:3310 policy \
       --value=QUERIES

#
# Showing options before command.
#
# Audit Log Variables and Options
#
+------------------------------+---------------+
| Variable_name                | Value         |
+------------------------------+---------------+
| audit_log_buffer_size        | 1048576       |
| audit_log_connection_policy  | ALL           |
| audit_log_current_session    | ON            |
| audit_log_exclude_accounts   |               |
| audit_log_file               | audit.log     |
| audit_log_flush              | OFF           |
| audit_log_format             | OLD           |
| audit_log_include_accounts   |               |
| audit_log_policy             | ALL           |
| audit_log_rotate_on_size     | 0             |
| audit_log_statement_policy   | ALL           |
| audit_log_strategy           | ASYNCHRONOUS  |
+------------------------------+---------------+

#
# Executing POLICY command.
#

#
# Showing options after command.
#
# Audit Log Variables and Options
#
+------------------------------+---------------+
| Variable_name                | Value         |
+------------------------------+---------------+
| audit_log_buffer_size        | 1048576       |
| audit_log_connection_policy  | NONE          |
| audit_log_current_session    | ON            |
| audit_log_exclude_accounts   |               |
| audit_log_file               | audit.log     |
| audit_log_flush              | OFF           |
| audit_log_format             | OLD           |
| audit_log_include_accounts   |               |
| audit_log_policy             | ALL           |
| audit_log_rotate_on_size     | 0             |
| audit_log_statement_policy   | ALL           |
| audit_log_strategy           | ASYNCHRONOUS  |
+------------------------------+---------------+
```

To change the audit log automatic file rotation size (audit_log_rotate_on_size) to 32535, and show the system variables before and after the execution of the `rotate_on_size` command, use the following command. (Notice that the value set is actually 28672 because the specified `rotate_on_size` value is truncated to a multiple of 4096):

```
shell> mysqlauditadmin --show-options --server=root@localhost:3310 rotate_on_size \
       --value=32535

#
# Showing options before command.
#
# Audit Log Variables and Options
#
+------------------------------+---------------+
| Variable_name                | Value         |
+------------------------------+---------------+
| audit_log_buffer_size        | 1048576       |
| audit_log_connection_policy  | ALL           |
| audit_log_current_session    | ON            |
| audit_log_exclude_accounts   |               |
| audit_log_file               | audit.log     |
| audit_log_flush              | OFF           |
| audit_log_format             | OLD           |
| audit_log_include_accounts   |               |
| audit_log_policy             | ALL           |
| audit_log_rotate_on_size     | 0             |
| audit_log_statement_policy   | ALL           |
| audit_log_strategy           | ASYNCHRONOUS  |
+------------------------------+---------------+

#
# Executing POLICY command.
#

#
# Showing options after command.
#
# Audit Log Variables and Options
#
+------------------------------+---------------+
| Variable_name                | Value         |
+------------------------------+---------------+
| audit_log_buffer_size        | 1048576       |
| audit_log_connection_policy  | NONE          |
| audit_log_current_session    | ON            |
| audit_log_exclude_accounts   |               |
| audit_log_file               | audit.log     |
| audit_log_flush              | OFF           |
| audit_log_format             | OLD           |
| audit_log_include_accounts   |               |
| audit_log_policy             | ALL           |
| audit_log_rotate_on_size     | 28672         |
| audit_log_statement_policy   | ALL           |
| audit_log_strategy           | ASYNCHRONOUS  |
+------------------------------+---------------+
```

To perform a copy of a audit log file to another location, use the following command:

```
shell> mysqlauditadmin --audit-log-name=../SERVER/data/audit.log.13486539046497235 \
       copy --copy-to=/BACKUP/Audit_Logs
```

To copy a audit log file from a remote server/location to the current location (a prompt is issued for the user password), use the following command:

```
shell> mysqlauditadmin --audit-log-name=audit.log.13486539046497235 \
       copy --remote-login=user:host --copy-to=.
```

PERMISSIONS REQUIRED

The user must have permissions to read the audit log file(s) on disk and write the file(s) to the remote location.

5.2 `mysqlauditgrep` — Allows users to search the current or an archived audit log

This utility allows you to search the current or archived audit logs permitting you to display data from the audit log file according to the defined search criterion. It also allows you to output the results in different formats, namely GRID (default), TAB, CSV, VERTICAL, and RAW (the original XML format).

This utility allows you to search and filter the returned audit log records by: users (`--users`), date and time ranges (`--start-date` and `--end-date`), SQL query types (`--query-type`), logged event and record types (`--event-type`), status (`--status`), and matching patterns (`--pattern`). Any of these search options can be combined and used together, with the retrieved records resulting from all options evaluated as an and condition (all must be true).

The `--pattern` supports two types of pattern matching: standard SQL, used with the SQL *LIKE* operator (SQL patterns), and standard *REGEXP* (POSIX regular expression patterns).

This utility always requires an audit log file. The *AUDIT_LOG_FILE* argument should contain the a full path and filename for the audit log file. If not specified, a notification concerning this requirement is displayed. If `--format` is specified without search parameters, all of the records of the audit log are displayed in the specified format. Thus, you can use this feature to view the audit log file in the supported formats.

The `--file-stats` option is not considered a search criteria and is used to display the file statistics of a specified audit log. Other search options are ignored when the `--file-stats` option is used, except the `--format` option, which formats the results accordingly.

To specify the format of the generated results, use one of the following values with the `--format` option:

- *GRID (default)*

  Display output in grid or table format like that of the `mysql` client command-line tool.

- *CSV*

  Display output in comma-separated values format.

- *VERTICAL*

  Display output in single-column format like that of the `\G` command for the `mysql` client command-line tool.

- *RAW*

  Display output results in the original raw format of the audit log records, which is written in XML.

Standard SQL Pattern Matching

The simple patterns defined by the SQL standard enables users to use two characters with special meanings: “`%`” (percent) matches zero or more characters, and “`_`” (underscore) matches exactly one arbitrary character. In standard SQL, these types of patterns are used with the `LIKE` comparison operator, and they are case-insensitive by default. This utility assumes that they are case-insensitive.

For example:

- `"audit%"`

  Match any string that starts with "audit".

- `"%log%"`

  Match any string containing the word "log".

- `"%_"`

  Match any string consisting of one or more characters.

For documentation about the standard SQL pattern matching syntax, see Pattern Matching.

REGEXP Pattern Matching (POSIX)

Standard *REGEXP* patterns are more powerful than the simple patterns defined in the SQL standard. A regular expression is a string of ordinary and special characters specified to match other strings. Unlike SQL Patterns, *REGEXP* patterns are case-sensitive. The *REGEXP* syntax defines the following characters with special meaning:

- *.*

  Match any character.

- ^

  Match the beginning of a string.

- *$*

  Match the end of a string.

- \

  Match zero or more repetitions of the preceding regular expression.

- +

  Match one or more repetitions of the preceding regular expression.

- *?*

  Match zero or one repetition of the preceding regular expression.

- |

  Match either the regular expressions from the left or right of `|`.

- *[]*

Indicates a set of characters to match.

> **Note**
>
> Special characters lose their special meaning inside sets. In particular, the caret symbol (`^`) acquires a different meaning if it is the first character of the set, matching the complementary set (i.e., all the characters that are not in the set are matched).

- *{m}*

  Match *m* repetitions of the preceding regular expression.

- *{m,n}*

  Match from *m* to *n* repetitions of the preceding regular expression.

- *()*

  Define a matching group, and matches the regular expression inside the parentheses.

For example:

- *`"a\*"`*

  Match a sequence of zero or more `a`.

- *`"a+"`*

  Match a sequence of one or more `a`.

- *`"a?"`*

  Match zero or one `a`.

- *`"ab|cd"`*

  Match `ab` or `cd`.

- *`"[axy]"`*

  Match `a`, `x` or `y`.

- *`"[a-f]"`*

  Match any character in the range `a` to `f` (that is, `a`, `b`, `c`, `d`, `e`, or `f`).

- *`"[^axy]"`*

  Match any character *except* `a`, `x` or `y`.

- *`"a{5}"`*

  Match exactly five copies of `a`.

- *`"a{2,5}"`*

  Match from two to five copies of `a`.

- *`"(abc)+"`*

Match one or more repetitions of `abc`.

This is a brief overview of regular expressions that can be used to define this type of patterns. The full syntax is described in the Python "re" module docs, supporting the definition of much more complex pattern matching expression.

OPTIONS

`mysqlauditgrep` accepts the following command-line options:

- --end-date=*`END_DATE`*

  End date/time to retrieve log entries until the specified date/time range. If not specified or the value is 0, all entries to the end of the log are displayed. Accepted formats: "yyyy-mm-ddThh:mm:ss" or "yyyy-mm-dd".

- --event-type=*`EVENT_TYPE`*

  Comma-separated list of event types to search in all audit log records matching the specified types. Supported values are: Audit, Binlog Dump, Change user, Close stmt, Connect Out, Connect, Create DB, Daemon, Debug, Delayed insert, Drop DB, Execute, Fetch, Field List, Init DB, Kill, Long Data, NoAudit, Ping, Prepare, Processlist, Query, Quit, Refresh, Register Slave, Reset stmt, Set option, Shutdown, Sleep, Statistics, Table Dump, Time.

- --file-stats

  Display the audit log file statistics.

- --format=FORMAT, -f FORMAT

  Output format to display the resulting data. Supported format values: GRID (default), TAB, CSV, VERTICAL and RAW.

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --pattern=*`PATTERN`*, -e *`PATTERN`*

  Search pattern to retrieve all entries with at least one attribute value matching the specified pattern. By default the standard SQL *LIKE* patterns are used for matching. If the `--regexp` option is set, then *REGEXP* patterns must be specified for matching.

- --query-type=*`QUERY_TYPE`*

  Comma-separated list of SQL statements/commands to search for and match. Supported values: CREATE, ALTER, DROP, TRUNCATE, RENAME, GRANT, REVOKE, SELECT, INSERT, UPDATE, DELETE, COMMIT, SHOW, SET, CALL, PREPARE, EXECUTE, DEALLOCATE.

- --regexp, --basic-regexp, -G

  Indicates that pattern matching is performed using a regular expression *REGEXP* (from the Python re module). By default, the simple standard SQL *LIKE* patterns are used for matching. This affects how the value specified by the `--pattern` option is interpreted.

- --start-date=*START_DATE*

  Starting date/time to retrieve log entries from the specified date/time range. If not specified or the value is 0, all entries from the start of the log are displayed. Accepted formats: yyyy-mm-ddThh:mm:ss or yyyy-mm-dd.

- --status=*STATUS*

  Comma-separated list of status values or intervals to search for all audit log records with a matching status. Status values are non-negative integers (corresponding to MySQL error codes). Status intervals are closed (i.e., include both endpoints) and defined simply using a dash between its endpoints. For Example: 1051,1068-1075,1109,1146.

  The `--status` option is available as of MySQL Utilities 1.2.4 / 1.3.3.

- --users=*USERS*, -u *USERS*

  Comma-separated list of user names, to search for their associated log entries. For example: "dan,jon,john,paul,philip,stefan".

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

NOTES

This utility is available as of MySQL Utilities 1.2.0.

This utility can only be applied to servers with the audit log plugin enabled. And the audit log plugin is available as of MySQL Server versions 5.5.28 and 5.6.10.

This utility support both of the existing audit log file formats (old and new). The new audit log format is supported as of MySQL Utilities 1.4.3. See The Audit Log File, for more information about available file formats.

This utility requires the use of Python version 2.6 or higher, but does not support Python 3.

Single or double quote characters (respectively, *'* or *"*) can be used around option values. In fact, quotes are required to set some options values correctly, such as values with whitespace. For example, to specify the event types `Create DB` and `Drop DB` for the `--event-type` option, the following syntax must be used: `--event-type='Create DB,Drop DB'` or `--event-type="Create DB,Drop DB"`.

EXAMPLES

To display the audit log file statistics and output the results in CSV format, run the following command:

```
shell> mysqlauditgrep --file-stats --format=CSV /SERVER/data/audit.log

  #
  # Audit Log File Statistics:
  #
  File,Size,Created,Last Modified
  audit.log,9101,Thu Sep 27 13:33:11 2012,Thu Oct 11 17:40:35 2012

  #
  # Audit Log Startup Entries:
  #

  SERVER_ID,STARTUP_OPTIONS,NAME,TIMESTAMP,MYSQL_VERSION,OS_VERSION,VERSION
  1,/SERVER/sql/mysqld --defaults-file=/SERVER/my.cnf,Audit,2012-09-27T13:33:11,5.5.29-log,x86_64-Linux,1
```

To display the audit log entries of specific users, use the following command:

```
shell> mysqlauditgrep --users=tester1,tester2 /SERVER/data/audit.log
```

To display the audit log file statistics, run the following command:

```
shell> mysqlauditgrep --users=tester1,tester2 /SERVER/data/audit.log

  +---------+-----------+----------+---------------------+---------------+------------+----------+---------
  | STATUS  | SERVER_ID | NAME     | TIMESTAMP           | CONNECTION_ID | HOST       | USER     | PRIV_USE
  +---------+-----------+----------+---------------------+---------------+------------+----------+---------
  | 0       | 1         | Connect  | 2012-09-28T11:26:50 | 9             | localhost  | root     | tester1
  | 0       | 1         | Query    | 2012-09-28T11:26:50 | 9             | None       | root     | tester1
  | 0       | 1         | Ping     | 2012-09-28T11:26:50 | 9             | None       | root     | tester1
  | 0       | 1         | Query    | 2012-09-28T11:26:50 | 9             | None       | root     | tester1
  | 0       | 1         | Query    | 2012-09-28T11:26:50 | 9             | None       | root     | tester1
  | 0       | 1         | Ping     | 2012-09-28T11:26:50 | 9             | None       | root     | tester1
  | 0       | 1         | Query    | 2012-09-28T11:26:50 | 9             | None       | root     | tester1
  | 0       | 1         | Quit     | 2012-09-28T11:26:50 | 9             | None       | root     | tester1
  | 0       | 1         | Connect  | 2012-10-10T15:55:55 | 11            | localhost  | tester2  | root
  | 0       | 1         | Query    | 2012-10-10T15:55:55 | 11            | None       | tester2  | root
  | 0       | 1         | Query    | 2012-10-10T15:56:10 | 11            | None       | tester2  | root
  | 1046    | 1         | Query    | 2012-10-10T15:57:26 | 11            | None       | tester2  | root
  | 1046    | 1         | Query    | 2012-10-10T15:57:36 | 11            | None       | tester2  | root
  | 0       | 1         | Query    | 2012-10-10T15:57:51 | 11            | None       | tester2  | root
  | 0       | 1         | Quit     | 2012-10-10T15:57:59 | 11            | None       | tester2  | root
  | 0       | 1         | Connect  | 2012-10-10T17:35:42 | 12            | localhost  | tester2  | root
  | 0       | 1         | Query    | 2012-10-10T17:35:42 | 12            | None       | tester2  | root
  | 0       | 1         | Quit     | 2012-10-10T17:47:22 | 12            | None       | tester2  | root
  +---------+-----------+----------+---------------------+---------------+------------+----------+---------
```

To display the audit log entries for a specific date/time range, use the following command:

```
shell> mysqlauditgrep --start-date=2012-09-27T13:33:47 --end-date=2012-09-28 /SERVER/data/audit.log

  +---------+---------------------+--------+---------------+-----------------------------------------------
  | STATUS  | TIMESTAMP           | NAME   | CONNECTION_ID | SQLTEXT
  +---------+---------------------+--------+---------------+-----------------------------------------------
  | 0       | 2012-09-27T13:33:47 | Ping   | 7             | None
  | 0       | 2012-09-27T13:33:47 | Query  | 7             | SELECT * FROM INFORMATION_SCHEMA.PLUGINS WHERE
  | 0       | 2012-09-27T13:33:47 | Query  | 7             | COMMIT
  | 0       | 2012-09-27T13:34:48 | Quit   | 7             | None
  | 0       | 2012-09-27T13:34:48 | Quit   | 8             | None
  +---------+---------------------+--------+---------------+-----------------------------------------------
```

To display the audit log entries matching a specific SQL *LIKE* pattern, use the following command:

```
shell> mysqlauditgrep --pattern="% = ___"; /SERVER/data/audit.log

  +---------+---------------------+--------+----------------------------------+----------------+
  | STATUS  | TIMESTAMP           | NAME   | SQLTEXT                          | CONNECTION_ID  |
  +---------+---------------------+--------+----------------------------------+----------------+
  | 0       | 2012-09-27T13:33:39 | Query  | SET @@session.autocommit = OFF   | 7              |
  | 0        | 2012-09-27T13:33:39  | Query  | SET @@session.autocommit = OFF  | 8              |
  | 0        | 2012-09-28T11:26:50  | Query  | SET @@session.autocommit = OFF  | 9              |
  | 0        | 2012-09-28T11:26:50  | Query  | SET @@session.autocommit = OFF  | 10             |
  +---------+---------------------+--------+---------------------------------+----------------+
```

To display the audit log entries matching a specific *REGEXP* pattern, use the following command:

```
shell> mysqlauditgrep --pattern=".* = ..." --regexp /SERVER/data/audit.log

  +---------+---------------------+--------+---------------------------------+----------------+
  | STATUS  | TIMESTAMP           | NAME   | SQLTEXT                         | CONNECTION_ID  |
  +---------+---------------------+--------+---------------------------------+----------------+
  | 0       | 2012-09-27T13:33:39  | Query  | SET @@session.autocommit = OFF  | 7              |
  | 0       | 2012-09-27T13:33:39  | Query  | SET @@session.autocommit = OFF  | 8              |
  | 0       | 2012-09-28T11:26:50  | Query  | SET @@session.autocommit = OFF  | 9              |
  | 0       | 2012-09-28T11:26:50  | Query  | SET @@session.autocommit = OFF  | 10             |
  +---------+---------------------+--------+---------------------------------+----------------+
```

To display the audit log entries of specific query types, use the following command:

```
shell> mysqlauditgrep --query-type=show,SET /SERVER/data/audit.log

  +---------+---------------------+--------+-----------------------------------------------------+----------
  | STATUS  | TIMESTAMP           | NAME   | SQLTEXT                                              | CONNECTION_
  +---------+---------------------+--------+-----------------------------------------------------+----------
  | 0       | 2012-09-27T13:33:39  | Query  | SET NAMES 'latin1' COLLATE 'latin1_swedish_ci'  | 7
  | 0       | 2012-09-27T13:33:39  | Query  | SET @@session.autocommit = OFF                   | 7
  | 0       | 2012-09-27T13:33:39  | Query  | SHOW VARIABLES LIKE 'READ_ONLY'                  | 7
  | 0       | 2012-09-27T13:33:39  | Query  | SHOW VARIABLES LIKE 'datadir'                    | 7
  | 0       | 2012-09-27T13:33:39  | Query  | SHOW VARIABLES LIKE 'basedir'                    | 7
  | 0       | 2012-09-27T13:33:39  | Query  | SET NAMES 'latin1' COLLATE 'latin1_swedish_ci'  | 8
  | 0       | 2012-09-27T13:33:39  | Query  | SET @@session.autocommit = OFF                   | 8
  | 0       | 2012-09-27T13:33:39  | Query  | SHOW VARIABLES LIKE 'READ_ONLY'                  | 8
  | 0       | 2012-09-27T13:33:39  | Query  | SHOW VARIABLES LIKE 'basedir'                    | 8
  | 0       | 2012-09-28T11:26:50  | Query  | SET NAMES 'latin1' COLLATE 'latin1_swedish_ci'  | 9
  | 0       | 2012-09-28T11:26:50  | Query  | SET @@session.autocommit = OFF                   | 9
  | 0       | 2012-09-28T11:26:50  | Query  | SHOW VARIABLES LIKE 'READ_ONLY'                  | 9
  | 0       | 2012-09-28T11:26:50  | Query  | SET NAMES 'latin1' COLLATE 'latin1_swedish_ci'  | 10
  | 0       | 2012-09-28T11:26:50  | Query  | SET @@session.autocommit = OFF                   | 10
  | 0       | 2012-09-28T11:26:50  | Query  | SHOW VARIABLES LIKE 'READ_ONLY'                  | 10
  | 0       | 2012-09-28T11:26:50  | Query  | SET @@GLOBAL.audit_log_flush = ON                | 10
  | 0       | 2012-09-28T11:26:50  | Query  | SHOW VARIABLES LIKE 'audit_log_policy'           | 10
  | 0       | 2012-09-28T11:26:50  | Query  | SHOW VARIABLES LIKE 'audit_log_rotate_on_size'  | 10
  | 0       | 2012-10-10T15:56:10  | Query  | show databases                                   | 11
  | 1046    | 2012-10-10T15:57:26  | Query  | show tables test                                 | 11
  | 1046    | 2012-10-10T15:57:36  | Query  | show tables test                                 | 11
  | 0       | 2012-10-10T15:57:51  | Query  | show tables in test                              | 11
  +---------+---------------------+--------+-----------------------------------------------------+----------
```

To display the audit log entries of specific event types, use the following command:

```
shell> mysqlauditgrep --event-type="Ping,Connect" /SERVER/data/audit.log

  +---------+----------+---------------------+----------------+------------+---------+-----------+------
  | STATUS  | NAME     | TIMESTAMP           | CONNECTION_ID  | HOST       | USER    | PRIV_USER  | IP
  +---------+----------+---------------------+----------------+------------+---------+-----------+------
  | 0       | Connect  | 2012-09-27T13:33:39  | 7              | localhost  | root    | root       | 127.0
  | 0       | Ping     | 2012-09-27T13:33:39  | 7              | None       | None    | None       | None
  | 0       | Ping     | 2012-09-27T13:33:39  | 7              | None       | None    | None       | None
  | 0       | Ping     | 2012-09-27T13:33:39  | 7              | None       | None    | None       | None
  | 0       | Ping     | 2012-09-27T13:33:39  | 7              | None       | None    | None       | None
  | 0       | Connect  | 2012-09-27T13:33:39  | 8              | localhost  | root    | root       | 127.0
  | 0       | Ping     | 2012-09-27T13:33:39  | 8              | None       | None    | None       | None
  | 0        | Ping     | 2012-09-27T13:33:39  | 8                | None       | None     | None        | None
  | 0        | Ping     | 2012-09-27T13:33:47  | 7                | None       | None     | None        | None
  | 0        | Connect  | 2012-09-28T11:26:50  | 9                | localhost  | root     | tester      | 127.0.0.1
  | 0        | Ping     | 2012-09-28T11:26:50  | 9                | None       | None     | None        | None
  | 0        | Ping     | 2012-09-28T11:26:50  | 9                | None       | None     | None        | None
  | 0        | Connect  | 2012-09-28T11:26:50  | 10               | localhost  | root     | root        | 127.0.0.1
  | 0        | Ping     | 2012-09-28T11:26:50  | 10               | None       | None     | None        | None
  | 0        | Ping     | 2012-09-28T11:26:50  | 10               | None       | None     | None        | None
  | 0        | Ping     | 2012-09-28T11:26:50  | 10               | None       | None     | None        | None
  | 0        | Ping     | 2012-09-28T11:26:50  | 10               | None       | None     | None        | None
  | 0        | Ping     | 2012-09-28T11:26:50  | 10               | None       | None     | None        | None
  | 0        | Connect  | 2012-10-10T15:55:55  | 11               | localhost  | tester   | root        | 127.0.0.1
  | 0        | Connect  | 2012-10-10T17:35:42  | 12               | localhost  | tester   | root        | 127.0.0.1
  +---------+----------+---------------------+----------------+------------+--------+------------+----------
```

To display the audit log entries with a specific status, use the following command:

```
shell> mysqlauditgrep --status=1100-1199,1046 /SERVER/data/audit.log

  +---------+---------------------+--------+---------------------------------------------------------------
  | STATUS  | TIMESTAMP           | NAME   | SQLTEXT
  +---------+---------------------+--------+---------------------------------------------------------------
  | 1046    | 2012-10-10T15:57:26 | Query  | show tables test
  | 1046    | 2012-10-10T15:57:36 | Query  | show tables test
  | 1146    | 2012-10-10T17:44:55 | Query  | select * from test.employees where salary > 500 and salary < 100
  | 1046    | 2012-10-10T17:47:17 | Query  | select * from test_encoding where value = '<>"&'
  +---------+---------------------+--------+---------------------------------------------------------------
```

Note

You can view all successful commands with `--status=0`, and all unsuccessful commands with `--status=1-9999`.

To display the audit log entries matching several search criteria, use the following command:

```
shell> mysqlauditgrep --users=root --start-date=0 --end-date=2012-10-10 --event-type=Query \
       --query-type=SET --status=0 --pattern="%audit_log%" /SERVER/data/audit.log

  +---------+------------+--------+---------------------+----------------+-------+------------+-------------
  | STATUS  | SERVER_ID  | NAME   | TIMESTAMP           | CONNECTION_ID  | USER  | PRIV_USER  | SQLTEXT
  +---------+------------+--------+---------------------+----------------+-------+------------+-------------
  | 0       | 1          | Query  | 2012-09-28T11:26:50 | 10             | root  | root       | SET @@GLOBAL.
  +---------+------------+--------+---------------------+----------------+-------+------------+-------------
```

PERMISSIONS REQUIRED

The user must have permissions to read the audit log file(s) on disk.

5.3 `mysqldbcompare` — Compare Two Databases and Identify Differences

This utility compares the objects and data from two databases to find differences. It identifies objects having different definitions in the two databases and presents them in a diff-style format of choice. Differences in the data are shown using a similar diff-style format. Changed or missing rows are shown in a standard format of GRID, CSV, TAB, or VERTICAL.

Use the notation db1:db2 to name two databases to compare, or, alternatively just db1 to compare two databases with the same name. The latter case is a convenience notation for comparing same-named databases on different servers.

The comparison may be run against two databases of different names on a single server by specifying only the `--server1` option. The user can also connect to another server by specifying the `--server2` option. In this case, db1 is taken from server1 and db2 from server2.

All databases between two servers can also be compared using the `--all` option. In this case, only the databases in common (with the same name) between the servers are successively compared. Therefore, no databases need to be specified but the `--server1` and `--server2` options are required. Users can skip the comparison of some of the databases using the `--exclude` option.

Note

The data must not be changed during the comparison. Unexpected errors may occur if data is changed during the comparison.

The objects considered in the database include tables, views, triggers, procedures, functions, and events. A count for each object type can be shown with the `-vv` option.

The check is performed using a series of steps called tests. By default, the utility stops on the first failed test, but you can specify the `--run-all-tests` option to cause the utility to run all tests regardless of their end state.

Note

Using `--run-all-tests` may produce expected cascade failures. For example, if the row counts differ among two tables being compared, the data consistency also fails.

The tests include the following:

1. Check database definitions

   A database existence precondition check ensures that both databases exist. If they do not, no further processing is possible and the `--run-all-tests` option is ignored.

2. Check existence of objects in both databases

   The test for objects in both databases identifies those objects missing from one or another database. The remaining tests apply only to those objects that appear in both databases. To skip this test, use the `--skip-object-compare` option. That can be useful when there are known missing objects among the databases.

3. Compare object definitions

   The definitions (the **CREATE** statements) are compared and differences are presented. To skip this test, use the `--skip-diff` option. That can be useful when there are object name differences only that you want to ignore.

4. Check table row counts

   This check ensures that both tables have the same number of rows. This does not ensure that the table data is consistent. It is merely a cursory check to indicate possible missing rows in one table or the other. The data consistency check identifies the missing rows. To skip this test, use the `--skip-row-count` option.

5. Check table data consistency

   This check identifies both changed rows as well as missing rows from one or another of the tables in the databases. Changed rows are displayed as a diff-style report with the format chosen (**GRID** by default) and missing rows are also displayed using the format chosen. This check is divided in two steps: first the full table checksum is compared between the tables, then if this step fails (or is skipped) the algorithm to find rows differences is executed. To skip the preliminary checksum table step in this test, use the `--skip-checksum-table` option. To skip this full test, use the `--skip-data-check` option.

You may want to use the `--skip-xxx` options to run only one of the tests. This might be helpful when working to bring two databases into synchronization, to avoid running all of the tests repeatedly during the process.

Each test completes with one of the following states:

- **pass**

  The test succeeded.

- **FAIL**

  The test failed. Errors are displayed following the test state line.

- **SKIP**

  The test was skipped due to a missing prerequisite or a skip option.

- **WARN**

  The test encountered an unusual but not fatal error.

- **-**

  The test is not applicable to this object.

To specify how to display diff-style output, use one of the following values with the `--difftype` option:

- **unified** (default)

  Display unified format output.

- **context**

  Display context format output.

- **differ**

  Display differ-style format output.

- **sql**

  Display SQL transformation statement output.

To specify how to display output for changed or missing rows, use one of the following values with the `--format` option:

- **grid** (default)

  Display output in grid or table format like that of the `mysql` client command-line tool.

- **csv**

  Display output in comma-separated values format.

- **tab**

  Display output in tab-separated format.

- **vertical**

  Display output in single-column format like that of the `\G` command for the `mysql` client command-line tool.

The `--changes-for` option controls the direction of the difference (by specifying the object to be transformed) in either the difference report (default) or the transformation report (designated with the `--difftype=sql` option). Consider the following command:

```
shell> mysqldbcompare --server1=root@host1 --server2=root@host2 --difftype=sql db1:dbx
```

The leftmost database (`db1`) exists on the server designated by the `--server1` option (`host1`). The rightmost database (`dbx`) exists on the server designated by the `--server2` option (`host2`).

- `--changes-for=server1`: Produce output that shows how to make the definitions of objects on `server1` like the definitions of the corresponding objects on `server2`.
- `--changes-for=server2`: Produce output that shows how to make the definitions of objects on `server2` like the definitions of the corresponding objects on `server1`.

The default direction is `server1`.

You must provide connection parameters (user, host, password, and so forth) for an account that has the appropriate privileges to access all objects in the operation.

If the utility is to be run on a server that has binary logging enabled, and you do not want the comparison steps logged, use the `--disable-binary-logging` option.

OPTIONS

`mysqldbcompare` accepts the following command-line options:

- --all, -a

  Compare all database in common (with the same name) between two servers.

  The `--all` option ignores the following databases: *INFORMATION_SCHEMA*, *PERFORMANCE_SCHEMA*, *mysql*, and *sys*.

  Note

  The *sys* database is ignored as of Utilities 1.5.5.

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --changes-for=*direction*

Specify the server to show transformations to match the other server. For example, to see the transformation for transforming object definitions on server1 to match the corresponding definitions on server2, use `--changes-for=server1`. Permitted values are **server1** and **server2**. The default is **server1**.

- --character-set=*`charset`*

  Sets the client character set. The default is retrieved from the server variable `character_set_client`.

- --difftype=*`difftype`*, -d*`difftype`*

  Specify the difference display format. Permitted format values are **unified**, **context**, **differ**, and **sql**. The default is **unified**.

- --disable-binary-logging

  If binary logging is enabled, disable it during the operation to prevent comparison operations from being written to the binary log. Note: Disabling binary logging requires the **SUPER** privilege.

- --exclude=*`exclude`*, -x*`exclude`*

  Exclude one or more databases from the operation using either a specific name such as `db1` or a search pattern. Use this option multiple times to specify multiple exclusions. By default, patterns use database patterns such as **LIKE**. With the `--regexp` option, patterns use regular expressions for matching names.

  Added in release-1.4.0.

- --format=*`format`*, -f*`format`*

  Specify the display format for changed or missing rows. Permitted format values are **grid**, **csv**, **tab**, and **vertical**. The default is **grid**.

- --compact

  Compacts the output by reducing the number of control lines that are displayed in the diff results. This option should be used together with one of the following difference types: unified or context. It is most effective when used with the unified difference type and the grid format.

- --quiet, -q

  Do not print anything. Return only an exit code of success or failure.

- --regexp, --basic-regexp, -G

  Perform pattern matches using the **REGEXP** operator. The default is to use **LIKE** for matching.

  Added in release-1.4.0.

- --run-all-tests, -t

  Do not halt at the first difference found. Process all objects.

- --server1=*`source`*

  Connection information for the first server.

To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

- Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
- Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
- Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --server2=*`source`*

  Connection information for the second server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --show-reverse

  Produce a transformation report containing the SQL statements to conform the object definitions specified in reverse. For example, if --changes-for is set to server1, also generate the transformation for server2. Note: The reverse changes are annotated and marked as comments.

- --skip-checksum-table

  Skip the CHECKSUM TABLE step in the data consistency check. Added in release-1.4.3.

- --skip-data-check

  Skip the data consistency check.

- --skip-diff

  Skip the object definition difference check.

- --skip-object-compare

  Skip the object comparison check.

- --skip-row-count

  Skip the row count check.

- --span-key-size=`*number of bytes to use for key*`

  Change the size of the key used for compare table contents. A higher value can help to get more accurate results comparing large databases, but may slow the algorithm.

  Default value is 8.

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

- --use-indexes

  List the index to use. Use this option to select the index to use if the table has no primary key or it has more than one unique index without null columns. Use this option in the format: --use-indexes="`*table1*`.`*indexA*`[;`*table2*`.`*indexB*`;]"

- --width=`*number*`

  Change the display width of the test report. The default is 75 characters.

NOTES

The login user must have the appropriate permissions to read all databases and tables listed.

For the `--difftype` option, the permitted values are not case sensitive. In addition, values may be specified as any unambiguous prefix of a valid value. For example, `--difftype=d` specifies the differ type. An error occurs if a prefix matches more than one valid value.

The path to the MySQL client tools should be included in the `PATH` environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the `my_print_defaults` tools which is required to read the login-path values from the login configuration file (`.mylogin.cnf`).

If any database identifier specified as an argument contains special characters or is a reserved word, then it must be appropriately quoted with backticks (`). In turn, names quoted with backticks must also be quoted with single or double quotes depending on the operating system, i.e. (**"**) in Windows or (**'**) in non-Windows systems, in order for the utilities to read backtick quoted identifiers as a single argument. For example, to compare a database with the name **weird`db.name** with **other:weird`db.name**, the database pair must be specified using the following syntax (in non-Windows): **'`weird``db.name`:`other:weird``db.name`'**.

EXAMPLES

Use the following command to compare the `emp1` and `emp2` databases on the local server, and run all tests even if earlier tests fail:

```
shell> mysqldbcompare --server1=root@localhost emp1:emp2 --run-all-tests
# server1 on localhost: ... connected.
# Checking databases emp1 on server1 and emp2 on server2
#
# WARNING: Objects in server2:emp2 but not in server1:emp1:
#   TRIGGER: trg
# PROCEDURE: p1
#     TABLE: t1
#      VIEW: v1
#
#                                                    Defn    Row     Data
# Type      Object Name                              Diff    Count   Check
# ---------------------------------------------------------------------------
# FUNCTION  f1                                       pass    -       -
# TABLE     departments                              pass    pass    -
#           - Compare table checksum                                 FAIL
#           - Find row differences                                   FAIL
#
# Data differences found among rows:
--- emp1.departments
+++ emp2.departments
@@ -1,4 +1,4 @@
 *************************       1. row *************************
   dept_no: d002
- dept_name: dunno
+ dept_name: Finance
 1 rows.

# Rows in emp1.departments not in emp2.departments
*************************       1. row *************************
   dept_no: d008
 dept_name: Research
1 rows.

# Rows in emp2.departments not in emp1.departments
*************************       1. row *************************
   dept_no: d100
 dept_name: stupid
1 rows.

# TABLE     dept_manager                             pass    pass    -
#           - Compare table checksum                                 pass

# Database consistency check failed.
#
# ...done
```

Given: two databases with the same table layout. Data for each table contains:

```
mysql> select * from db1.t1;
+---+---------------+
| a | b             |
+---+---------------+
| 1 | Test 789      |
| 2 | Test 456      |
| 3 | Test 123      |
| 4 | New row - db1 |
+---+---------------+
4 rows in set (0.00 sec)

mysql> select * from db2.t1;
+---+---------------+
| a | b             |
+---+---------------+
| 1 | Test 123      |
| 2 | Test 456      |
| 3 | Test 789      |
| 5 | New row - db2 |
+---+---------------+
4 rows in set (0.00 sec)
```

To generate the SQL statements for data transformations to make `db1.t1` the same as `db2.t1`, use the `--changes-for=server1` option. We must also include the `-a` option to ensure that the data consistency test is run. The following command illustrates the options used and an excerpt from the results generated:

```
shell> mysqldbcompare --server1=root:root@localhost \
    --server2=root:root@localhost db1:db2 --changes-for=server1 -a \/
    --difftype=sql

[...]

#                                                    Defn    Row     Data
# Type      Object Name                              Diff    Count   Check
#-------------------------------------------------------------------------
# TABLE     t1                                       pass    pass    -
#           - Compare table checksum                                 FAIL
#           - Find row differences                                   FAIL
#
# Transformation for --changes-for=server1:
#

# Data differences found among rows:
UPDATE db1.t1 SET b = 'Test 123' WHERE a = '1';
UPDATE db1.t1 SET b = 'Test 789' WHERE a = '3';
DELETE FROM db1.t1 WHERE a = '4';
INSERT INTO db1.t1 (a, b) VALUES('5', 'New row - db2');


# Database consistency check failed.
#
# ...done
```

Similarly, when the same command is run with `--changes-for=server2` and `--difftype=sql`, the following report is generated:

```
shell> mysqldbcompare --server1=root:root@localhost \
    --server2=root:root@localhost db1:db2 --changes-for=server2 -a \
    --difftype=sql

[...]

#                                                    Defn    Row     Data
# Type      Object Name                              Diff    Count   Check
#-------------------------------------------------------------------------
# TABLE     t1                                       pass    pass    -
#           - Compare table checksum                                FAIL
#           - Find row differences                                  FAIL
#
# Transformation for --changes-for=server2:
#

# Data differences found among rows:
UPDATE db2.t1 SET b = 'Test 789' WHERE a = '1';
UPDATE db2.t1 SET b = 'Test 123' WHERE a = '3';
DELETE FROM db2.t1 WHERE a = '5';
INSERT INTO db2.t1 (a, b) VALUES('4', 'New row - db1');


# Database consistency check failed.
#
# ...done
```

With the `--difftype=sql` SQL generation option set, `--show-reverse` shows the object transformations in both directions. Here is an excerpt of the results:

```
shell> mysqldbcompare --server1=root:root@localhost \
          --server2=root:root@localhost db1:db2 --changes-for=server1 \
          --show-reverse -a --difftype=sql

[...]

#                                                   Defn    Row     Data
# Type      Object Name                             Diff    Count   Check
# ---------------------------------------------------------------------------
# TABLE     t1                                      pass    pass    -
#           - Compare table checksum                                FAIL
#           - Find row differences                                  FAIL
#
# Transformation for --changes-for=server1:
#

# Data differences found among rows:
UPDATE db1.t1 SET b = 'Test 123' WHERE a = '1';
UPDATE db1.t1 SET b = 'Test 789' WHERE a = '3';
DELETE FROM db1.t1 WHERE a = '4';
INSERT INTO db1.t1 (a, b) VALUES('5', 'New row - db2');

#
# Transformation for reverse changes (--changes-for=server2):
#
# # Data differences found among rows:
# UPDATE db2.t1 SET b = 'Test 789' WHERE a = '1';
# UPDATE db2.t1 SET b = 'Test 123' WHERE a = '3';
# DELETE FROM db2.t1 WHERE a = '5';
# INSERT INTO db2.t1 (a, b) VALUES('4', 'New row - db1');


# Database consistency check failed.
#
# ...done
```

LIMITATIONS

The utility reads the primary key of each row into a data structure, which is then used to generate checksums for each row. The primary key and checksum are then sorted and compared to detect which rows differ. Due to this design, the utility may exhibit slower performance for very large tables (many rows) especially for tables with wide primary keys. Use of this utility with tables that have blob fields as part of the primary key is not recommended.

PERMISSIONS REQUIRED

The user must have the SELECT, CREATE TEMPORARY TABLES and INSERT privileges for the databases being compared on both connections. The user must also have SELECT privilege on the mysql database. If the binary log is enabled and the `--disable-binary-logging` option is used, the user must also have the SUPER privilege.

5.4 `mysqldbcopy` — Copy Database Objects Between Servers

This utility copies a database on a source server to a database on a destination server. If the source and destination servers are different, the database names can be the same or different. If the source and destination servers are the same, the database names must be different.

The utility accepts one or more database pairs on the command line. To name a database pair, use *db_name*:*new_db_name* syntax to specify the source and destination names explicitly. If the source and destination database names are the same, *db_name* can be used as shorthand for *db_name*:*db_name*.

By default, the operation copies all objects (tables, views, triggers, events, procedures, functions, and database-level grants) and data to the destination server. There are options to turn off copying any or all of the objects as well as not copying the data.

To exclude specific objects by name, use the `--exclude` option with a name in *db*.*obj* format, or you can supply a search pattern. For example, `--exclude=db1.trig1` excludes the single trigger and `--exclude=trig_` excludes all objects from all databases having a name that begins with `trig` and has a following character.

By default, the utility creates each table on the destination server using the same storage engine as the original table. To override this and specify the storage engine to use for all tables created on the destination server, use the `--new-storage-engine` option. If the destination server supports the new engine, all tables use that engine.

To specify the storage engine to use for tables for which the destination server does not support the original storage engine on the source server, use the `--default-storage-engine` option.

The `--new-storage-engine` option takes precedence over `--default-storage-engine` if both are given.

If the `--new-storage-engine` or `--default-storage-engine` option is given and the destination server does not support the specified storage engine, a warning is issued and the server's default storage engine setting is used instead.

By default, the operation uses a consistent snapshot to read the source databases. To change the locking mode, use the `--locking` option with a locking type value. Use a value of **no-locks** to turn off locking altogether or **lock-all** to use only table locks. The default value is **snapshot**. Additionally, the utility uses WRITE locks to lock the destination tables during the copy.

You can include replication statements for copying data among a master and slave or between slaves. The `--rpl` option permits you to select from the following replication statements to include in the export.

- **master**

  Create and execute a **CHANGE MASTER** statement to make the destination server a slave of the server specified in the `--source` option. This executes the appropriate STOP and START slave statements. The **STOP SLAVE** statement is executed at the start of the copy and the **CHANGE MASTER** followed by the **START SLAVE** statements are executed after the copy.

- **slave**

Create and execute a **CHANGE MASTER** statement to make the destination server a slave connected to the same master as the server specified in the `--source` option. This executes the appropriate STOP and START slave statements. The STOP SLAVE statement is executed at the start of the copy and the **CHANGE MASTER** followed by the **START SLAVE** statements after the copy.

To include the replication user in the **CHANGE MASTER** statement, use the `--rpl-user` option to specify the user and password. If this option is omitted, the utility attempts to identify the replication user. In the event that there are multiple candidates or the user requires a password, the utility aborts with an error.

If you attempt to copy databases on a server with GTIDs enabled (GTID_MODE = ON), a warning is generated if the copy does not include all databases. This is because the GTID statements generated include the GTIDs for all databases and not only those databases in the export.

The utility also generates a warning if you copy databases on a GTID enabled server but use the `--skip-gtid` option.

To make the most use of GTIDs, you should copy all of the databases on the server with the `--all` option.

OPTIONS

`mysqldbcopy` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --character-set=*`charset`*

  Sets the client character set. The default is retrieved from the server variable `character_set_client`.

- --default-storage-engine=*`def_engine`*

  The engine to use for tables if the destination server does not support the original storage engine on the source server.

- --destination=*`destination`*

  Connection information for the destination server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --exclude=*exclude*, -x*exclude*

  Exclude one or more objects from the operation using either a specific name such as db1.t1 or a search pattern. Use this option multiple times to specify multiple exclusions. By default, patterns use **LIKE** matching. With the `--regexp` option, patterns use **REGEXP** matching.

  This option does not apply to grants.

- --drop-first

  Drop each database to be copied if exists before copying anything into it. Without this option, an error occurs if you attempt to copy objects into an existing database.

  Note

  Before MySQL Utilities 1.4.2, this option was named `--force`.

- --locking=*locking*

  Choose the lock type for the operation. Permitted lock values are **no-locks** (do not use any table locks), **lock-all** (use table locks but no transaction and no consistent read), and **snapshot** (consistent read using a single transaction). The default is **snapshot**.

- --multiprocess

  Specify the number of processes to concurrently copy the specified databases. Special values: 0 (number of processes equal to the number of detected CPUs) and 1 (default - no concurrency). Multiprocessing works at the database level for Windows and at the table level for Non-Windows (POSIX) systems.

- --new-storage-engine=*new_engine*

  The engine to use for all tables created on the destination server.

- --quiet, -q

  Turn off all messages for quiet execution.

- --regexp, --basic-regexp, -G

  Perform pattern matches using the **REGEXP** operator. The default is to use **LIKE** for matching.

- --rpl=*dump_option*, --replication=*dump_option*

  Include replication information. Permitted values are **master** (make destination a slave of the source server) and **slave** (make destination a slave of the same master as the source - only works if the source server is a slave).

- --rpl-user=*replication_user*

  The user and password for the replication user requirement in the form: *user*[:*password*] or *login-path*. E.g. rpl:passwd Default = None.

- l --skip-gtid

  Skip creation and execution of GTID statements during the copy operation.

- --all

Copy all of the databases on the server.

- --skip=*objects*

  Specify objects to skip in the operation as a comma-separated list (no spaces). Permitted values are **CREATE_DB**, **DATA**, **EVENTS**, **FUNCTIONS**, **GRANTS**, **PROCEDURES**, **TABLES**, **TRIGGERS**, and **VIEWS**.

- --source=*source*

  Connection information for the source server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *login-path*[:*port*][:*socket*]

  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *configuration-file-path*[:*section*]

  - Specify the data on the command-line (unencrypted, visible). Example : *user*[:*passwd*]@*host*[:*port*][:*socket*]

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

NOTES

You must provide connection parameters (user, host, password, and so forth) for an account that has the appropriate privileges to access all objects in the operation.

On the source to copy all objects from the database, the user must have these privileges: **SELECT** for tables, **SHOW VIEW** for views, **EVENT** for events and **TRIGGER** for triggers. Additionally, the **SELECT** privilege is also required for the `mysql` database.

On the destination to copy all objects, the user must have these privileges: **CREATE**, **ALTER**, **SELECT**, **INSERT**, **UPDATE**, **LOCK TABLES**, **DROP** if `--drop-first` option is used, **SUPER** when binary logging is enabled, **CREATE VIEW** for views, **CREATE ROUTINE**, **EXECUTE** for procedures and functions, **EVENT** for events, **TRIGGER** for triggers and **GRANT OPTION** to copy grants. The **SUPER** privilege might also be required for some objects (views, procedures, functions, events and triggers), depending on their **DEFINER** value.

Actual privileges required may differ from installation to installation depending on the security privileges present and whether the database contains certain objects such as views or events and whether binary logging is enabled.

The `--new-storage-engine` and `--default-storage-engine` options apply to all destination tables in the operation.

Some option combinations may result in errors during the operation. For example, eliminating tables but not views may result in an error a the view is copied.

The `--rpl` option is not valid for copying databases on the same server. If used in this manner, an error is generated.

When copying data and including the GTID commands, you may encounter an error similar to "GTID_PURGED can only be set when GTID_EXECUTED is empty". This occurs because the destination server is not in a clean replication state. To alleviate this problem, you can issue a "RESET MASTER" command on the destination prior to executing the copy.

Cloning databases that contain foreign key constraints does not change the constraint in the cloned table. For example, if table db1.t1 has a foreign key constraint on table db1.t2, when db1 is cloned to db2, table db2.t1 contains a foreign key constraint on db1.t2.

The path to the MySQL client tools should be included in the `PATH` environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the `my_print_defaults` tools which is required to read the login-path values from the login configuration file (`.mylogin.cnf`).

If any database identifier specified as an argument contains special characters or is a reserved word, then it must be appropriately quoted with backticks (**`**). In turn, names quoted with backticks must also be quoted with single or double quotes depending on the operating system, i.e. (**"**) in Windows or (**'**) in non-Windows systems, in order for the utilities to read backtick quoted identifiers as a single argument. For example, to copy a database with the name **weird`db.name** with **other:weird`db.name**, the database pair must be specified using the following syntax (in non-Windows): **'`weird``db.name`:`other:weird``db.name`'**.

Keep in mind that you can only take advantage of multiprocessing if your system has multiple CPUs available for concurrent execution. Also note that multiprocessing is applied at a different level according to the operating system where the mysqldbcopy utility is executed (due to python limitations). In particular, it is applied at the database level for Windows (i.e., different databases are concurrently copied) and at the table level for Non-Windows (POSIX) systems (i.e., different tables within the same database are concurrently copied).

EXAMPLES

The following example demonstrates how to use the utility to copy a database named `util_test` to a new database named `util_test_copy` on the same server:

```
shell> mysqldbcopy \
  --source=root:pass@localhost:3310:/test123/mysql.sock \
  --destination=root:pass@localhost:3310:/test123/mysql.sock \
  util_test:util_test_copy
# Source on localhost: ... connected.
# Destination on localhost: ... connected.
# Copying database util_test renamed as util_test_copy
# Copying TABLE util_test.t1
# Copying table data.
# Copying TABLE util_test.t2
# Copying table data.
# Copying TABLE util_test.t3
# Copying table data.
# Copying TABLE util_test.t4
# Copying table data.
# Copying VIEW util_test.v1
# Copying TRIGGER util_test.trg
# Copying PROCEDURE util_test.p1
# Copying FUNCTION util_test.f1
# Copying EVENT util_test.e1
# Copying GRANTS from util_test
#...done.
```

If the database to be copied does not contain only InnoDB tables and you want to ensure data integrity of the copied data by locking the tables during the read step, add a `--locking=lock-all` option to the command:

```
shell> mysqldbcopy \
  --source=root:pass@localhost:3310:/test123/mysql.sock \
  --destination=root:pass@localhost:3310:/test123/mysql.sock \
  util_test:util_test_copy --locking=lock-all
# Source on localhost: ... connected.
# Destination on localhost: ... connected.
# Copying database util_test renamed as util_test_copy
# Copying TABLE util_test.t1
# Copying table data.
# Copying TABLE util_test.t2
# Copying table data.
# Copying TABLE util_test.t3
# Copying table data.
# Copying TABLE util_test.t4
# Copying table data.
# Copying VIEW util_test.v1
# Copying TRIGGER util_test.trg
# Copying PROCEDURE util_test.p1
# Copying FUNCTION util_test.f1
# Copying EVENT util_test.e1
# Copying GRANTS from util_test
#...done.
```

To copy one or more databases from a master to a slave, you can use the following command to copy the databases. Use the master as the source and the slave as the destination:

```
shell> mysqldbcopy --source=root@localhost:3310 \
  --destination=root@localhost:3311 test123 --rpl=master \
  --rpl-user=rpl
# Source on localhost: ... connected.
# Destination on localhost: ... connected.
# Source on localhost: ... connected.
# Stopping slave
# Copying database test123
# Copying TABLE test123.t1
# Copying data for TABLE test123.t1
# Connecting to the current server as master
# Starting slave
#...done.
```

To copy a database from one slave to another attached to the same master, you can use the following command using the slave with the database to be copied as the source and the slave where the database needs to copied to as the destination:

```
shell> mysqldbcopy --source=root@localhost:3311 \
  --destination=root@localhost:3312 test123 --rpl=slave \
  --rpl-user=rpl

# Source on localhost: ... connected.
# Destination on localhost: ... connected.
# Source on localhost: ... connected.
# Stopping slave
# Copying database test123
# Copying TABLE test123.t1
# Copying data for TABLE test123.t1
# Connecting to the current server's master
# Starting slave
#...done.
```

LIMITATIONS

When copying tables with blob fields, the copy operation fails for any table with a blob field that is defined as **NOT NULL**. This is because the copy attempts to use a bulk insert technique to copy the data in two passes; one to copy the data without blob field data, and another to update the rows with the blob data. This has shown to be efficient for most use cases.

However, if one or more tables have blob fields defined as **NOT NULL**, the two pass copy process fails because the server does not permit inserting of null values for fields defined as **NOT NULL** on the first pass. Thus, the utility checks the tables in the copy for any blob fields defined as **NOT NULL**. If any are found, an error is thrown and the copy aborted.

A workaround for this limitation is to alter the table(s) to remove the **NOT NULL** restriction on blob fields identified before the copy and restore the restriction after the copy. Similarly, any indexes that require **NOT NULL** on blob fields must be removed before the copy and recreated after the copy.

PERMISSIONS REQUIRED

The user must have SELECT, SHOW VIEW, EVENT and TRIGGER privileges for the database(s) on the source server. On the destination server, the user must have the following privileges for the copied database(s): CREATE, ALTER, SELECT, INSERT, UPDATE, LOCK TABLES, DROP if `--drop-first` option is used, and SUPER depending on the objects DEFINER value. When copying tables that include foreign keys, the user must also have the REFERENCES privilege.

5.5 `mysqldbexport` — Export Object Definitions or Data from a Database

This utility exports metadata (object definitions) or data or both from one or more databases. By default, the export includes only definitions.

`mysqldbexport` differs from `mysqldump` in that it can produce output in a variety of formats to make your data extraction/transport much easier. It permits you to export your data in the format most suitable to an external tool, another MySQL server, or other use without the need to reformat the data.

To exclude specific objects by name, use the `--exclude` option with a name in *db*.*obj* format, or you can supply a search pattern. For example, `--exclude=db1.trig1` excludes the single trigger and `--exclude=trig_` excludes all objects from all databases having a name that begins with `trig` and has a following character.

To skip objects by type, use the `--skip` option with a list of the objects to skip. This enables you to extract a particular set of objects, say, for exporting only events (by excluding all other types). Similarly, to skip creation of **UPDATE** statements for `BLOB` data, specify the `--skip-blobs` option.

To specify how to display output, use one of the following values with the `--format` option:

- **sql** (default)

  Display output using SQL statements. For definitions, this consists of the appropriate **CREATE** and **GRANT** statements. For data, this is an **INSERT** statement (or bulk insert if the `--bulk-insert` option is specified).

- **grid**

  Display output in grid or table format like that of the `mysql` client command-line tool.

- **csv**

  Display output in comma-separated values format.

- **tab**

  Display output in tab-separated format.

- **vertical**

  Display output in single-column format like that of the `\G` command for the `mysql` client command-line tool.

To specify how much data to display, use one of the following values with the `--display` option:

- **brief**

  Display only the minimal columns for recreating the objects.

- **full**

  Display the complete column list for recreating the objects.

- **names**

  Display only the object names.

Note

The `--display` option is ignored when combined with the SQL-format output type.

To turn off the headers for **csv** or **tab** display format, specify the `--no-headers` option.

To turn off all feedback information, specify the `--quiet` option.

To write the data for individual tables to separate files, use the `--file-per-table` option. The name of each file is composed of the database and table names followed by the file format. For example, the following command produces files named db1.*table_name*.csv:

```
mysqldbexport --server=root@server1:3306 --format=csv db1 --export=data
```

By default, the operation uses a consistent snapshot to read the source databases. To change the locking mode, use the `--locking` option with a locking type value. Use a value of **no-locks** to turn off locking altogether or **lock-all** to use only table locks. The default value is **snapshot**. Additionally, the utility uses WRITE locks to lock the destination tables during the copy.

You can include replication statements for exporting data among a master and slave or between slaves. The `--rpl` option permits you to select from the following replication statements to include in the export.

- **master**

  Include the **CHANGE MASTER** statement to make the destination server a slave of the server specified in the `--server` option. This places the appropriate STOP and START slave statements in the export whereby the **STOP SLAVE** statement is placed at the start of the export and the **CHANGE MASTER** followed by the **START SLAVE** statements are placed after the export stream.

- **slave**

  Include the **CHANGE MASTER** statement to make the destination server a slave connected to the same master as the server specified in the `--server` option. It only works if the current server is a slave. This places the appropriate STOP and START slave statements in the export whereby the **STOP SLAVE** statement is placed at the start of the export and the **CHANGE MASTER** followed by the **START SLAVE** statements are placed after the export stream.

- **both**

  Include both the 'master' and 'slave' information for **CHANGE MASTER** statements for either spawning a new slave with the current server's master or using the current server as the master. All statements generated are labeled and commented to enable the user to choose which to include when imported.

To include the replication user in the **CHANGE MASTER** statement, use the `--rpl-user` option to specify the user and password. If this option is omitted, the utility attempts to identify the replication user. In the event that there are multiple candidates or the user requires a password, these statements are placed inside comments for the **CHANGE MASTER** statement.

You can also use the `--comment-rpl` option to place the replication statements inside comments for later examination.

If you specify the `--rpl-file` option, the utility writes the replication statements to the file specified instead of including them in the export stream.

Exporting Data with GTIDs

If you attempt to export databases on a server with GTIDs enabled (GTID_MODE = ON), a warning is generated if the export does not include all databases. This is because the GTID statements generated include the GTIDs for all databases and not only those databases in the export.

The utility also generates a warning if you export databases on a GTID enabled server but use the `--skip-gtid` option.

To make the most use of GTIDs and export/import, you should export all of the databases on the server with the `--all` option. This action generates an export file with all of the databases and the GTIDs executed to that point.

Importing this file on another server ensures that server has all of the data as well as all of the GTIDs recorded correctly in its logs.

OPTIONS

`mysqldbexport` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --bulk-insert, -b

  Use bulk insert statements for data.

- --character-set=*charset*

  Sets the client character set. The default is retrieved from the server variable `character_set_client`.

- --comment-rpl

  Place the replication statements in comment statements. Valid only with the `--rpl` option.

- --display=*display*, -d*display*

  Control the number of columns shown. Permitted display values are **brief** (minimal columns for object creation), **full* (all columns), and **names** (only object names; not valid for `--format=sql`). The default is **brief**.

- --exclude=*exclude*, -x*exclude*

  Exclude one or more objects from the operation using either a specific name such as `db1.t1` or a search pattern. Use this option multiple times to specify multiple exclusions. By default, patterns use **LIKE** matching. With the `--regexp` option, patterns use **REGEXP** matching.

  This option does not apply to grants.

- --export=*export*, -e*export*

  Specify the export format. Permitted format values include the following. The default is **definitions**.

  Table 5.1 mysqldbexport Export Types

Export Type	Definition
`definitions` (default)	Only export the definitions (metadata) for the objects in the database list
`data`	Only export the table data for the tables in the database list
both	Export both the definitions (metadata) and data

- --file-per-table

  Write table data to separate files. This is valid only if the export output includes data (that is, if `--export=data` or `--export=both` are given). This option produces files named *db_name*.*tbl_name*.*format*. For example, a **csv** export of two tables named `t1` and `t2` in database `d1`, results in files named `db1.t1.csv` and `db1.t2.csv`. If table definitions are included in the export, they are written to stdout as usual.

- --format=*`format`*, -f*`format`*

  Specify the output display format. Permitted format values are **sql**, **grid**, **tab**, **csv**, and **vertical**. The default is **sql**.

- --locking=*`locking`*

  Choose the lock type for the operation. Permitted lock values are **no-locks** (do not use any table locks), **lock-all** (use table locks but no transaction and no consistent read), and **snapshot** (consistent read using a single transaction). The default is **snapshot**.

- --multiprocess

  Specify the number of processes to concurrently export the specified databases. Special values: 0 (number of processes equal to the number of detected CPUs) and 1 (default - no concurrency). Multiprocessing works at the database level for Windows and at the table level for Non-Windows (POSIX) systems.

- --no-headers, -h

  Do not display column headers. This option applies only for **csv** and **tab** output.

- --output-file

  Specify the path and filename to store the generated export output. By default the standard output is used (no file).

- --quiet, -q

  Turn off all messages for quiet execution.

- --regexp, --basic-regexp, -G

  Perform pattern matches using the **REGEXP** operator. The default is to use **LIKE** for matching.

- --rpl=*`rpl_mode`*, --replication=*`rpl_mode`*

  Include replication information. Permitted values are **master** (make destination a slave of the source server), **slave** (make destination a slave of the same master as the source - only works if the source server is a slave), and **both** (include the **master** and **slave** options where applicable).

- --rpl-file=RPL_FILE, --replication-file=RPL_FILE

  The path and filename where the generated replication information should be written. Valid only with the `--rpl` option.

- --rpl-user=*`replication_user`*

  The user and password for the replication user requirement, in the format: *`user`*[:*`password`*] or *`login-path`*. For example, `rpl:passwd`. The default is None.

- --server=*`server`*

  Connection information for the server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --skip=*`skip-objects`*

  Specify objects to skip in the operation as a comma-separated list (no spaces). Permitted values are **CREATE_DB**, **DATA**, **EVENTS**, **FUNCTIONS**, **GRANTS**, **PROCEDURES**, **TABLES**, **TRIGGERS**, and **VIEWS**.

- --skip-blobs

  Do not export `BLOB` data.

- --skip-gtid

  Skip creation of GTID_PURGED statements.

- --all

  Generate an export file with all of the databases and the GTIDs executed to that point.

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

NOTES

You must provide connection parameters (user, host, password, and so forth) for an account that has the appropriate privileges to access (e.g., SELECT) all objects in the operation.

To export all objects from a source database, the user must have these privileges: **SELECT** and **SHOW VIEW** on the database as well as **SELECT** on the `mysql` database.

Actual privileges needed may differ from installation to installation depending on the security privileges present and whether the database contains certain objects such as views, events, and stored routines.

Some combinations of the options may result in errors when the export is imported later. For example, eliminating tables but not views may result in an error when a view is imported on another server.

For the `--format`, `--export`, and `--display` options, the permitted values are not case sensitive. In addition, values may be specified as any unambiguous prefix of a valid value. For example, `--format=g` specifies the grid format. An error occurs if a prefix matches more than one valid value.

The path to the MySQL client tools should be included in the `PATH` environment variable in order to use the authentication mechanism with login-paths. This allows the utility to use the `my_print_defaults` tools which is required to read the login-path values from the login configuration file (`.mylogin.cnf`).

If any database identifier specified as an argument contains special characters or is a reserved word, then it must be appropriately quoted with backticks (**`**). In turn, names quoted with backticks must also be quoted with single or double quotes depending on the operating system, i.e. (**"**) in Windows or (**'**) in non-Windows systems, in order for the utilities to read backtick quoted identifiers as a single argument. For example, to export a database with the name **weird`db.name**, it must be specified as argument using the following syntax (in non-Windows): **'`weird``db.name`'**.

Keep in mind that you can only take advantage of multiprocessing if your system has multiple CPUs available for concurrent execution. Also note that multiprocessing is applied at a different level according to the operating system where the `mysqldbexport` utility is executed (due to python limitations). In particular, it is applied at the database level for Windows (i.e., different databases are concurrently exported) and at the table level for Non-Windows (POSIX) systems (i.e., different tables within the same database are concurrently exported).

EXAMPLES

To export the definitions of the database `dev` from a MySQL server on the local host via port 3306, producing output consisting of **CREATE** statements, use this command:

```
shell> mysqldbexport --server=root:pass@localhost \
  --skip=GRANTS --export=DEFINITIONS util_test
# Source on localhost: ... connected.
# Exporting metadata from util_test
DROP DATABASE IF EXISTS util_test;
CREATE DATABASE util_test;
USE util_test;
# TABLE: util_test.t1
CREATE TABLE `t1` (
  `a` char(30) DEFAULT NULL
) ENGINE=MEMORY DEFAULT CHARSET=latin1;
# TABLE: util_test.t2
CREATE TABLE `t2` (
  `a` char(30) DEFAULT NULL
) ENGINE=MyISAM DEFAULT CHARSET=latin1;
# TABLE: util_test.t3
CREATE TABLE `t3` (
  `a` int(11) NOT NULL AUTO_INCREMENT,
  `b` char(30) DEFAULT NULL,
  PRIMARY KEY (`a`)
) ENGINE=InnoDB AUTO_INCREMENT=4 DEFAULT CHARSET=latin1;
# TABLE: util_test.t4
CREATE TABLE `t4` (
  `c` int(11) NOT NULL,
  `d` int(11) NOT NULL,
  KEY `ref_t3` (`c`),
  CONSTRAINT `ref_t3` FOREIGN KEY (`c`) REFERENCES `t3` (`a`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1;
# VIEW: util_test.v1
[...]
#...done.
```

Similarly, to export the data of the database `util_test`, producing bulk insert statements, use this command:

```
shell> mysqldbexport --server=root:pass@localhost \
          --export=DATA --bulk-insert util_test
# Source on localhost: ... connected.
USE util_test;
# Exporting data from util_test
# Data for table util_test.t1:
INSERT INTO util_test.t1 VALUES  ('01 Test Basic database example'),
  ('02 Test Basic database example'),
  ('03 Test Basic database example'),
  ('04 Test Basic database example'),
  ('05 Test Basic database example'),
  ('06 Test Basic database example'),
  ('07 Test Basic database example');
# Data for table util_test.t2:
INSERT INTO util_test.t2 VALUES  ('11 Test Basic database example'),
  ('12 Test Basic database example'),
  ('13 Test Basic database example');
# Data for table util_test.t3:
INSERT INTO util_test.t3 VALUES  (1, '14 test fkeys'),
  (2, '15 test fkeys'),
  (3, '16 test fkeys');
# Data for table util_test.t4:
INSERT INTO util_test.t4 VALUES  (3, 2);
#...done.
```

If the database to be exported does not contain only InnoDB tables and you want to ensure data integrity of the exported data by locking the tables during the read step, add a `--locking=lock-all` option to the command:

```
shell> mysqldbexport --server=root:pass@localhost \
  --export=DATA --bulk-insert util_test --locking=lock-all
# Source on localhost: ... connected.
USE util_test;
# Exporting data from util_test
# Data for table util_test.t1:
INSERT INTO util_test.t1 VALUES  ('01 Test Basic database example'),
  ('02 Test Basic database example'),
  ('03 Test Basic database example'),
  ('04 Test Basic database example'),
  ('05 Test Basic database example'),
  ('06 Test Basic database example'),
  ('07 Test Basic database example');
# Data for table util_test.t2:
INSERT INTO util_test.t2 VALUES  ('11 Test Basic database example'),
  ('12 Test Basic database example'),
  ('13 Test Basic database example');
# Data for table util_test.t3:
INSERT INTO util_test.t3 VALUES  (1, '14 test fkeys'),
  (2, '15 test fkeys'),
  (3, '16 test fkeys');
# Data for table util_test.t4:
INSERT INTO util_test.t4 VALUES  (3, 2);
#...done.
```

To export a database and include the replication commands to use the current server as the master (for example, to start a new slave using the current server as the master), use the following command:

```
shell> mysqldbexport --server=root@localhost:3311 util_test \
          --export=both --rpl-user=rpl:rpl --rpl=master -v
# Source on localhost: ... connected.
#
# Stopping slave
STOP SLAVE;
#
# Source on localhost: ... connected.
# Exporting metadata from util_test
DROP DATABASE IF EXISTS util_test;
CREATE DATABASE util_test;
USE util_test;
# TABLE: util_test.t1
CREATE TABLE `t1` (
  `a` char(30) DEFAULT NULL
) ENGINE=MEMORY DEFAULT CHARSET=latin1;
#...done.
# Source on localhost: ... connected.
USE util_test;
# Exporting data from util_test
# Data for table util_test.t1:
INSERT INTO util_test.t1 VALUES ('01 Test Basic database example');
INSERT INTO util_test.t1 VALUES ('02 Test Basic database example');
INSERT INTO util_test.t1 VALUES ('03 Test Basic database example');
INSERT INTO util_test.t1 VALUES ('04 Test Basic database example');
INSERT INTO util_test.t1 VALUES ('05 Test Basic database example');
INSERT INTO util_test.t1 VALUES ('06 Test Basic database example');
INSERT INTO util_test.t1 VALUES ('07 Test Basic database example');
#...done.
#
# Connecting to the current server as master
CHANGE MASTER TO MASTER_HOST = 'localhost',
  MASTER_USER = 'rpl',
  MASTER_PASSWORD = 'rpl',
  MASTER_PORT = 3311,
  MASTER_LOG_FILE = 'clone-bin.000001' ,
  MASTER_LOG_POS = 106;
#
# Starting slave
START SLAVE;
#
```

Similarly, to export a database and include the replication commands to use the current server's master (for example, to start a new slave using the same the master), use the following command:

```
shell> mysqldbexport --server=root@localhost:3311 util_test \
          --export=both --rpl-user=rpl:rpl --rpl=slave -v
# Source on localhost: ... connected.
#
# Stopping slave
STOP SLAVE;
#
# Source on localhost: ... connected.
# Exporting metadata from util_test
DROP DATABASE IF EXISTS util_test;
CREATE DATABASE util_test;
USE util_test;
# TABLE: util_test.t1
CREATE TABLE `t1` (
  `a` char(30) DEFAULT NULL
) ENGINE=MEMORY DEFAULT CHARSET=latin1;
#...done.
```

```
# Source on localhost: ... connected.
USE util_test;
# Exporting data from util_test
# Data for table util_test.t1:
INSERT INTO util_test.t1 VALUES ('01 Test Basic database example');
INSERT INTO util_test.t1 VALUES ('02 Test Basic database example');
INSERT INTO util_test.t1 VALUES ('03 Test Basic database example');
INSERT INTO util_test.t1 VALUES ('04 Test Basic database example');
INSERT INTO util_test.t1 VALUES ('05 Test Basic database example');
INSERT INTO util_test.t1 VALUES ('06 Test Basic database example');
INSERT INTO util_test.t1 VALUES ('07 Test Basic database example');
#...done.
#
# Connecting to the current server's master
CHANGE MASTER TO MASTER_HOST = 'localhost',
  MASTER_USER = 'rpl',
  MASTER_PASSWORD = 'rpl',
  MASTER_PORT = 3310,
  MASTER_LOG_FILE = 'clone-bin.000001' ,
  MASTER_LOG_POS = 1739;
#
# Starting slave
START SLAVE;
#
```

PERMISSIONS REQUIRED

The user account specified must have permission to read all databases listed including access to any objects exported. For example, if the export includes stored routines, the user specified must be able to access and view stored routines.

5.6 `mysqldbimport` — Import Object Definitions or Data into a Database

This utility imports metadata (object definitions), data, or both for one or more databases from one or more files.

If an object exists on the destination server with the same name as an imported object, it may be dropped first by using the `--drop-first` option.

To skip objects by type, use the `--skip` option with a list of the objects to skip. This enables you to extract a particular set of objects, say, for importing only events (by excluding all other types). Similarly, to skip creation of **UPDATE** statements for `BLOB` data, specify the `--skip-blobs` option.

To specify the input format, use one of the following values with the `--format` option. These correspond to the output formats of the `mysqldbexport` utility:

- **sql** (default)

  Input consists of SQL statements. For definitions, this consists of the appropriate **CREATE** and **GRANT** statements. For data, this is an **INSERT** statement (or bulk insert if the `--bulk-insert` option is specified).

- **grid**

  Display output in grid or table format like that of the `mysql` client command-line tool.

- **csv**

  Input is formatted in comma-separated values format.

- **raw_csv**

  Input is a simple CSV file containing uniform rows with values separated with commas. The file can contain a header (the first row) that lists the table columns. The option `--table` is required to use this format.

- **tab**

  Input is formatted in tab-separated format.

- **vertical**

  Display output in single-column format like that of the `\G` command for the `mysql` client command-line tool.

To indicate that input in **csv** or **tab** format does not contain column headers, specify the `--no-headers` option.

To turn off all feedback information, specify the `--quiet` option.

You must provide connection parameters (user, host, password, and so forth) for an account that has the appropriate privileges to access all objects in the operation. For details, see NOTES.

Changing Storage Engines

By default, the utility creates each table on the destination server using the same storage engine as the original table. To override this and specify the storage engine to use for all tables created on the destination server, use the `--new-storage-engine` option. If the destination server supports the new engine, all tables use that engine.

To specify the storage engine to use for tables for which the destination server does not support the original storage engine on the source server, use the `--default-storage-engine` option.

The `--new-storage-engine` option takes precedence over `--default-storage-engine` if both are given.

If the `--new-storage-engine` or `--default-storage-engine` option is given and the destination server does not support the specified storage engine, a warning is issued and the server's default storage engine setting is used instead.

Importing Data with GTIDs

If you attempt to import databases on a server with GTIDs enabled (GTID_MODE = ON), a warning is generated if the import file did not include the GTID statements generated by `mysqldbexport`.

The utility also generates a warning if you import databases on a server without GTIDs enabled and there are GTID statements present in the file. Use the `--skip-gtid` option to ignore the GTID statements.

To make the most use of GTIDs and export/import, you should export all of the databases on the server with the `--all` option. This action generates an export file with all of the databases and the GTIDs executed to that point. Importing this file on another server ensures that server has all of the data as well as all of the GTIDs recorded correctly in its logs.

OPTIONS

`mysqldbimport` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --autocommit

  Enable autocommit for data import. By default, autocommit is off and data changes are only committed once at the end of each imported file.

- --bulk-insert, -b

  Use bulk insert statements for data.

- --character-set=*`charset`*

  Sets the client character set. The default is retrieved from the server variable `character_set_client`.

- --default-storage-engine=*`def_engine`*

  The engine to use for tables if the destination server does not support the original storage engine on the source server.

- --drop-first, -d

  Drop each database to be imported if exists before importing anything into it.

- --dryrun

  Import the files and generate the statements but do not execute them. This is useful for testing input file validity.

- --format=*`format`*, -f*`format`*

  Specify the input format. Permitted format values are **sql** (default), **grid**, **tab**, **csv**, **raw_csv**, and **vertical**.

- --import=*`import_type`*, -i*`import_type`*

  Specify the import format. Permitted format values are:

  Table 5.2 mysqldbimport Import Types

Import Type	Definition
`definitions` (default)	Only import the definitions (metadata) for the objects in the database list
`data`	Only import the table data for the tables in the database list
both	Import both the definitions (metadata) and data

  If you attempt to import objects into an existing database, the result depends on the import format. If the format is **definitions** or **both**, an error occurs unless `--drop-first` is given. If the format is **data**, imported table data is added to existing table data.

- --max-bulk-insert

Specify the maximum number of INSERT statements to bulk, by default 30000. This option is only used with `--bulk-insert`.

- --multiprocess

  Specify the number of processes to concurrently import the specified files. Special values: 0 (number of processes equal to the number of detected CPUs) and 1 (default - no concurrency). Multiprocessing works at the files level for any operating systems.

- --new-storage-engine=*`new_engine`*

  The engine to use for all tables created on the destination MySQL server.

- --no-headers, -h

  Input does not contain column headers. This option only applies to the **csv** and **tab** file formats.

- --quiet, -q

  Turn off all messages for quiet execution.

- --server=*`server`*

  Connection information for the server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]

  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]

  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --skip=*`skip_objects`*

  Specify objects to skip in the operation as a comma-separated list (no spaces). Permitted values for this list are; **CREATE_DB**, **DATA**, **EVENTS**, **FUNCTIONS**, **GRANTS**, **PROCEDURES**, **TABLES**, **TRIGGERS**, and **VIEWS**.

- --skip-blobs

  Do not import `BLOB` data.

- --skip-gtid

  Skip execution of `GTID_PURGED` statements.

- --skip-rpl

  Do not execute replication commands.

- --ssl-ca

The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --table=*`db`*,*`table`*

  Specify the table for importing. This option is required while using `--format=raw_csv`.

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

NOTES

The login user must have the appropriate permissions to create new objects, access (read) the `mysql` database, and grant privileges. If a database to be imported already exists, the user must have read permission for it, which is needed to check the existence of objects in the database.

Actual privileges needed may differ from installation to installation depending on the security privileges present and whether the database contains certain objects such as views or events and whether binary logging is enabled.

Some combinations of the options may result in errors during the operation. For example, excluding tables but not views may result in an error when a view is imported.

The `--new-storage-engine` and `--default-storage-engine` options apply to all destination tables in the operation.

For the `--format` and `--import` options, the permitted values are not case sensitive. In addition, values may be specified as any unambiguous prefix of a valid value. For example, `--format=g` specifies the grid format. An error occurs if a prefix matches more than one valid value.

When importing data and including the GTID commands, you may encounter an error similar to "GTID_PURGED can only be set when GTID_EXECUTED is empty". This occurs because the destination server is not in a clean replication state. To solve this problem, you can issue a "RESET MASTER" command on the destination prior to executing the import.

The path to the MySQL client tools should be included in the `PATH` environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the `my_print_defaults` tools which is required to read the login-path values from the login configuration file (`.mylogin.cnf`).

Keep in mind that you can only take advantage of multiprocessing if your system has multiple CPUs available for concurrent execution. Also note that multiprocessing is applied at the file level for the `mysqldbimport` utility, which means that only different files can be concurrently imported.

EXAMPLES

To import the metadata from the `util_test` database to the server on the local host using a file in CSV format, use this command:

```
shell> mysqldbimport --server=root@localhost --import=definitions \
          --format=csv data.csv
# Source on localhost: ... connected.
# Importing definitions from data.csv.
#...done.
```

Similarly, to import the data from the `util_test` database to the server on the local host, importing the data using bulk insert statements, use this command:

```
shell> mysqldbimport --server=root@localhost --import=data \
          --bulk-insert --format=csv data.csv
# Source on localhost: ... connected.
# Importing data from data.csv.
#...done.
```

To import both data and definitions from the `util_test` database, importing the data using bulk insert statements from a file that contains SQL statements, use this command:

```
shell> mysqldbimport --server=root@localhost --import=both --bulk-insert --format=sql data.sql

# Source on localhost: ... connected.
# Importing definitions and data from data.sql.
#...done.
```

PERMISSIONS REQUIRED

You also need permissions to create the new data directory and write data to it including permissions to create all objects in the import stream such as views, events, and stored routines. Thus, actual permissions vary based on the contents of the import stream.

5.7 `mysqldiff` — Identify Differences Among Database Objects

This utility reads the definitions of objects and compares them using a diff-like method to determine whether they are the same. The utility displays the differences for objects that are not the same.

Use the notation `db1:db2` to name two databases to compare, or, alternatively just db1 to compare two databases with the same name. The latter case is a convenience notation for comparing same-named databases on different servers.

The comparison may be executed against two databases of different names on a single server by specifying only the `--server1` option. The user can also connect to another server by specifying the `--server2` option. In this case, db1 is taken from server1 and db2 from server2.

When a database pair is specified, all objects in one database are compared to the corresponding objects in the other. Objects not appearing in either database produce an error.

To compare a specific pair of objects, add an object name to each database name using the *db.obj* format. For example, use the `db1.obj1:db2.obj2` format to compare two named objects, or db1.obj1 to compare an object with the same name in databases with the same name. It is not permitted to mix a database name with an object name. For example, db1.obj1:db2 and db1:db2.obj2 are illegal formats.

The comparison may be run against a single server for comparing two databases of different names on the same server by specifying only the --server1 option. Alternatively, you can also connect to another server by specifying the --server2 option. In this case, the first object to compare is taken from server1 and the second from server2.

By default, the utility generates object differences as a difference report. However, you can generate a transformation report containing SQL statements for transforming the objects for conformity instead. Use the 'sql' value for the --difftype option to produce a listing that contains the appropriate ALTER commands to conform the object definitions for the object pairs specified. If a transformation cannot be formed, the utility reports the diff of the object along with a warning statement. See important limitations in the NOTES section.

To specify how to display the diff styled output, use one of the following values with the --difftype option:

- **unified** (default)

  Display unified format output.

- **context**

  Display context format output.

- **differ**

  Display differ-style format output.

- **sql**

  Display SQL transformation statement output.

The --changes-for option controls the direction of the difference (by specifying the object to be transformed) in either the difference report (default) or the transformation report (designated with the --difftype=sql option). Consider the following command:

```
shell> mysqldiff --server1=root@host1 --server2=root@host2 --difftype=sql \
          db1.table1:dbx.table3
```

The leftmost database (db1) exists on the server designated by the --server1 option (host1). The rightmost database (dbx) exists on the server designated by the --server2 option (host2).

- --changes-for=server1: Produces output that shows how to make the definitions of objects on server1 like the definitions of the corresponding objects on server2.

- --changes-for=server2: Produces output that shows how to make the definitions of objects on server2 like the definitions of the corresponding objects on server1.

The default direction is server1.

For the **sql** difference format, you can also see the reverse transformation by specifying the --show-reverse option.

The utility stops at the first occurrence of missing objects or when an object does not match. To override this behavior, specify the --force option to cause the utility to attempt to compare all objects listed as arguments.

OPTIONS

`mysqldiff` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --changes-for=*`direction`*

  Specify the server to show transformations to match the other server. For example, to see the transformation for transforming object definitions on server1 to match the corresponding definitions on server2, use `--changes-for=server1`. Permitted values are **server1** and **server2**. The default is **server1**.

- --character-set=*`charset`*

  Sets the client character set. The default is retrieved from the server variable `character_set_client`.

- --difftype=*`difftype`*, -d*`difftype`*

  Specify the difference display format. Permitted format values are **unified** (default), **context**, **differ**, and **sql**.

- --compact

  Compacts the output by reducing the control lines that are displayed in the diff results. This option should be used together with one of the following difference types: unified or context.

- --force

  Do not halt at the first difference found. Process all objects to find all differences.

- --quiet, -q

  Do not print anything. Return only an exit code of success or failure.

- --server1=*`source`*

  Connection information for the first server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --server2=`source`

  Connection information for the second server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : `login-path`[:`port`][:`socket`]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : `configuration-file-path`[:`section`]
  - Specify the data on the command-line (unencrypted, visible). Example : `user`[:`passwd`]@`host`[:`port`][:`socket`]

- --show-reverse

  Produce a transformation report containing the SQL statements to conform the object definitions specified in reverse. For example, if `--changes-for` is set to server1, also generate the transformation for server2.

  Note

  The reverse changes are annotated and marked as comments.

- --skip-table-options

  Ignore the differences between all table options, such as AUTO_INCREMENT, ENGINE, CHARSET, etc.). A warning is issued if the `--skip-table-options` option is used and table option differences are found.

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

Display version information and exit.

- --width=*number*

  Change the display width of the test report. The default is 75 characters.

SQL TRANSFORMATION LIMITATIONS

The SQL transformation feature has these known limitations:

- When tables with partition differences are encountered, the utility generates the **ALTER TABLE** statement for all other changes but prints a warning and omits the partition differences.
- If the transformation detects table options in the source table (specified with the `--changes-for` option) that are not changed or do not exist in the target table, the utility generates the **ALTER TABLE** statement for all other changes but prints a warning and omits the table option differences.
- Rename for events is not supported. This is because `mysqldiff` compares objects by name. In this case, depending on the direction of the diff, the event is identified as needing to be added or a **DROP EVENT** statement is generated.
- Changes in the definer clause for events are not supported.
- SQL extensions specific to MySQL Cluster are not supported.

NOTES

You must provide connection parameters (user, host, password, and so forth) for an account that has the appropriate privileges to access all objects to be compared.

For the `--difftype` option, the permitted values are not case sensitive. In addition, values may be specified as any unambiguous prefix of a valid value. For example, `--difftype=d` specifies the differ type. An error occurs if a prefix matches more than one valid value.

The path to the MySQL client tools should be included in the `PATH` environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the `my_print_defaults` tools which is required to read the login-path values from the login configuration file (`.mylogin.cnf`).

If any database object identifier specified as an argument contains special characters or is a reserved word, then it must be appropriately quoted with backticks (**`**). In turn, names quoted with backticks must also be quoted with single or double quotes depending on the operating system, i.e. (**"**) in Windows or (**'**) in non-Windows systems, in order for the utilities to read backtick quoted identifiers as a single argument. For example, to show the difference between table **weird`table1** from database **weird`db.name** and table **weird`table2** from database **other:weird`db.name**, the objects pair must be specified using the following syntax (in non-Windows): **'`weird``db.name`.`weird``table1`:`other:weird``db.name`.`weird``table2`'**.

EXAMPLES

To compare the `employees` and `emp` databases on the local server, use this command:

```
shell> mysqldiff --server1=root@localhost employees:emp1
# server1 on localhost: ... connected.
WARNING: Objects in server1:employees but not in server2:emp1:
  EVENT: e1
Compare failed. One or more differences found.

shell> mysqldiff --server1=root@localhost \
          employees.t1:emp1.t1 employees.t3:emp1.t3

# server1 on localhost: ... connected.
# Comparing employees.t1 to emp1.t1                              [PASS]
# server1 on localhost: ... connected.
# Comparing employees.t3 to emp1.t3                              [PASS]
Success. All objects are the same.

shell> mysqldiff --server1=root@localhost \
          employees.salaries:emp1.salaries --differ

# server1 on localhost: ... connected.
# Comparing employees.salaries to emp1.salaries                  [FAIL]
# Object definitions are not the same:
  CREATE TABLE `salaries` (
    `emp_no` int(11) NOT NULL,
    `salary` int(11) NOT NULL,
    `from_date` date NOT NULL,
    `to_date` date NOT NULL,
    PRIMARY KEY (`emp_no`,`from_date`),
    KEY `emp_no` (`emp_no`)
- ) ENGINE=InnoDB DEFAULT CHARSET=latin1
?           ^^^^^
+ ) ENGINE=MyISAM DEFAULT CHARSET=latin1
?          ++ ^^^
Compare failed. One or more differences found.
```

The following examples show how to generate a transformation report. Assume the following object definitions:

Host1:

```
CREATE TABLE db1.table1 (num int, misc char(30));
```

Host2:

```
CREATE TABLE dbx.table3 (num int, notes char(30), misc char(55));
```

To generate a set of SQL statements that transform the definition of `db1.table1` to `dbx.table3`, use this command:

```
shell> mysqldiff --server1=root@host1 --server2=root@host2 \
          --changes-for=server1 --difftype=sql \
          db1.table1:dbx.table3

# server1 on host1: ... connected.
# server2 on host2: ... connected.
# Comparing db1.table1 to dbx.table3                             [FAIL]
# Transformation statements:

ALTER TABLE db1.table1
  ADD COLUMN notes char(30) AFTER a,
  CHANGE COLUMN misc misc char(55);

Compare failed. One or more differences found.
```

To generate a set of SQL statements that transform the definition of `dbx.table3` to `db1.table1`, use this command:

```
shell> mysqldiff --server1=root@host1 --server2=root@host2 \
      --changes-for=server2 --difftype=sql \
      db1.table1:dbx.table3
```

```
# server1 on host1: ... connected.
# server2 on host2: ... connected.
# Comparing db1.table1 to dbx.table3                               [FAIL]
# Transformation statements:

ALTER TABLE dbx.table3
  DROP COLUMN notes,
  CHANGE COLUMN misc misc char(30);

Compare failed. One or more differences found.
```

To generate a set of SQL statements that transform the definitions of `dbx.table3` and `db1.table1` in both directions, use this command:

```
shell> mysqldiff --server1=root@host1 --server2=root@host2 \
          --show-reverse --difftype=sql \
          db1.table1:dbx.table3

# server1 on host1: ... connected.
# server2 on host2: ... connected.
# Comparing db1.table1 to dbx.table3                               [FAIL]
# Transformation statements:

# --destination=server1:
ALTER TABLE db1.table1
  ADD COLUMN notes char(30) AFTER a,
  CHANGE COLUMN misc misc char(55);

# --destination=server2:
# ALTER TABLE dbx.table3
#   DROP COLUMN notes,
#   CHANGE COLUMN misc misc char(30);

Compare failed. One or more differences found.
```

PERMISSIONS REQUIRED

The user must have SELECT privileges for both objects on both servers as well as SELECT on the mysql database.

5.8 `mysqldiskusage` — Show Database Disk Usage

This utility displays disk space usage for one or more databases. The utility optionally displays disk usage for the binary log, slow query log, error log, general query log, relay log, and InnoDB tablespaces. The default is to only show database disk usage.

If the command-line lists no databases, the utility shows the disk space usage for all databases.

Sizes displayed without a unit indicator (such as MB) are in bytes.

The utility determines the location of the data directory by requesting it from the server. For a local server, the utility obtains size information directly from files in the data directory and InnoDB home directory. In this case, you must have file system access to read those directories. Disk space usage shown includes the sum of all storage engine- specific files such as the .MYI and .MYD files for MyISAM and the tablespace files for InnoDB.

If the file system read fails, or if the server is not local, the utility cannot determine exact file sizes. It is limited to information that can be obtained from the system tables, which therefore should be considered an estimate. For information read from the server, the account used to connect to the server must have the appropriate permissions to read any objects accessed during the operation.

If information requested requires file system access but is not available that way, the utility prints a message that the information is not accessible. This occurs, for example, if you request log usage but the server is not local and the log files cannot be examined directly.

To specify how to display output, use one of the following values with the `--format` option:

- **grid** (default)

  Display output in grid or table format like that of the `mysql` client command-line tool.

- **csv**

  Display output in comma-separated values format.

- **tab**

  Display output in tab-separated format.

- **vertical**

  Display output in single-column format like that of the `\G` command for the `mysql` client command-line tool.

To turn off the headers for **grid**, **csv**, or **tab** display format, specify the `--no-headers` option.

OPTIONS

`mysqldiskusage` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --all, -a

  Display all disk usage. This includes usage for databases, logs, and InnoDB tablespaces.

- --binlog, -b

  Display binary log usage.

- --empty, -m

  Include empty databases.

- --format=*`format`*, -f*`format`*

  Specify the output display format. Permitted format values are **grid**, **csv**, **tab**, and **vertical**. The default is **grid**.

- --innodb, -i

  Display InnoDB tablespace usage. This includes information about the shared InnoDB tablespace as well as .idb files for InnoDB tables with their own tablespace.

- --logs, -l

  Display general query log, error log, and slow query log usage.

- --no-headers, -h

  Do not display column headers. This option applies only for **grid**, **csv**, and **tab** output.

- --quiet, -q

  Suppress informational messages.

- --relaylog, -r

  Display relay log usage.

- --server=`server`

  Connection information for the server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : `login-path`[:`port`][:`socket`]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : `configuration-file-path`[:`section`]
  - Specify the data on the command-line (unencrypted, visible). Example : `user`[:`passwd`]@`host`[:`port`][:`socket`]

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

For the `--format` option, the permitted values are not case sensitive. In addition, values may be specified as any unambiguous prefix of a valid value. For example, `--format=g` specifies the grid format. An error occurs if a prefix matches more than one valid value.

NOTES

You must provide connection parameters (user, host, password, and so forth) for an account that has the appropriate privileges for all objects accessed during the operation.

The path to the MySQL client tools should be included in the `PATH` environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the `my_print_defaults` tools which is required to read the login-path values from the login configuration file (`.mylogin.cnf`).

EXAMPLES

To show only the disk space usage for the `employees` and `test` databases in grid format (the default), use this command:

```
shell> mysqldiskusage --server=root@localhost employees test
# Source on localhost: ... connected.
# Database totals:
+------------+--------------+
| db_name    |       total  |
+------------+--------------+
| employees  | 205,979,648  |
| test       |       4,096  |
+------------+--------------+

Total database disk usage = 205,983,744 bytes or 196.00 MB

#...done.
```

To see all disk usage for the server in CSV format, use this command:

```
shell> mysqldiskusage --server=root@localhost --format=csv -a -vv
# Source on localhost: ... connected.
# Database totals:
db_name,db_dir_size,data_size,misc_files,total
test1,0,0,0,0
db3,0,0,0,0
db2,0,0,0,0
db1,0,0,0,0
backup_test,19410,1117,18293,19410
employees,242519463,205979648,242519463,448499111
mysql,867211,657669,191720,849389
t1,9849,1024,8825,9849
test,56162,4096,52066,56162
util_test_a,19625,2048,17577,19625
util_test_b,17347,0,17347,17347
util_test_c,19623,2048,17575,19623

Total database disk usage = 449,490,516 bytes or 428.00 MB

# Log information.
# The general_log is turned off on the server.
# The slow_query_log is turned off on the server.

# binary log information:
Current binary log file = ./mysql-bin.000076
log_file,size
/data/mysql-bin.000076,125
```

```
/data/mysql-bin.000077,125
/data/mysql-bin.000078,556
/data/mysql-bin.000079,168398223
/data/mysql-bin.index,76

Total size of binary logs = 168,399,105 bytes or 160.00 MB

# Server is not an active slave - no relay log information.
# InnoDB tablespace information:
InnoDB_file,size,type,specification
/data/ib_logfile0,5242880,log file,
/data/ib_logfile1,5242880,log file,
/data/ibdata1,220200960,shared tablespace,ibdata1:210M
/data/ibdata2,10485760,shared tablespace,ibdata2:10M:autoextend
/data/employees/departments.ibd,114688,file tablespace,
/data/employees/dept_emp.ibd,30408704,file tablespace,
/data/employees/dept_manager.ibd,131072,file tablespace,
/data/employees/employees.ibd,23068672,file tablespace,
/data/employees/salaries.ibd,146800640,file tablespace,
/data/employees/titles.ibd,41943040,file tablespace,

Total size of InnoDB files = 494,125,056 bytes or 471.00 MB

#...done.
```

PERMISSIONS REQUIRED

The user must have permissions to read the data directory or use an administrator, super user (sudo), or an account with elevated privileges to obtain access to the data directory.

5.9 `mysqlfailover` — Automatic replication health monitoring and failover

This utility permits users to perform replication health monitoring and automatic failover on a replication topology consisting of a single master and its slaves. The utility is designed to run interactively or continuously refreshing the health information and checking the master status at periodic intervals. Its primary mission is to monitor the master for failure and when a failure occurs, execute failover to one of the slaves that is in a valid state. The utility accepts an optional list of slaves to be considered for the candidate slave.

This utility is designed to work exclusively for servers that support global transaction identifiers (GTIDs) and have `gtid_mode=ON`. MySQL server versions 5.6.5 and higher support GTIDs. See Replication with Global Transaction Identifiers for more information. Thus, this utility does not work with anonymous replication servers (binary log + position).

The user can specify the interval in seconds to use for detecting the master status and generating the health report using the `--interval` option. At each interval, the utility checks to see if the server is alive via a ping operation followed by a check of the connector to detect if the server is still reachable. The ping operation can be controlled with the `--ping` option (see below).

If the master is found to be offline or unreachable, the utility executes one of the following actions based on the `--failover-mode` option value. The available values are:

- **auto** (default): Execute automatic failover to the list of candidates first and if no slaves are viable, continue to search the remaining slaves for a viable candidate. The command tests each candidate slave listed for the prerequisites. Once a candidate slave is elected, it is made a slave of each of the other slaves thereby collecting any transactions executed on other slaves but not the candidate. In this way, the candidate becomes the most up-to-date slave. If no slave is found to be a viable candidate, the utility generates an error and exit.

- **elect**: This mode is the same as auto, except if no candidates specified in the list of candidate slaves are viable, then it does not check the remaining slaves, and instead generates an error and then exits. Use this option to force failover to one or more specific slaves using the `--candidates` option.
- **fail**: This mode produces an error and does not failover when the master is detected as down or unreachable. This mode is used to provide periodic health monitoring without the failover action taken.

For all options that permit specifying multiple servers, the options require a comma-separated list of connection parameters in the following form (where the password, port, and socket are optional).:

```
*user*[:*passwd*]@*host*[:*port*][:*socket*] or
*login-path*[:*port*][:*socket*]
```

The utility permits users to discover slaves connected to the master. The discover slaves feature is run automatically on each interval. Furthermore, it is required that slaves use the --master-info-repository=TABLE startup setting.

The discover slaves option **requires** that all slaves use the `--report-host` and `--report-port` server startup options with the correct hostname and port. If these are missing or report incorrect information, the slave may not be detected and thus not included in the operation of the utility. The discover slaves option ignores any slaves to which it cannot connect.

Note

If you have one or more slaves which do not report their hostname and port and should a failover event occur, those slaves are not included in the resulting topology. That is, they are not a slave of the new master. Be sure to check that all of your slaves are accounted for in the health report before relying on the utility for complete automatic failover.

The utility permits the user to specify an external script to execute before and after the switchover and failover commands. The user can specify these with the `--exec-before` and `--exec-after` options. The return code of the script is used to determine success. Each script must report 0 (success) to be considered successful. If a script returns a value other than 0, the result code is presented in an error message.

The utility also permits the user to specify a script to be used for detecting a downed master or an application-level event to trigger failover. This can be specified using the `--exec-fail-check` option. The return code for the script is used to invoke failover. A return code of 0 indicates failover should not take place. A return code other than 0 indicates failover should take place. This is checked at the start of each interval if a script is supplied. The timeout option is not used in this case and the script is run once at the start of each interval.

The utility permits the user to log all actions taken during the commands. The `--log` option requires a valid path and filename of the file to use for logging operations. The log is active only when this option is specified. The option `--log-age` specifies the age in days that log entries are kept. The default is seven (7) days. Older entries are automatically deleted from the log file (but only if the `--log` option is specified).

The format of the log file includes the date and time of the event, the level of the event (informational - INFO, warning - WARN, error - ERROR, critical failure - CRITICAL), and the message reported by the utility.

The interface provides a number of options for displaying additional information. You can choose to view the replication health report (default), or choose to view the list of GTIDs in use, the UUIDs in use, or view the log file contents if logging is enabled. Each of these reports is described below.

- **health** Display the replication health of the topology. This report is the default view for the interface. By default, this includes the host name, port, role (MASTER or SLAVE) of the server, state of the server

(UP = is connected, WARN = not connected but can ping, DOWN = not connected and cannot ping), the GTID_MODE, and health state.

The master health state is based on the following: if GTID_MODE=ON, the server must have the binary log enabled, and a user must exist with the REPLICATE SLAVE privilege.

The `--seconds-behind` option is used to detect when a slave is behind the master. It allows users to set a threshold for reporting purposes only. It does not apply to slave candidacy or selection during failover.

The slave health state is based on the following: the IO_THREAD and SQL_THREADS must be running, it must be connected to the master, there are no errors, the slave delay for non-GTID enabled scenarios is not more than the threshold provided by the `--max-position` and the slave is reading the correct master log file, and slave delay is not more than the `--seconds-behind` threshold option.

At each interval, if the discover slaves option was specified at startup and new slaves are discovered, the health report is refreshed.

- **gtid**: Display the master's list of executed GTIDs, contents of the GTID variables; `@@GLOBAL.GTID_EXECUTED`, `@@GLOBAL.GTID_PURGED`, and `@@GLOBAL.GTID_OWNED`. Thus, you can toggle through the four screens by pressing the '`G`' key.
- **UUID**: Display universally unique identifiers (UUIDs) for all servers.
- **Log**: This option displays the contents of the log file, which only visible if the `--log` option is specified. This can be helpful to see when failover occurred, and which actions or messages were recorded at the time.

The user interface is designed to match the size of the terminal window in which it is run. A refresh option is provided to permit users to resize their terminal windows or refresh the display at any time. However, the interface automatically resizes to the terminal window on each interval.

The interface displays the name of the utility, the master's status including binary log file, position, and filters as well as the date and time of the next interval event.

The interface also permits the user to scroll up or down through a list longer than what the terminal window permits. When a long list is presented, the scroll options become enabled. The user can scroll the list up with the up arrow key and down with the down arrow key.

Use the `--verbose` option to see additional information in the health report and additional messages during failover.

MODES OF OPERATION

The utility supports two modes of operation. The default mode, running as a console, works as described above. An additional mode that permits you to run the utility as a daemon is provided for POSIX platforms.

When run as a daemon, the utility does not have interactivity. However, all events are written to the log file. You can control what is written to the log by using the `--report-values` option.

To run the utility as a daemon, use the `--daemon` option. There are four commands that can be used in `--daemon` option. These include:

- start

  Starts the daemon. The `--log` option is required.

- stop

  Stops the daemon. If you used the option `--pidfile`, the value must be the same when starting the daemon.

- restart

  Restarts the daemon. If you used the option `--pidfile`, the value must be the same when starting the daemon.

- nodetach

  Starts the daemon, but does not detach the process from the console. The `--log` option is required.

OPTIONS

`mysqlfailover` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --candidates=*`candidate slave connections`*

  Connection information for candidate slave servers. Valid only with failover command. List multiple slaves in comma-separated list.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]

  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]

  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --daemon=*`command`*

  Run as a daemon. The *`command`* can be `start` (start daemon), `stop` (stop daemon), `restart` (stop then start the daemon) or `nodetach` (start but do not detach the process). This option is only available for POSIX systems.

- --discover-slaves-login=*`user:password`*

  At startup, query master for all registered slaves and use the user name and password specified to connect. Supply the user and password in the form *`user`*[:*`passwd`*] or *`login-path`*. For example, --discover=joe:secret uses 'joe' as the user and 'secret' as the password for each discovered slave.

- --exec-after=*`script`*

Name of script to execute after failover or switchover. Script name may include the path.

- --exec-before=*script*

  Name of script to execute before failover or switchover. Script name may include the path.

- --exec-fail-check=*script*

  Name of script to execute on each interval to invoke failover.

- --exec-post-failover=*script*

  Name of script to execute after failover is complete and the utility has refreshed the health report.

- --failover-mode=*mode*, -f *mode*

  Action to take when the master fails. 'auto' = automatically fail to best slave, 'elect' = fail to candidate list or if no candidate meets criteria fail, 'fail' = take no action and stop when master fails. Default = 'auto'.

- --force

  Override the registration check on master for multiple instances of the console monitoring the same master. See notes.

- --interval=*seconds*, -i *seconds*

  Interval in seconds for polling the master for failure and reporting health. Default = 15 seconds. Minimum is 5 seconds.

- --log=*log_file*

  Specify a log file to use for logging messages

- --log-age=*days*

  Specify maximum age of log entries in days. Entries older than this are purged on startup. Default = 7 days.

- --master=*connection*

  Connection information for the master server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *login-path*[:*port*][:*socket*]

  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *configuration-file-path*[:*section*]

  - Specify the data on the command-line (unencrypted, visible). Example : *user*[:*passwd*]@*host*[:*port*][:*socket*]

- --max-position=*position*

Used to detect slave delay. The maximum difference between the master's log position and the slave's reported read position of the master. A value greater than this means the slave is too far behind the master. Default = 0.

- --pedantic, -p

  Used to stop failover if some inconsistencies are found, such as errant transactions on slaves or SQL thread errors, during server checks. By default, the utility only generates warnings if issues are found when checking a slave's status during failover, and it continues execution unless this option is specified.

- --pidfile=*`pidfile`*

  Pidfile for running `mysqlfailover` as a daemon. This file contains the PID (process identifier), that uniquely identifies a process. It is needed to identify and control the process forked by `mysqlfailover`.

- --ping=*`number`*

  The code uses three attempts to contact the server with the ping command as part of the detection algorithm to check to see if the master is alive. This option sets the number of seconds to wait between each ping attempt. The default `--ping` value is 3 seconds.

  Note

  On some platforms, this is the same as number of seconds to wait for ping to return.

- --report-values=*`report_values`*

  Report values used in mysqlfailover running as a daemon. It can be health, gtid or uuid. Multiple values can be used separated by commas.

  - health

    Display the replication health of the topology.

  - gtid

    Display the master's list of executed GTIDs, contents of the GTID variables; `@@GLOBAL.GTID_EXECUTED`, `@@GLOBAL.GTID_PURGED` and `@@GLOBAL.GTID_OWNED`.

  - uuid

    Display universally unique identifiers (UUIDs) for all servers.

  Default = health.

- --rpl-user=:*`replication_user`*

  The user and password for the replication user requirement, in the form: *`user`*[:*`password`*] or *`login-path`*. E.g. rpl:passwd

  Default = None.

- --script-threshold=*`return_code`*

  Value for external scripts to trigger aborting the operation if result is greater than or equal to the threshold.

Default = None (no threshold checking).

- --seconds-behind=*seconds*

  Used to detect slave delay (only for health reporting purposes). The maximum number of seconds behind the master permitted before slave is considered behind the master in the health report state. Default = 0.

- --slaves=*slave connections*

  Connection information for slave servers. List multiple slaves in comma-separated list. The list is evaluated literally whereby each server is considered a slave to the master listed regardless if they are a slave of the master.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *login-path*[:*port*][:*socket*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *configuration-file-path*[:*section*]
  - Specify the data on the command-line (unencrypted, visible). Example : *user*[:*passwd*]@*host*[:*port*][:*socket*]

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --timeout=*seconds*

  Maximum timeout in seconds to wait for each replication command to complete. For example, timeout for slave waiting to catch up to master.

  Default = 3.

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

Display version information and exit.

NOTES

The login user must have the appropriate permissions for the utility to check servers and monitor their status (e.g., SHOW SLAVE STATUS, SHOW MASTER STATUS). The user must also have permissions to execute the failover procedure (e.g., STOP SLAVE, START SLAVE, WAIT_UNTIL_SQL_THREAD_AFTER_GTIDS, CHANGE MASTER TO ...). Lastly, the user must have the REPLICATE SLAVE privilege for slaves to connect to their master. The same permissions are required by the failover utility for master and slaves in order to run successfully. In particular, users connected to slaves, candidates and master require **SUPER**, **GRANT OPTION**, **REPLICATION SLAVE**, **RELOAD**, **DROP**, **CREATE**, **INSERT** and **SELECT** privileges.

The **DROP**, **CREATE**, **INSERT** and **SELECT** privileges are required to register the failover instance on the initial master or the new master (after a successful failover). Therefore, since any slave can become the new master, slaves and candidates also require those privileges. The utility checks permissions for the master, slaves, and candidates at startup.

Mixing IP and hostnames is not recommended. The replication-specific utilities attempt to compare hostnames and IP addresses as aliases for checking slave connectivity to the master. However, if your installation does not support reverse name lookup, the comparison could fail. Without the ability to do a reverse name lookup, the replication utilities could report a false negative that the slave is (not) connected to the master.

For example, if you setup replication using MASTER_HOST=ubuntu.net on the slave and later connect to the slave with mysqlrplcheck and have the master specified as --master=192.168.0.6 using the valid IP address for ubuntu.net, you must have the ability to do a reverse name lookup to compare the IP (192.168.0.6) and the hostname (ubuntu.net) to determine if they are the same machine.

Similarly, in order to avoid issues mixing local IP '127.0.0.1' with 'localhost', the addresse '127.0.0.1' is converted to 'localhost' by the utility. Nevertheless, It is best to use the actual hostname of the master when connecting or setting up replication.

The utility checks to see if the slaves are using the option --master-info-repository=TABLE. If they are not, the utility stops with an error.

The path to the MySQL client tools should be included in the PATH environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the my_print_defaults tools which is required to read the login-path values from the login configuration file (.mylogin.cnf).

At startup, the console attempts to register itself with the master. If another console is already registered, and the failover mode is auto or elect, the console is blocked from running failover. When a console quits, it unregisters itself from the master. If this process is broken, the user may override the registration check by using the `--force` option.

The console creates a special table in the mysql database that is used to keep track of which instance is communicating with the master. If you use the `--force` option, the console removes the rows in this table. The table is constructed with:

```
CREATE TABLE IF NOT EXISTS mysql.failover_console (host char(30), port char(10))
```

When the console starts, a row is inserted containing the hostname and port of the master. On startup, if a row matches these values, the console does not start. If you use the `--force` option, the row is deleted.

When running the utility using the `--daemon=nodetach` option, the `--pidfile` option can be omitted and is ignored if used in this context.

When using the external scripts, the following parameters are passed in the order shown.

For example, suppose you have a script named 'run_before.sh' and you specify that you want it executing before the failover is performed (using the `--exec-before` option). Further, let us assume the master MySQL Server is using port 3306 on the host ‘host1’ and the MySQL Server that becomes the new master is using port 3308 on host 'can_host2'. The script would therefore be invoked in the following manner.

```
% run_before.sh host1 3306 can_host2 3308
```

Table 5.3 External Script Parameters

MySQL Failover Option	Parameters Passed to External Script
`--exec-before`	master host, master port, candidate host, candidate port
`--exec-after`	new master host, new master port
`--exec-fail-check`	master host, master port
`--exec-post-failover` (no errors during failover)	old master host, old master port, new master host, new master port
`--exec-post-failover` (errors during failover)	old master host, old master port

EXAMPLES

To launch the utility, you must specify at a minimum the `--master` option and either the `--discover-slaves-login` option or the `--slaves` option. The `--discover-slaves-login` option can be used in conjunction with the `--slaves` option to specify a list of known slaves (or slaves that do not report their host and IP) and to discover any other slaves connected to the master.

An example of the user interface and some of the report views are shown in the following examples.

Note

The "GTID Executed Set" displays the first GTID listed in the `SHOW MASTER STATUS` view. If there are multiple GTIDs listed, the utility displays `[...]` to indicate there are additional GTIDs to view. You can view the complete list of GTIDs on the GTID display screens.

The default interface displays the replication health report like the following. In this example the log file is enabled. A sample startup command is shown below:

```
shell> mysqlfailover --master=root@localhost:3331 --discover-slaves-login=root --log=log.txt

MySQL Replication Monitor and Failover Utility
Failover Mode = auto     Next Interval = Mon Mar 19 15:56:03 2012

Master Information
------------------
Binary Log File   Position  Binlog_Do_DB  Binlog_Ignore_DB
mysql-bin.000001  571

GTID Executed Set
2A67DE00-2DA1-11E2-A711-00764F2BE90F:1-7 [...]

Replication Health Status
+------------+-------+---------+--------+------------+---------+
| host        | port  | role    | state  | gtid_mode  | health  |
+------------+-------+---------+--------+------------+---------+
| localhost  | 3331  | MASTER  | UP     | ON         | OK      |
| localhost  | 3332  | SLAVE   | UP     | ON         | OK      |
| localhost  | 3333  | SLAVE   | UP     | ON         | OK      |
| localhost  | 3334  | SLAVE   | UP     | ON         | OK      |
+------------+-------+---------+--------+------------+---------+
Q-quit R-refresh H-health G-GTID Lists U-UUIDs L-log entries
```

Press **Q** to exit the utility, **R** to refresh the current display, and **H** returns to the replication health report.

Press **G** key to show a GTID report similar to the following. The first page shown is the master's executed GTID set:

```

MySQL Replication Monitor and Failover Utility
Failover Mode = auto     Next Interval = Mon Mar 19 15:59:33 2012

Master Information
------------------
Binary Log File   Position  Binlog_Do_DB  Binlog_Ignore_DB
mysql-bin.000001  571

GTID Executed Set
2A67DE00-2DA1-11E2-A711-00764F2BE90F:1-7 [...]

Master GTID Executed Set
+--------------------------------------------+
| gtid                                       |
+--------------------------------------------+
| 2A67DE00-2DA1-11E2-A711-00764F2BE90F:1-7   |
| 5503D37E-2DB2-11E2-A781-8077D4C14B33:1-3   |
+--------------------------------------------+

Q-quit R-refresh H-health G-GTID Lists U-UUIDs L-log entries Up|Down-scroll
```

Continuing to press **G** key cycles through the three GTID lists.

If the list is longer than the screen permits as shown in the example above, the scroll up and down help is also shown. In this case, press the **down arrow** key to scroll down.

Press **U** to view the list of UUIDs used in the topology, for example:

```

MySQL Replication Monitor and Failover Utility
Failover Mode = auto     Next Interval = Mon Mar 19 16:02:34 2012

Master Information
------------------
Binary Log File   Position  Binlog_Do_DB  Binlog_Ignore_DB
mysql-bin.000001  571

GTID Executed Set
2A67DE00-2DA1-11E2-A711-00764F2BE90F:1-7 [...]

UUIDs
+------------+-------+---------+---------------------------------------+
| host       | port  | role    | uuid                                  |
+------------+-------+---------+---------------------------------------+
| localhost  | 3331  | MASTER  | 55c65a00-71fd-11e1-9f80-ac64ef85c961  |
| localhost  | 3332  | SLAVE   | 5dd30888-71fd-11e1-9f80-dc242138b7ec  |
| localhost  | 3333  | SLAVE   | 65ccbb38-71fd-11e1-9f80-bda8146bdb0a  |
| localhost  | 3334  | SLAVE   | 6dd6abf4-71fd-11e1-9f80-d406a0117519  |
+------------+-------+---------+---------------------------------------+
Q-quit R-refresh H-health G-GTID Lists U-UUIDs L-log entries
```

If, once the master is detected as down and failover mode is auto or elect and there are viable candidate slaves, the failover feature engages automatically and the user sees the failover messages appear. When failover is complete, the interface returns to monitoring replication health after 5 seconds. The following shows an example of failover occurring.:

```
Failover starting...
# Candidate slave localhost:3332 will become the new master.
# Preparing candidate for failover.
# Creating replication user if it does not exist.
# Stopping slaves.
# Performing STOP on all slaves.
# Switching slaves to new master.
# Starting slaves.
# Performing START on all slaves.
# Checking slaves for errors.
# Failover complete.
# Discovering slaves for master at localhost:3332

Failover console will restart in 5 seconds.
```

After the failover event, the new topology is shown in the replication health report.:

```
MySQL Replication Monitor and Failover Utility
Failover Mode = auto     Next Interval = Mon Mar 19 16:05:12 2012

Master Information
------------------
Binary Log File   Position  Binlog_Do_DB  Binlog_Ignore_DB
mysql-bin.000001  1117

GTID Executed Set
2A67DE00-2DA1-11E2-A711-00764F2BE90F:1-7 [...]

UUIDs
+------------+-------+---------+--------+------------+---------+
| host       | port  | role    | state  | gtid_mode  | health  |
+------------+-------+---------+--------+------------+---------+
| localhost  | 3332  | MASTER  | UP     | ON         | OK      |
| localhost  | 3333  | SLAVE   | UP     | ON         | OK      |
| localhost  | 3334  | SLAVE   | UP     | ON         | OK      |
+------------+-------+---------+--------+------------+---------+

Q-quit R-refresh H-health G-GTID Lists U-UUIDs L-log entries
```

Pressing **L** with the `--log` option specified causes the interface to show the entries in the log file, such as:

```
MySQL Replication Monitor and Failover Utility
Failover Mode = auto     Next Interval = Mon Mar 19 16:06:13 2012

Master Information
------------------
Binary Log File   Position  Binlog_Do_DB  Binlog_Ignore_DB
mysql-bin.000001  1117

GTID Executed Set
2A67DE00-2DA1-11E2-A711-00764F2BE90F:1-7 [...]

Log File
+-------------------------+----------------------------------------- ... --+
| Date                    | Entry                                    ...   |
+-------------------------+----------------------------------------- ... --+
| 2012-03-19 15:55:33 PM  | INFO Failover console started.           ...   |
| 2012-03-19 15:55:33 PM  | INFO Failover mode = auto.               ...   |
| 2012-03-19 15:55:33 PM  | INFO Getting health for master: localhos ...   |
| 2012-03-19 15:55:33 PM  | INFO Master status: binlog: mysql-bin.00 ...   |
+-------------------------+--------------------------------------- ... --+
Q-quit R-refresh H-health G-GTID Lists U-UUIDs L-log entries Up|Down-scroll\
```

PERMISSIONS REQUIRED

The user must have permissions to monitor the servers on the topology and configure replication to successfully perform the failover operation. Additional permissions are also required to register and unregister the running mysqlfailover instance on the master and slaves. Specifically, the login user must have the following privileges: SUPER, GRANT OPTION, REPLICATION SLAVE, RELOAD, DROP, CREATE, INSERT, and SELECT.

The referred permissions are required for the login users used for all servers (master, slaves and candidates).

5.10 `mysqlfrm` — File reader for .frm files.

The `mysqlfrm` utility is designed as a recovery tool that reads .frm files and produces equivalent *CREATE* statements from the table definition data found in the file. In most cases, the generated *CREATE* statement is usable for recreating the table on another server, or for extended diagnostics. However, some features are not saved in the .frm files and therefore are omitted. The exclusions include but are not limited to:

- foreign key constraints
- auto increment number sequences

The `mysqlfrm` utility has two modes of operation. The default mode is designed to spawn an instance of an installed server by referencing the base directory using the `--basedir` option, or by connecting to the server with the `--server` option. The process does not alter the original .frm file(s). This mode also requires the `--port` option to specify a port to use for the spawned server. It must be different than the port for the installed server and no other server must be using the port. The spawned server is shutdown and all temporary files removed after the .frm files are read.

A diagnostic mode is available by using the `--diagnostic` option. This switches the utility to read the .frm files byte-by-byte to recover as much information as possible. The diagnostic mode has additional limitations in that it cannot decipher character set or collation values without using an existing server installation specified with either the `--server` or `--basedir` option. This can also affect the size of the columns if the table uses multibyte characters. Use this mode when the default mode cannot read the file, or if a MySQL server is not installed on the host.

To read .frm files, list each file as a separate argument for the utility as shown in the following examples. You must specify the path for each .frm file you want to read or supply a path to a directory and all of the .frm files in that directory to be read.

You can specify the database name to be used in the resulting *CREATE* statement by adding the name of the database followed by a colon to the .frm filename. For example, oltp:t1.frm uses 'oltp' for the database name in the *CREATE* statement. The optional database name can also be used with paths. For example, */home/me/oltp:t1.frm* uses 'oltp' as the database name. If you leave off the optional database name and include a path, the last folder is the database name. For example */home/me/data1/t1.frm* uses 'data1' as the database name. If you do not want to use the last folder as the database name, simply specify the colon like this: */home/me/data1/:t1.frm*. In this case, the database is omitted from the CREATE statement.

OPTIONS

- --help

show the program's help page

- --license

  Display license information and exit.

- --basedir=`basedir`

  The base directory for the server installed. Use this or `--server` for the default mode.

- --diagnostic

  Turn on diagnostic mode to read .frm files byte-by-byte and generate best-effort *CREATE* statement.

- --new-storage-engine=`engine`

  Set the ENGINE= option for all .frm files read.

- --port=`port`

  The port to use for the spawned server in the default mode. Must be a free port. Required for default mode.

- --server=`server`

  Connection information for a server. Use this option or `--basedir` for the default mode. If provided with the diagnostic mode, the storage engine and character set information are validated against this server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : `login-path`[:`port`][:`socket`]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : `configuration-file-path`[:`section`]
  - Specify the data on the command-line (unencrypted, visible). Example : `user`[:`passwd`]@`host`[:`port`][:`socket`]

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --show-stats, -s

  Show file statistics and general table information for each .frm file read.

- --start-timeout=`timeout_in_seconds`

  Number of seconds to wait for spawned server to start. The default is 10 seconds.

- --user

  Execute the spawned server using this user account. Permits the execution of the utility as one user but the spawned server as another. Required if running the utility as the root user (e.g. su or sudo).

- --quiet

  Turn off all messages for quiet execution except *CREATE* statements and errors.

- --verbose, -v

  Control how much information is displayed. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug

- --version

  Show program's version number and exit

NOTES

Tables with certain storage engines cannot be read in the default mode. These include *PARTITION*, *PERFORMANCE_SCHEMA*. You must read these with the `--diagnostic` mode.

Use the `--diagnostic` mode for tables that fail to open correctly in the default mode or if there is no server installed on the host.

To change the storage engine in the *CREATE* statement generated for all .frm files read, use the `--new-storage-engine` option

To turn off all messages except the *CREATE* statement and warnings or errors, use the `--quiet` option.

Use the `--show-stats` option to see file statistics for each .frm file.

If you need to run the utility with elevated privileges, use the `--user` option to execute the spawned server using a normal user account.

If you encounter connection or similar errors when running in default mode, re-run the command with the `--verbose` option and view the output from the spawned server and repair any errors in launching the server. If `mysqlfrm` fails in the middle, you may need to manually shutdown the server on the port specified with `--port`.

EXAMPLES

The following example reads a single .frm file in the default mode from the current working directory using the server installed in `/usr/local/bin/mysql` and port 3333 for the spawned server. Notice the use of the *db:table.frm* format for specifying the database name for the table. The database name appears to the left of ':' and the .frm name to the right. In this case, we have database = test1 and table = city, so the `CREATE` statement reads `CREATE TABLE test1.city`.

```
shell> mysqlfrm --basedir=/usr/local/bin/mysql test1:city.frm --port=3333
# Starting the spawned server on port 3333 ... done.
# Reading .frm files
#
# Reading the city.frm file.
#
# CREATE statement for city.frm:
#

CREATE TABLE `test1`.`city` (
  `city_id` smallint(5) unsigned NOT NULL AUTO_INCREMENT,
  `city` varchar(50) NOT NULL,
  `country_id` smallint(5) unsigned NOT NULL,
  `last_update` timestamp NOT NULL DEFAULT CURRENT_TIMESTAMP ON UPDATE CURRENT_TIMESTAMP,
  PRIMARY KEY (`city_id`),
  KEY `idx_fk_country_id` (`country_id`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8

#...done.
```

The following demonstrates reading multiple .frm files in the default mode using a running server. The .frm files are located in different folders. Notice the use of the database name option for each of the files. The t1 file was given the database name temp1 since that is the folder in which it resides, t2 was given db1 since that was specified in the path, and t3 was not given a database name since we used the ':' without providing a database name.

```

shell> mysqlfrm --server=root:pass@localhost:3306 /mysql/data/temp1/t1.frm \
          /mysql/data/temp2/db1:t2.frm --port=3310
# Starting the spawned server on port 3333 ... done.
# Reading .frm files
#
#
# Reading the t1.frm file.
#
# CREATE statement for ./mysql-test/std_data/frm_files/t1.frm:
#

CREATE TABLE `temp1`.`t1` (
  `a` int(11) DEFAULT NULL
) ENGINE=MyISAM DEFAULT CHARSET=latin1

# Reading the t2.frm file.
#
# CREATE statement for ./mysql-test/std_data/frm_files/t2.frm:
#

CREATE TABLE `db1`.`t2` (
  `a` int(11) DEFAULT NULL
) ENGINE=MyISAM DEFAULT CHARSET=latin1

#
# Reading the t3.frm file.
#
# CREATE statement for ./mysql-test/std_data/frm_files/t3.frm:
#

CREATE TABLE `t3` (
  `a` int(11) DEFAULT NULL
) ENGINE=MyISAM DEFAULT CHARSET=latin1

#...done.
```

The following demonstrates running the utility in diagnostic mode to read all of the .frm files in a directory.

```
shell> mysqlfrm --diagnostic /mysql/data/sakila
# WARNING: Cannot generate character set or collation names without the --server option.
# CAUTION: The diagnostic mode is a best-effort parse of the .frm file. As such, it may not identify all o
# Reading .frm file for /mysql/data/sakila/city.frm:
# The .frm file is a TABLE.
# CREATE TABLE Statement:

CREATE TABLE `city` (
  `city_id` smallint(5) unsigned NOT NULL AUTO_INCREMENT,
  `city` varchar(150) NOT NULL,
  `country_id` smallint(5) unsigned NOT NULL,
  `last_update` timestamp NOT NULL DEFAULT CURRENT_TIMESTAMP ON UPDATE CURRENT_TIMESTAMP,
PRIMARY KEY `PRIMARY` (`city_id`),
KEY `idx_fk_country_id` (`country_id`)
) ENGINE=InnoDB;

#...done.
```

PERMISSIONS REQUIRED

The permissions for using `mysqlfrm` vary and depend entirely on how you use it. If you use the utility to read .frm files in a protected folder like the example above (in either mode), you must have the ability to run the spawned server with privileges that allow you to read the protected files. For example, you could use a user account that has root-level privileges.

If you use the utility with a server connection, the user you use to connect must have the ability to read system variables at a minimum including read access to the mysql database.

Note

You should never use the root user to spawn the server nor should you use the mysql user when spawning the server or running the utility.

5.11 `mysqlindexcheck` — Identify Potentially Redundant Table Indexes

This utility reads the indexes for one or more tables and identifies duplicate and potentially redundant indexes.

To check all tables in a database, only specify the database name. To check a specific table, name the table in *db.table* format. It is possible to mix database and table names.

You can scan tables in any database except the internal databases **mysql**, **INFORMATION_SCHEMA**, and **performance_schema**.

Depending on the index type, the utility applies the following rules to compare indexes (designated as `idx_a` and `idx_b`):

- **BTREE**

  `idx_b` is redundant to `idx_a` if and only if all the columns from `idx_b` are a prefix of `idx_a`. Order and uniqueness count.

- **HASH**

  `idx_a` and `idx_b` are redundant if they are duplicates, i.e. if and only if they contain the same columns in the same order.

- **SPATIAL**

  `idx_a` and `idx_b` are duplicates if and only if they contain the same column (only one column is permitted).

- **FULLTEXT**

  `idx_b` is redundant to `idx_a` if and only if all columns in `idx_b` are included in `idx_a`. Order does not count.

To see `DROP` statements drop redundant indexes, specify the `--show-drops` option. To examine the existing indexes, use the `--verbose` option, which prints the equivalent **CREATE INDEX** (or **ALTER TABLE**) for primary keys.

To display the best or worst non-primary key indexes for each table, use the `--best` or `--worst` option. This causes the output to show the best or worst indexes from tables with 10 or more rows. By default, each option shows five indexes. To override that, provide an integer value for the option.

To change the format of the index lists displayed for the `--show-indexes`, `--best`, and `--worst` options, use one of the following values with the `--format` option:

- **grid** (default)

  Display output in grid or table format like that of the `mysql` client command-line tool.

- **csv**

  Display output in comma-separated values format.

- **tab**

  Display output in tab-separated format.

- **sql**

  Print SQL statements rather than a list.

- **vertical**

  Display output in single-column format like that of the `\G` command for the `mysql` client command-line tool.

Note

The `--best` and `--worst` lists cannot be printed as SQL statements.

OPTIONS

`mysqlindexcheck` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --best[=*N*]

  If `--stats` is given, limit index statistics to the best *N* indexes. The default value of *N* is 5 if omitted.

- --format=*`index_format`*, -f*`index_format`*

  Specify the index list display format for output produced by `--stats`. Permitted format values are **grid**, **csv**, **tab**, **sql**, and **vertical**. The default is **grid**.

- --report-indexes, -r

  Reports if a table has neither UNIQUE indexes nor a PRIMARY key.

- --server=*`source`*

  Connection information for the server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]

  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]

  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --show-drops, -d

  Display **DROP** statements for dropping indexes.

- --show-indexes, -i

  Display indexes for each table.

- --skip, -s

  Skip tables that do not exist.

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --stats

  Show index performance statistics.

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

- --worst[=*N*]

  If `--stats` is also passed in, limit index statistics to the worst *N* indexes. The default value of *N* is 5, if omitted.

NOTES

You must provide connection parameters (user, host, password, and so forth) for an account that has the appropriate privileges to read all objects accessed during the operation.

For the `--format` option, the permitted values are not case sensitive. In addition, values may be specified as any unambiguous prefix of a valid value. For example, `--format=g` specifies the grid format. An error occurs if a prefix matches more than one valid value.

The path to the MySQL client tools should be included in the `PATH` environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the `my_print_defaults` tools which is required to read the login-path values from the login configuration file (`.mylogin.cnf`).

EXAMPLES

To check all tables in the `employees` database on the local server to see the possible redundant and duplicate indexes, use this command:

```
shell> mysqlindexcheck --server=root@localhost employees
# Source on localhost: ... connected.
# The following indexes are duplicates or redundant \
  for table employees.dept_emp:
#
CREATE INDEX emp_no ON employees.dept_emp (emp_no) USING BTREE
#     may be redundant or duplicate of:
ALTER TABLE employees.dept_emp ADD PRIMARY KEY (emp_no, dept_no)
# The following indexes are duplicates or redundant \
  for table employees.dept_manager:
#
CREATE INDEX emp_no ON employees.dept_manager (emp_no) USING BTREE
#     may be redundant or duplicate of:
ALTER TABLE employees.dept_manager ADD PRIMARY KEY (emp_no, dept_no)
# The following indexes are duplicates or redundant \
  for table employees.salaries:
#
CREATE INDEX emp_no ON employees.salaries (emp_no) USING BTREE
#     may be redundant or duplicate of:
ALTER TABLE employees.salaries ADD PRIMARY KEY (emp_no, from_date)
# The following indexes are duplicates or redundant \
  for table employees.titles:
#
CREATE INDEX emp_no ON employees.titles (emp_no) USING BTREE
```

```
#     may be redundant or duplicate of:
ALTER TABLE employees.titles ADD PRIMARY KEY (emp_no, title, from_date)
```

PERMISSIONS REQUIRED

Regarding the privileges needed to run this utility, the user needs SELECT privilege on the mysql database as well as for the databases which tables are being checked.

5.12 `mysqlmetagrep` — Search Database Object Definitions

This utility searches for objects matching a given pattern on all the servers specified using instances of the `--server` option. It produces output that displays the matching objects. By default, the first non-option argument is taken to be the pattern unless the `--pattern` option is given. If the `--pattern` option is given, then all non-option arguments are treated as connection specifications.

Internally, the utility generates an SQL statement for searching the necessary tables in the **INFORMATION_SCHEMA** database on the designated servers, and then executes it before collecting the result and printing it as a table. Use the `--sql` option to have `mysqlmetagrep` display the statement, rather than execute it. This can be useful if you want to feed the output of the statement to another application, such as the `mysql` client command-line tool.

The MySQL server supports two forms of patterns when matching strings: SQL Simple Patterns (used with the **LIKE** operator) and POSIX Regular Expressions (used with the **REGEXP** operator).

By default, the utility uses the **LIKE** operator to match the name (and optionally, the body) of objects. To use the **REGEXP** operator instead, use the `--regexp` option.

Note

Because the **REGEXP** operator does substring searching, it is necessary to anchor the expression to the beginning of the string if you want to match the beginning of the string.

To specify how to display output, use one of the following values with the `--format` option:

- **grid** (default)

  Display output in grid or table format like that of the `mysql` client command-line tool.

- **csv**

  Display output in comma-separated values format.

- **tab**

  Display output in tab-separated format.

- **vertical**

  Display output in single-column format like that of the `\G` command for the `mysql` client command-line tool.

SQL Simple Patterns

The simple patterns defined by the SQL standard consist of a string of characters with two characters that have special meaning: `%` (percent) matches zero or more characters, and `_` (underscore) matches exactly one character.

For example:

- `'john%'`

  Match any string that starts with 'john'.

- `'%doe%'`

  Match any string containing the word 'doe'.

- `'%_'`

  Match any string consisting of one or more characters.

POSIX Regular Expressions

POSIX regular expressions are more powerful than the simple patterns defined in the SQL standard. A regular expression is a string of characters, optionally containing characters with special meaning.

Documenting these regular expressions goes beyond the scope of this manual, but the full syntax is described in the MySQL manual and other locations, such as executing 'man regex' in your terminal.

- **.**

  Match any character.

- **^**

  Match the beginning of a string.

- **$**

  Match the end of a string.

- **[axy]**

  Match **a**, **x**, or **y**.

- **[a-f]**

  Match any character in the range **a** to **f** (that is, **a**, **b**, **c**, **d**, **e**, or **f**).

- **[^axy]**

  Match any character *except* **a**, **x**, or **y**.

- **a***

  Match a sequence of zero or more **a**.

- **a+**

  Match a sequence of one or more **a**.

- **a?**

  Match zero or one **a**.

- **ab|cd**

Match **ab** or **cd**.

- **a{5}**

  Match five instances of **a**.

- **a{2,5}**

  Match from two to five instances of **a**.

- **(abc)+**

  Match one or more repetitions of **abc**.

OPTIONS

`mysqlmetagrep` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --body, -b

  Search the body of stored programs (procedures, functions, triggers, and events). The default is to match only the name.

- --character-set=*`charset`*

  Sets the client character set. The default is retrieved from the server variable `character_set_client`.

- --database=*`pattern`*

  Look only in databases matching this pattern.

- --format=*`format`*, -f*`format`*

  Specify the output display format. Permitted format values are **grid** (default), **csv**, **tab**, and **vertical**.

- --object-types=*`types`*, --search-objects=*`types`*

  Search only the object types named in *types*, which is a comma-separated list of one or more of the values **database**, **trigger**, **user**, **routine**, **column**, **table**, **partition**, **event** and **view**.

  The default is to search in objects of all types.

- --pattern=*`pattern`*, -e=*`pattern`*

  The pattern to use when matching. This is required when the first non-option argument looks like a connection specification rather than a pattern.

  If the `--pattern` option is given, the first non-option argument is treated as a connection specifier, not as a pattern.

- --regexp, --basic-regexp, -G

  Perform pattern matches using the **REGEXP** operator. The default is to use **LIKE** for matching. This affects the `--database` and `--pattern` options.

- --server=*`source`*

  Connection information for a server. Use this option multiple times to search multiple servers.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]

  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]

  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --sql, --print-sql, -p

  Print rather than executing the SQL code that would be executed to find all matching objects. This can be useful to save the statement for later execution or to use it as input for other programs.

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --version

  Display version information and exit.

NOTES

For the `--format` option, the permitted values are not case sensitive. In addition, values may be specified as any unambiguous prefix of a valid value. For example, `--format=g` specifies the grid format. An error occurs if a prefix matches more than one valid value.

The path to the MySQL client tools should be included in the `PATH` environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the `my_print_defaults` tools which is required to read the login-path values from the login configuration file (`.mylogin.cnf`).

EXAMPLES

Find all objects with a name that matches the pattern `'t_'` (the letter **t** followed by any single character):

```
shell> mysqlmetagrep --pattern="t_" --server=john@localhost
+------------------------+-------------+-------------+-----------+
| Connection             | Object Type | Object Name | Database  |
+------------------------+-------------+-------------+-----------+
| john:*@localhost:3306  | TABLE       | t1          | test      |
| john:*@localhost:3306  | TABLE       | t2          | test      |
| john:*@localhost:3306  | TABLE       | tm          | test      |
+------------------------+-------------+-------------+-----------+
```

To find all object that contain `'t2'` in the name or the body (for routines, triggers, and events):

```
shell> mysqlmetagrep -b --pattern="%t2%" --server=john@localhost:3306
+------------------------+-------------+-------------+-----------+
| Connection             | Object Type | Object Name | Database  |
+------------------------+-------------+-------------+-----------+
| john:*@localhost:3306  | TRIGGER     | tr_foo      | test      |
| john:*@localhost:3306  | TABLE       | t2          | test      |
+------------------------+-------------+-------------+-----------+
```

In the preceding output, the trigger name does not match the pattern, but is displayed because its body does.

This is the same as the previous example, but using the **REGEXP** operator. Note that in the pattern it is not necessary to add wildcards before or after t2:

```
shell> mysqlmetagrep -Gb --pattern="t2" --server=john@localhost

+------------------------+-------------+-------------+-----------+
| Connection             | Object Type | Object Name | Database  |
+------------------------+-------------+-------------+-----------+
| root:*@localhost:3306  | TRIGGER     | tr_foo      | test      |
| root:*@localhost:3306  | TABLE       | t2          | test      |
+------------------------+-------------+-------------+-----------+
```

PERMISSIONS REQUIRED

The user must have the SELECT privilege on the mysql database.

5.13 `mysqlprocgrep` — Search Server Process Lists

This utility scans the process lists for the servers specified using instances of the `--server` option and selects those that match the conditions specified using the `--age` and `--match-xxx` options. For a process to match, all conditions given must match. The utility then either prints the selected processes (the default) or executes certain actions on them.

If no `--age` or `--match-xxx` options are given, the utility selects all processes.

The `--match-xxx` options correspond to the columns in the **INFORMATION_SCHEMA.PROCESSLIST** table. For example, `--match-command` specifies a matching condition for **PROCESSLIST.COMMAND** column values. There is no `--match-time` option. To specify a condition based on process time, use `--age`.

Processes that can be seen and killed are subject to whether the account used to connect to the server has the **PROCESS** and **SUPER** privileges. Without **PROCESS**, the account cannot see processes belonging to other accounts Without **SUPER**, the account cannot kill processes belonging to other accounts

To specify how to display output, use one of the following values with the `--format` option:

- **grid** (default)

  Display output in grid or table format like that of the `mysql` client command-line tool.

- **csv**

  Display output in comma-separated values format.

- **tab**

  Display output in tab-separated format.

- **vertical**

  Display output in single-column format like that of the `\G` command for the `mysql` client command-line tool.

Options

`mysqlprocgrep` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --age=*`time`*

  Select only processes that have been in the current state more than a given time. The time value can be specified in two formats: either using the `hh:mm:ss` format, with hours and minutes optional, or as a sequence of numbers with a suffix giving the period size.

  The permitted suffixes are **s** (second), **m** (minute), **h** (hour), **d** (day), and **w** (week). For example, **4h15m** represents 4 hours and 15 minutes.

  For both formats, the specification can optionally be preceded by `+` or `-`, where `+` means older than the given time, and `-` means younger than the given time.

- --character-set=*`charset`*

  Sets the client character set. The default is retrieved from the server variable `character_set_client`.

- --format=*`format`*, -f*`format`*

  Specify the output display format. Permitted format values are **grid** (default), **csv**, **tab**, and **vertical**.

- --kill-connection

  Kill the connection for all matching processes (like the `KILL CONNECTION` statement).

- --kill-query

Kill the query for all matching processes (like the `KILL QUERY` statement).

- --match-command=*`pattern`*

  Match all processes where the **Command** field matches the pattern.

- --match-db=*`pattern`*

  Match all processes where the **Db** field matches the pattern.

- --match-host=*`pattern`*

  Match all processes where the **Host** field matches the pattern.

- --match-id=*`pattern`*

  Match all processes where the **ID** field matches the pattern.

- --match-info=*`pattern`*

  Match all processes where the **Info** field matches the pattern.

- --match-state=*`pattern`*

  Match all processes where the **State** field matches the pattern.

- --match-user=*`pattern`*

  Match all processes where the **User** field matches the pattern.

- --print

  Print information about the matching processes. This is the default if no `--kill-connection` or `--kill-query` option is given. If a kill option is given, `--print` prints information about the processes before killing them.

- --regexp, --basic-regexp, -G

  Perform pattern matches using the **REGEXP** operator. The default is to use **LIKE** for matching. This affects the `--match-xxx` options.

- --server=*`source`*

  Connection information for a server. Use this option multiple times to search multiple servers.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]

  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]

  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --sql, --print-sql, -Q

  Instead of displaying the selected processes, emit the **SELECT** statement that retrieves information about them. If the `--kill-connection` or `--kill-query` option is given, the utility generates a stored procedure named `kill_processes()` for killing the queries rather than a **SELECT** statement.

- --sql-body

  Like `--sql`, but produces the output as the body of a stored procedure without the **CREATE PROCEDURE** part of the definition. This could be used, for example, to generate an event for the server Event Manager.

  When used with a kill option, code for killing the matching queries is generated. Note that it is not possible to execute the emitted code unless it is put in a stored routine, event, or trigger. For example, the following code could be generated to kill all idle connections for user `www-data`:

```
shell> mysqlprocgrep --kill-connection --sql-body \
          --match-user=www-data --match-state=sleep

DECLARE kill_done INT;
DECLARE kill_cursor CURSOR FOR
  SELECT
        Id, User, Host, Db, Command, Time, State, Info
      FROM
        INFORMATION_SCHEMA.PROCESSLIST
      WHERE
          user LIKE 'www-data'
        AND
          State LIKE 'sleep'
OPEN kill_cursor;
BEGIN
   DECLARE id BIGINT;
   DECLARE EXIT HANDLER FOR NOT FOUND SET kill_done = 1;
   kill_loop: LOOP
      FETCH kill_cursor INTO id;
      KILL CONNECTION id;
   END LOOP kill_loop;
END;
CLOSE kill_cursor;
```

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

NOTES

For the `--format` option, the permitted values are not case sensitive. In addition, values may be specified as any unambiguous prefix of a valid value. For example, `--format=g` specifies the grid format. An error occurs if a prefix matches more than one valid value.

The path to the MySQL client tools should be included in the `PATH` environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the `my_print_defaults` tools which is required to read the login-path values from the login configuration file (`.mylogin.cnf`).

EXAMPLES

For each example, assume that the `root` user on `localhost` has sufficient privileges to kill queries and connections.

Kill all queries created by user `john` that are less than 1 minute:

```
shell> mysqlprocgrep --server=root@localhost \
          --match-user=john --age=-1m --kill-query
```

Kill all connections that have been idle for more than 1 hour:

```
shell> mysqlprocgrep --server=root@localhost \
          --match-command=sleep --age=1h --kill-connection
```

PERMISSIONS REQUIRED

The user must have the SELECT privilege on the mysql database.

5.14 `mysqlreplicate` — Set Up and Start Replication Between Two Servers

This utility permits an administrator to setup and start replication from one server (the master) to another (the slave). The user provides login information for the slave and connection information for connecting to the master. It is also possible to specify a database to be used to test replication.

The utility reports conditions where the storage engines on the master and the slave differ for older versions of the server. It also reports a warning if the InnoDB storage engine type (plugin verus built-in) differs on the master and slave. For InnoDB to be the same, both servers must be running the same "type" of InnoDB (built-in or the InnoDB Plugin), and InnoDB on both servers must have the same major and minor version numbers and enabled state.

By default, the utility issues warnings for mismatches between the sets of storage engines, the default storage engine, and the InnoDB storage engine. To produce errors instead, use the `--pedantic` option, which requires storage engines to be the same on the master and slave.

The `-vv` option displays any discrepancies between the storage engines and InnoDB values, with or without the `--pedantic` option.

Replication can be started using one of the following strategies.

- Start from the current position (default)

  Start replication from the current master binary log file and position. The utility uses the `SHOW MASTER STATUS` statement to retrieve this information.

- Start from the beginning

  Start replication from the first event recorded in the master binary log. To do this, use the `--start-from-beginning` option.

- Start from a binary log file

  Start replication from the first event in a specific master binary log file. To do this, use the `--master-log-file` option.

- Start from a specific event

  Start replication from specific event coordinates (specific binary log file and position). To do this, use the `--master-log-file` and `--master-log-pos` options.

OPTIONS

`mysqlreplicate` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --master=*`master`*

  Connection information for the master server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]

  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]

  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

  - login-path (.mylogin.cnf) : *`login-path`*[:*`port`*][:*`socket`*]

  - Configuration file : *`configuration-file-path`*[:*`section`*]

  - Command-line : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --master-log-file=*`master_log_file`*

Begin replication from the beginning of this master log file.

- --master-log-pos=*`master_log_pos`*

  Begin replication from this position in the master log file. This option is not valid unless `--master-log-file` is given.

- --pedantic, -p

  Fail if both servers do not have the same set of storage engines, the same default storage engine, and the same InnoDB storage engine.

- --rpl-user=*`replication_user`*

  The user and password for the replication user, in the format: *`user`*[:*`password`*] or *`login-path`*.

- --slave=*`slave`*

  Connection information for the slave server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --start-from-beginning, -b

  Start replication at the beginning of events logged in the master binary log. This option is not valid unless both `--master-log-file` and `--master-log-pos` are given.

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --test-db=*`test_database`*

The database name to use for testing the replication setup. If this option is not given, no testing is done, only error checking.

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

NOTES

The login user for the master server must have the appropriate permissions to grant access to all databases, and have the ability to create user accounts. For example, the user account used to connect to the master must have the **WITH GRANT OPTION** privilege.

The server IDs on the master and slave must be nonzero and unique. The utility reports an error if the server ID is 0 on either server or the same on the master and slave. Set these values before starting this utility.

Mixing IP and hostnames is not recommended. The replication-specific utilities attempt to compare hostnames and IP addresses as aliases for checking slave connectivity to the master. However, if your installation does not support reverse name lookup, the comparison could fail. Without the ability to do a reverse name lookup, the replication utilities could report a false negative that the slave is (not) connected to the master.

For example, if you setup replication using "MASTER_HOST=ubuntu.net" on the slave and later connect to the slave with `mysqlrplcheck` and have the master specified as "--master=192.168.0.6" using the valid IP address for "ubuntu.net", you must have the ability to do a reverse name lookup to compare the IP (192.168.0.6) and the hostname (ubuntu.net) to determine if they are the same machine.

The path to the MySQL client tools should be included in the `PATH` environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the `my_print_defaults` tools which is required to read the login-path values from the login configuration file (`.mylogin.cnf`).

EXAMPLES

To set up replication between two MySQL instances running on different ports of the same host using the default settings, use this command:

```
shell> mysqlreplicate --master=root@localhost:3306 \
          --slave=root@localhost:3307 --rpl-user=rpl:rpl
# master on localhost: ... connected.
# slave on localhost: ... connected.
# Checking for binary logging on master...
# Setting up replication...
# ...done.
```

The following command uses `--pedantic` to ensure that replication between the master and slave is successful if and only if both servers have the same storage engines available, the same default storage engine, and the same InnoDB storage engine:

```
shell> mysqlreplicate --master=root@localhost:3306 \
          --slave=root@localhost:3307 --rpl-user=rpl:rpl -vv --pedantic
# master on localhost: ... connected.
# slave on localhost: ... connected.
# master id = 2
#  slave id = 99
# Checking InnoDB statistics for type and version conflicts.
# Checking storage engines...
# Checking for binary logging on master...
# Setting up replication...
# Flushing tables on master with read lock...
# Connecting slave to master...
# CHANGE MASTER TO MASTER_HOST = [...omitted...]
# Starting slave...
# status: Waiting for master to send event
# error: 0:
# Unlocking tables on master...
# ...done.
```

The following command starts replication from the current position of the master (which is the default):

```
shell> mysqlreplicate --master=root@localhost:3306 \
          --slave=root@localhost:3307 --rpl-user=rpl:rpl
 # master on localhost: ... connected.
 # slave on localhost: ... connected.
 # Checking for binary logging on master...
 # Setting up replication...
 # ...done.
```

The following command starts replication from the beginning of recorded events on the master:

```
shell> mysqlreplicate --master=root@localhost:3306 \
     --slave=root@localhost:3307 --rpl-user=rpl:rpl \
     --start-from-beginning
 # master on localhost: ... connected.
 # slave on localhost: ... connected.
 # Checking for binary logging on master...
 # Setting up replication...
 # ...done.
```

The following command starts replication from the beginning of a specific master binary log file:

```
shell> mysqlreplicate --master=root@localhost:3306 \
          --slave=root@localhost:3307 --rpl-user=rpl:rpl \
          --master-log-file=my_log.000003
 # master on localhost: ... connected.
 # slave on localhost: ... connected.
 # Checking for binary logging on master...
 # Setting up replication...
 # ...done.
```

The following command starts replication from specific master binary log coordinates (specific log file and position):

```
shell> mysqlreplicate --master=root@localhost:3306 \
          --slave=root@localhost:3307 --rpl-user=rpl:rpl \
          --master-log-file=my_log.000001 --master-log-pos=96
 # master on localhost: ... connected.
 # slave on localhost: ... connected.
 # Checking for binary logging on master...
 # Setting up replication...
# ...done.
```

RECOMMENDATIONS

You should set `read_only=1` in the `my.cnf` file for the slave to ensure that no accidental data changes, such as **INSERT**, **DELETE**, **UPDATE**, and so forth, are permitted on the slave other than those produced by events read from the master.

Use the `--pedantic` and `-vv` options for setting up replication on production servers to avoid possible problems with differing storage engines.

PERMISSIONS REQUIRED

The users on the master need the following privileges: SELECT and INSERT privileges on mysql database, REPLICATION SLAVE, REPLICATION CLIENT and GRANT OPTION. The slave users need the SUPER privilege. The repl user, used as the argument for the `--rpl-user` option, is either created automatically or if it exists, it needs the REPLICATION SLAVE privilege.

5.15 `mysqlrplms` — Set Up and Start Replication from a Slave to Multiple Masters

This utility permits a user to start replication from multiple master servers (also called multi-source replication) to a single slave. The user provides login information for the slave and each of the masters.

The utility reports conditions where the storage engines on the masters and the slave differ. It also reports a warning if the InnoDB storage engine differs on the master and slave. For InnoDB to be the same, both servers must be running the same "type" of InnoDB (built-in or the InnoDB Plugin), and InnoDB on both servers must have the same major and minor version numbers and enabled state. By default, the utility issues warnings for mismatches between the sets of storage engines, the default storage engine, and the InnoDB storage engine.

The `-vv` option displays any discrepancies between the storage engines and InnoDB values.

A round-robin scheduling is used to setup replication among the masters and slave.

The mysqlrplms utility follows these assumptions:

- All servers must have GTIDs enabled.
- There are no conflicts between transactions from different masters. For example, there are no updates to the same object from multiple masters.
- Replication is asynchronous.

OPTIONS

`mysqlrplms` accepts the following command-line options:

- --daemon=*`command`*

  Run as a daemon. The *`command`* can be `start` (start daemon), `stop` (stop daemon), `restart` (stop then start the daemon) or `nodetach` (start but do not detach the process). This option is only available for POSIX systems.

- --format=*`format`*, -f *`format`*

Display the replication health output in either grid (default), tab, csv, or vertical format.

- --help

  Display a help message and exit.

- --interval=*seconds*, -i *seconds*

  Interval in seconds for reporting health. Default = 15 seconds. Minimum is 5 seconds.

- --license

  Display license information and exit.

- --log=*log_file*

  Specify a log file to use for logging messages

- --log-age=*days*

  Specify maximum age of log entries in days. Entries older than this are purged on startup. Default = 7 days.

- --masters=*master connections*

  Connection information for master servers. List multiple masters in comma-separated list.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *login-path*[:*port*][:*socket*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *configuration-file-path*[:*section*]
  - Specify the data on the command-line (unencrypted, visible). Example : *user*[:*passwd*]@*host*[:*port*][:*socket*]

- --report-values=*report_values*

  Report values used in mysqlrplms. It can be health, gtid or uuid. Multiple values can be used separated by commas.

  - health

    Display the replication health of the topology.

  - gtid

    Display the master's list of executed GTIDs, contents of the GTID variables; `@@GLOBAL.GTID_EXECUTED`, `@@GLOBAL.GTID_PURGED` and `@@GLOBAL.GTID_OWNED`.

  - uuid

    Display universally unique identifiers (UUIDs) for all servers.

Default = health.

- --rpl-user=*replication_user*

  The user and password for the replication user, in the format: *user*[:*password*] or *login-path*.

- --slave=*slave*

  Connection information for the slave server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *login-path*[:*port*][:*socket*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *configuration-file-path*[:*section*]
  - Specify the data on the command-line (unencrypted, visible). Example : *user*[:*passwd*]@*host*[:*port*][:*socket*]

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --start-from-beginning, -b

  Start replication at the beginning of events logged in the master binary log.

- --switchover-interval=*seconds*

  Interval in seconds for switching masters. Default = 60 seconds. Minimum is 30 seconds.

- --pidfile=*pidfile*

  Pidfile for running mysqlrplms as a daemon. This file contains the PID (process identifier), that uniquely identify a process. It is needed to identify and control the process forked by mysqlrplms.

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

NOTES

The login user for the master servers must have the appropriate permissions to grant access to all databases, and have the ability to create user accounts. For example, the user accounts used to connect to each of the masters must have the **WITH GRANT OPTION** privilege.

The server IDs on the masters and slave must be nonzero and unique. The utility reports an error if the server ID is 0 on either server or the same on the masters and slave. Set these values before starting this utility.

Mixing IP and hostnames is not recommended. The replication-specific utilities attempts to compare hostnames and IP addresses as aliases for checking slave connectivity to the master. However, if your installation does not support reverse name lookup, the comparison could fail. Without the ability to do a reverse name lookup, the replication utilities could report a false negative that the slave is (not) connected to the master.

The path to the MySQL client tools should be included in the `PATH` environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the `my_print_defaults` tools which is required to read the login-path values from the login configuration file (`.mylogin.cnf`).

Due to a known server issue, there are some limitations with the use of temporary tables with multi-source replication. In order to avoid problems, we recommend the execution of all statements for a temporary table in a single transaction. See Replication and Temporary Tables, for more information.

EXAMPLES

To set up multi-source replication among two masters and a slave, running on different ports of the same host using the default settings, use this command:

```
shell> mysqlrplms --slave=root:root@localhost:3306 \
       --masters=root:root@localhost:3307,root:root@localhost:3308
# Starting multi-source replication...
# Press CTRL+C to quit.
# Switching to master 'localhost:3307'.
# master on localhost: ... connected.
# slave on localhost: ... connected.
#
# Current Master Information:
+--------------------+-----------+---------------+-------------------+
| Binary Log File    | Position  | Binlog_Do_DB  | Binlog_Ignore_DB  |
+--------------------+-----------+---------------+-------------------+
| clone-bin.000001   | 594       | N/A           | N/A               |
+--------------------+-----------+---------------+-------------------+
# GTID Executed Set: 00a4e027-a83a-11e3-8bd6-28d244017f26:1-2
#
# Health Status:
+------------+-------+---------+--------+------------+---------+
| host       | port  | role    | state  | gtid_mode  | health  |
+------------+-------+---------+--------+------------+---------+
| localhost  | 3307  | MASTER  | UP     | ON         | OK      |
| localhost  | 3306  | SLAVE   | UP     | ON         | OK      |
| localhost  | 3308  | MASTER  | UP     | ON         | OK      |
+------------+-------+---------+--------+------------+---------+
#
```

```
(...)
```

The following command uses --report-values to report health, GTID and UUID status:

```
shell> mysqlrplms --slave=root:root@localhost:3306 \
       --masters=root:root@localhost:3307,root:root@localhost:3308\n
       --report-values=health,gtid,uuid
# Starting multi-source replication...
# Press CTRL+C to quit.
# Switching to master 'localhost:3307'.
# master on localhost: ... connected.
# slave on localhost: ... connected.
#
# Current Master Information:
+-------------------+-----------+--------------+-------------------+
| Binary Log File   | Position  | Binlog_Do_DB  | Binlog_Ignore_DB  |
+-------------------+-----------+--------------+-------------------+
| clone-bin.000001  | 594       | N/A           | N/A               |
+-------------------+-----------+--------------+-------------------+
# GTID Executed Set: 00a4e027-a83a-11e3-8bd6-28d244017f26:1-2
#
# Health Status:
+------------+-------+---------+--------+------------+---------+
| host       | port  | role    | state  | gtid_mode  | health  |
+------------+-------+---------+--------+------------+---------+
| localhost  | 3307  | MASTER  | UP     | ON         | OK      |
| localhost  | 3306  | SLAVE   | UP     | ON         | OK      |
| localhost  | 3308  | MASTER  | UP     | ON         | OK      |
+------------+-------+---------+--------+------------+---------+
#
# GTID Status - Transactions executed on the servers:
+------------+-------+---------+-------------------------------------------+
| host       | port  | role    | gtid                                      |
+------------+-------+---------+-------------------------------------------+
| localhost  | 3307  | MASTER  | 00a4e027-a83a-11e3-8bd6-28d244017f26:1-2  |
| localhost  | 3306  | SLAVE   | 00a4e027-a83a-11e3-8bd6-28d244017f26:1-2  |
| localhost  | 3306  | SLAVE   | faf0874f-a839-11e3-8bd6-28d244017f26:1    |
+------------+-------+---------+-------------------------------------------+
#
# UUID Status:
+------------+-------+---------+---------------------------------------+
| host       | port  | role    | uuid                                  |
+------------+-------+---------+---------------------------------------+
| localhost  | 3307  | MASTER  | 00a4e027-a83a-11e3-8bd6-28d244017f26  |
| localhost  | 3306  | SLAVE   | faf0874f-a839-11e3-8bd6-28d244017f26  |
+------------+-------+---------+---------------------------------------+
#
(...)
```

Start multi-source replication running as a daemon (POSIX only):

```
shell> mysqlrplms --slave=root:root@localhost:3306 \
       --masters=root:root@localhost:3307,root:root@localhost:3308 \
       --log=rplms_daemon.log --pidfile=rplms_daemon.pid --daemon=start
```

Restart multi-source replication running as a daemon:

```
shell> mysqlrplms --slave=root:root@localhost:3306 \
       --masters=root:root@localhost:3307,root:root@localhost:3308 \
       --log=rplms_daemon.log --pidfile=rplms_daemon.pid --daemon=restart
```

Stop multi-source replication running as a daemon:

```
shell> mysqlrplms --slave=root:root@localhost:3306 \
       --masters=root:root@localhost:3307,root:root@localhost:3308 \
       --log=rplms_daemon.log --pidfile=rplms_daemon.pid --daemon=stop
```

RECOMMENDATIONS

You should set `read_only=1` in the `my.cnf` file for the slave to ensure that no accidental data changes, such as **INSERT**, **DELETE**, **UPDATE**, and so forth, are permitted on the slave other than those produced by events read from the master.

PERMISSIONS REQUIRED

The users on the masters need the following privileges: SELECT and INSERT privileges on mysql database, REPLICATION SLAVE, REPLICATION CLIENT and GRANT OPTION. The slave users need the SUPER privilege. The rpl user, used as the argument for the `--rpl-user` option, is either created automatically or if it exists, it needs the REPLICATION SLAVE privilege.

5.16 `mysqlrpladmin` — Administration utility for MySQL replication

This utility permits users to perform administrative actions on a replication topology consisting of a single master and its slaves. The utility is designed to make it easy to recover from planned maintenance of the master, or from an event that takes the master offline unexpectedly.

The act of taking the master offline intentionally and switching control to another slave is called switchover. In this case, there is no loss of transactions as the master is locked and all slaves are allowed to catch up to the master. Once the slaves have read all events from the master, the master is shutdown and control switched to a slave (in this case called a candidate slave).

Recovering from the loss of a downed master is more traumatic and since there is no way to know what transactions the master may have failed to send, the new master (called a candidate slave) must be the slave that is most up-to-date. How this is determined depends on the version of the server (see below). However, it can result in the loss of some transactions that were executed on the downed master but not sent to the slaves.

The utility accepts a list of slaves to be considered the candidate slave. If no slave is found to meet the requirements, the operation searches the list of known slaves.

Detection of a downed master is performed as follows. If the connection to the master is lost, wait `--ping` seconds and check again. If the master connection is lost and the master cannot be pinged or reconnected, the failover event occurs.

For all commands that require specifying multiple servers, the options require a comma-separated list of connection parameters in the following form (where the password, port, and socket are optional).:

```
*user*[:*passwd*]@*host*[:*port*][:*socket*] or
*login-path*[:*port*][:*socket*]
```

The utility permits users to discover slaves connected to the master.

The discover slaves option **requires** that all slaves use the `--report-host` and `--report-port` server startup options with the correct hostname and port. If these are missing or report incorrect information, the slave may not be detected and thus not included in the operation of the utility. The discover slaves option ignores any slaves to which it cannot connect.

Note

If discovered slaves are missing or report the incorrect information, the slaves health may not be reported correctly or the slave may not be listed at all.

The utility permits the user to demote a master to a slave during the switchover operation. The `--demote-master` option tells the utility to, once the new master is established, make the old master a slave of the new master. This permits rotation of the master role among a set of servers.

The utility permits the user to specify an external script to execute before and after the switchover and failover commands. The user can specify these with the `--exec-before` and `--exec-after` options. The return code of the script is used to determine success thus each script must report 0 (success) to be considered successful. If a script returns a value other than 0, the result code is presented in an error message.

The utility permits the user to log all actions taken during the commands. The `--log` option requires a valid path and filename of the file to use for logging operations. The log is active only when this option is specified. The option `--log-age` specifies the age in days that log entries are kept. The default is seven (7) days. Older entries are automatically deleted from the log file (but only if the `--log` option is specified).

The format of the log file includes the date and time of the event, the level of the event (informational - INFO, warning - WARN, error - ERROR, critical failure - CRITICAL), and the message reported by the utility.

The utility has a number of options each explained in more detail below. Some of the options are specific to certain commands. Warning messages are issued whenever an option is used that does not apply to the command requested. A brief overview of each command and its options is presented in the following paragraphs.

The start, stop, and reset commands require the `--slaves` option to list all of the slaves in the topology. Optionally, the `--master` option can be specified for the utility to check if the specified slaves are associated to the given master before executing the command, making sure that the command is only applied to slaves connected to the right replication master.

The options required for the elect, health and gtid commands include the `--master` option to specify the existing master, and either the `--slaves` option to list all of the slaves in the topology or the `--discover-slaves-login` option to provide the user name and password to discover any slaves in the topology that are registered and connected to the master.

The options required for switchover include the `--master` option to specify the existing master, the `--new-master` option to specify the candidate slave (the slave to become the new master), and either the `--slaves` option to list the considered slaves in the topology or the `--discover-slaves-login` option to provide the user name and password to discover any slaves in the topology that are registered and connected to the master.

The failover command requires only the `--slaves` option to explicitly list all of the slaves in the topology because it is expected that the master is down when this command is used.

Note

The option to pass in --slaves without also passing in --master was added in MySQL Utilities 1.6.0.

Use the `--verbose` option to see additional information in the health report and additional messages during switchover or failover.

COMMANDS

The utility also provides a number of useful commands for managing a replication topology including the following.

elect This command is available to only those servers supporting global transaction identifiers (GTIDs), perform slave election and report the candidate slave to use in the event a switchover or failover is required. Slave election is simply the first slave to meet the prerequisites. GTIDs are supported in version 5.6.5 and higher. This command requires the options `--master` and either `--slaves` or `--discover-slaves-login`.

failover This command is available to only those servers supporting GTIDs. Conduct failover to the best slave. The command tests each candidate slave listed for the prerequisites. Once a candidate slave is elected, it is made a slave of each of the other slaves thereby collecting any transactions executed on other slaves but not the candidate. In this way, the candidate becomes the most up-to-date slave. This command requires the `--slaves` option. The `--discover-slaves-login` option is not allowed because, for failover, the master is presumed to be offline or otherwise unreachable (so there is no way to discover the slaves). The `--master` option is ignored for this command.

gtid This command is available to only those servers supporting GTIDs. It displays the contents of the GTID variables, @@GLOBAL.GTID_EXECUTED, @@GLOBAL.GTID_PURGED, and @@GLOBAL.GTID_OWNED. The command also displays universally unique identifiers (UUIDs) for all servers. This command requires one of the following combinations: `--master` and `--slaves`, or `--master` and `--discover-slaves-login`.

health Display the replication health of the topology. By default, this includes the host name, port, role (MASTER or SLAVE) of the server, state of the server (UP = is connected, WARN = not connected but can ping, DOWN = not connected and cannot ping), the GTID_MODE, and health state. This command can be run with the following combination of options:

- `--master` and `--slaves`
- `--master` and `--discover-slaves-login`
- `--slaves`

Note

The health column displays "no master specified" when generating a health report for a collection of slaves and no `--master` option specified.

The master health state is based on the following; if GTID_MODE=ON, the server must have binary log enabled, and there must exist a user with the REPLICATE SLAVE privilege.

The slave health state is based on the following; the IO_THREAD and SQL_THREADS must be running, it must be connected to the master, there are no errors, the slave delay for non-gtid enabled scenarios is not more than the threshold provided by the `--max-position` and the slave is reading the correct master log file, and slave delay is not more than the `--seconds-behind` threshold option.

reset Execute the STOP SLAVE and RESET SLAVE commands on all slaves. This command requires the `--slaves` option. The `--discover-slaves-login` option is not allowed because it might not provide the expected result, excluding slaves with the IO thread stopped. Optionally, the `--master` option can also be used and in this case the utility performs an additional check to verify if the specified slaves are associated (replication is configured) to the given master.

start Execute the START SLAVE command on all slaves. This command requires the `--slaves` option. The `--discover-slaves-login` option is not allowed because it might not provide the expected result, excluding slaves with the IO thread stopped. Optionally, the `--master` option can also be used and in this case the utility performs an additional check to verify if the specified slaves are associated (replication is configured) to the given master.

stop Execute the STOP SLAVE command on all slaves. This command requires the `--slaves` option. The `--discover-slaves-login` option is not allowed because it might not provide the expected result, excluding slaves with the IO thread stopped. Optionally, the `--master` option can also be used and in this case the utility performs an additional check to verify if the specified slaves are associated (replication is configured) to the given master.

switchover Perform slave promotion to a specified candidate slave as designated by the `--new-master` option. This command is available for both gtid-enabled servers and non-gtid-enabled scenarios. This command requires one of the following combinations:

- `--master`, `--new-master` and `--slaves`
- `--master`, `--new-master` and `--discover-slaves-login`

OPTIONS

`mysqlrpladmin` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --candidates=*`candidate slave connections`*

  Connection information for candidate slave servers for failover. Valid only with failover command. List multiple slaves in comma-separated list.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --demote-master

  Make master a slave after switchover.

- --discover-slaves-login=*`slave_login`*

  At startup, query master for all registered slaves and use the user name and password specified to connect. Supply the user and password in the form *`user`*[:*`passwd`*] or *`login-path`*. For example, --discover=joe:secret uses 'joe' as the user and 'secret' as the password for each discovered slave.

- --exec-after=*`script`*

Name of external script to execute after failover or switchover. Script name may include the full path.

The return code of the script is used to determine success, thus each script must report 0 (success) to be considered successful. If a script returns a value other than 0, the result code is presented in an error message. The script specified using this option only runs if the switchover/failover executed with success.

- --exec-before=*`script`*

  Name of external script to execute before failover or switchover. Script name may include the full path.

  The return code of the script is used to determine success, thus each script must report 0 (success) to be considered successful. If a script returns a value other than 0, the result code is presented in an error message.

- --force

  Ignore prerequisite checks or any inconsistencies found, such as errant transactions on the slaves or SQL thread errors, thus forcing the execution of the specified command. This option must be used carefully as it does not solve any detected issue, but only ignores them and displays a warning message.

- --format=*`format`*, -f *`format`*

  Display the replication health output in either grid (default), tab, csv, or vertical format.

- --log=*`log_file`*

  Specify a log file to use for logging messages

- --log-age=*`days`*

  Specify maximum age of log entries in days. Entries older than this are purged on startup. Default = 7 days.

- --master=*`connection`*

  Connection information for the master server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --max-position=*`position`*

  Used to detect slave delay. The maximum difference between the master's log position and the slave's reported read position of the master. A value greater than this means the slave is too far behind the master. Default = 0.

- --new-master=*`connection`*

  Connection information for the slave to be used to replace the master for switchover. Valid only with switchover command.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --no-health

  Turn off health report after switchover or failover.

- --ping=*`number`*

  Number of ping attempts for detecting downed server. Note: on some platforms this is the same as number of seconds to wait for *ping* to return. This value is also used to check down status of master. Failover waits for *ping* seconds to check master response. If no response, failover event occurs.

- --quiet, -q

  Turn off all messages for quiet execution.

- --rpl-user=*`replication_user`*

  The user and password for the replication user requirement, in the format: *`user`*[:*`password`*] or *`login-path`*. E.g. rpl:passwd Default = None.

- --script-threshold=*`return_code`*

  Value for external scripts to trigger aborting the operation if result is greater than or equal to the threshold.

  Default = None (no threshold checking).

- --seconds-behind=*`seconds`*

  Used to detect slave delay. The maximum number of seconds behind the master permitted before slave is considered behind the master. Default = 0.

- --slaves=*`slave connections`*

  Connection information for slave servers. List multiple slaves in comma-separated list. The list is evaluated literally whereby each server is considered a slave to the master listed regardless if they are a slave of the master.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --timeout=*`seconds`*

  Maximum timeout in seconds to wait for each replication command to complete. For example, timeout for slave waiting to catch up to master. Default = 300 seconds.

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

NOTES

The login user must have the appropriate permissions to execute **SHOW SLAVE STATUS**, **SHOW MASTER STATUS**, and **SHOW VARIABLES** on the appropriate servers as well as grant the REPLICATE SLAVE privilege. The utility checks permissions for the master, slaves, and candidates at startup.

Mixing IP and hostnames is not recommended. The replication-specific utilities attempts to compare hostnames and IP addresses as aliases for checking slave connectivity to the master. However, if your installation does not support reverse name lookup, the comparison could fail. Without the ability to do a reverse name lookup, the replication utilities could report a false negative that the slave is (not) connected to the master.

For example, if you setup replication using "MASTER_HOST=ubuntu.net" on the slave and later connect to the slave with `mysqlrplcheck` and have the master specified as "--master=192.168.0.6" using the valid IP address for "ubuntu.net", you must have the ability to do a reverse name lookup to compare the IP (192.168.0.6) and the hostname (ubuntu.net) to determine if they are the same machine.

Similarly, if you use localhost to connect to the master, the health report may not show all of the slaves. It is best to use the actual hostname of the master when connecting or setting up replication.

If the user does not specify the `--rpl-user` and the user has specified the switchover or failover command, the utility checks to see if the slaves are using `--master-info-repository=TABLE`. If they are not, the utility stops with an error.

All the commands require either the `--slaves` or `--discover-slaves-login` option but both cannot be used at the same time. In fact, some commands only allow the use of the `--slaves` option which is safer to specify the list slaves, because `--discover-slaves-login` might not provide an up to date list of available slaves.

The path to the MySQL client tools should be included in the `PATH` environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the `my_print_defaults` tools which is required to read the login-path values from the login configuration file (`.mylogin.cnf`).

EXAMPLES

To perform best slave election for a topology with GTID_MODE=ON (server version 5.6.5 or higher) where all slaves are specified with the `--slaves` option, run the following command.:

```
shell> mysqlrpladmin --master=root@localhost:3331 \
          --slaves=root@localhost:3332,root@localhost:3333,root@localhost:3334 elect
# Electing candidate slave from known slaves.
# Best slave found is located on localhost:3332.
# ...done.
```

To perform best slave election supplying a candidate list, use the following command.:

```
shell> mysqlrpladmin --master=root@localhost:3331 \
  --slaves=root@localhost:3332,root@localhost:3333,root@localhost:3334 \
  --candidates=root@localhost:3333,root@localhost:3334 elect
# Electing candidate slave from candidate list then slaves list.
# Best slave found is located on localhost:3332.
# ...done.
```

To perform failover after a master has failed, use the following command.:

```
shell> mysqlrpladmin  \
  --slaves=root@localhost:3332,root@localhost:3333,root@localhost:3334 \
  --candidates=root@localhost:3333,root@localhost:3334 failover
# Performing failover.
# Candidate slave localhost:3333 will become the new master.
# Preparing candidate for failover.
# Creating replication user if it does not exist.
# Stopping slaves.
# Performing STOP on all slaves.
# Switching slaves to new master.
# Starting slaves.
# Performing START on all slaves.
# Checking slaves for errors.
# Failover complete.
# ...done.
```

To see the replication health of a topology with GTID_MODE=ON (server version 5.6.5 or higher) and discover all slaves attached to the master, run the following command. We use the result of the failover command above.:

```
shell> mysqlrpladmin --master=root@localhost:3333 \
  --slaves=root@localhost:3332,root@localhost:3334 health
# Getting health for master: localhost:3333.
#
# Replication Topology Health:
+------------+-------+---------+--------+------------+---------+
| host       | port  | role    | state  | gtid_mode  | health  |
+------------+-------+---------+--------+------------+---------+
| localhost  | 3333  | MASTER  | UP     | ON         | OK      |
| localhost  | 3332  | SLAVE   | UP     | ON         | OK      |
| localhost  | 3334  | SLAVE   | UP     | ON         | OK      |
+------------+-------+---------+--------+------------+---------+
# ...done.
```

To view a detailed replication health report but with all of the replication health checks revealed, use the `--verbose` option as shown below. In this example, we use vertical format to make viewing easier.:

```
shell> mysqlrpladmin --master=root@localhost:3331 \
          --slaves=root@localhost:3332,root@localhost:3333,root@localhost:3334 \
          --verbose health
# Getting health for master: localhost:3331.
# Attempting to contact localhost ... Success
# Attempting to contact localhost ... Success
# Attempting to contact localhost ... Success
# Attempting to contact localhost ... Success
#
# Replication Topology Health:
*************************       1. row *************************
            host: localhost
            port: 3331
            role: MASTER
           state: UP
       gtid_mode: ON
          health: OK
         version: 5.6.5-m8-debug-log
 master_log_file: mysql-bin.000001
  master_log_pos: 571
       IO_Thread:
      SQL_Thread:
     Secs_Behind:
 Remaining_Delay:
    IO_Error_Num:
        IO_Error:
*************************       2. row *************************
            host: localhost
            port: 3332
            role: SLAVE
           state: UP
       gtid_mode: ON
          health: OK
         version: 5.6.5-m8-debug-log
 master_log_file: mysql-bin.000001
  master_log_pos: 571
       IO_Thread: Yes
      SQL_Thread: Yes
     Secs_Behind: 0
 Remaining_Delay: No
    IO_Error_Num: 0
        IO_Error:
*************************       3. row *************************
            host: localhost
            port: 3333
            role: SLAVE
           state: UP
       gtid_mode: ON
```

```
          health: OK
         version: 5.6.5-m8-debug-log
 master_log_file: mysql-bin.000001
  master_log_pos: 571
       IO_Thread: Yes
      SQL_Thread: Yes
     Secs_Behind: 0
 Remaining_Delay: No
    IO_Error_Num: 0
        IO_Error:
*************************       4. row *************************
            host: localhost
            port: 3334
            role: SLAVE
           state: UP
       gtid_mode: ON
          health: OK
         version: 5.6.5-m8-debug-log
 master_log_file: mysql-bin.000001
  master_log_pos: 571
       IO_Thread: Yes
      SQL_Thread: Yes
     Secs_Behind: 0
 Remaining_Delay: No
    IO_Error_Num: 0
        IO_Error:
4 rows.
# ...done.
```

To run the same failover command above, but specify a log file, use the following command.:

```
shell> mysqlrpladmin  \
  --slaves=root@localhost:3332,root@localhost:3333,root@localhost:3334 \
  --candidates=root@localhost:3333,root@localhost:3334 \
  --log=test_log.txt failover
# Performing failover.
# Candidate slave localhost:3333 will become the new master.
# Preparing candidate for failover.
# Creating replication user if it does not exist.
# Stopping slaves.
# Performing STOP on all slaves.
# Switching slaves to new master.
# Starting slaves.
# Performing START on all slaves.
# Checking slaves for errors.
# Failover complete.
# ...done.
```

After this command, the log file contains entries like the following:

```
2012-03-19 14:44:17 PM INFO Executing failover command...
2012-03-19 14:44:17 PM INFO Performing failover.
2012-03-19 14:44:17 PM INFO Candidate slave localhost:3333 will become the new master.
2012-03-19 14:44:17 PM INFO Preparing candidate for failover.
2012-03-19 14:44:19 PM INFO Creating replication user if it does not exist.
2012-03-19 14:44:19 PM INFO Stopping slaves.
2012-03-19 14:44:19 PM INFO Performing STOP on all slaves.
2012-03-19 14:44:19 PM INFO Switching slaves to new master.
2012-03-19 14:44:20 PM INFO Starting slaves.
2012-03-19 14:44:20 PM INFO Performing START on all slaves.
2012-03-19 14:44:20 PM INFO Checking slaves for errors.
2012-03-19 14:44:21 PM INFO Failover complete.
2012-03-19 14:44:21 PM INFO ...done.
```

To perform switchover and demote the current master to a slave, use the following command.:

```
shell> mysqlrpladmin --master=root@localhost:3331 \
  --slaves=root@localhost:3332,root@localhost:3333,root@localhost:3334 \
  --new-master=root@localhost:3332 --demote-master switchover
# Performing switchover from master at localhost:3331 to slave at localhost:3332.
# Checking candidate slave prerequisites.
# Waiting for slaves to catch up to old master.
# Stopping slaves.
# Performing STOP on all slaves.
# Demoting old master to be a slave to the new master.
# Switching slaves to new master.
# Starting all slaves.
# Performing START on all slaves.
# Checking slaves for errors.
# Switchover complete.
# ...done.
```

If the replication health report is generated on the topology following the above command, it displays the old master as a slave as shown below.:

```
# Replication Topology Health:
+------------+-------+---------+--------+------------+---------+
| host       | port  | role    | state  | gtid_mode  | health  |
+------------+-------+---------+--------+------------+---------+
| localhost  | 3332  | MASTER  | UP     | ON         | OK      |
| localhost  | 3331  | SLAVE   | UP     | ON         | OK      |
| localhost  | 3333  | SLAVE   | UP     | ON         | OK      |
| localhost  | 3334  | SLAVE   | UP     | ON         | OK      |
+------------+-------+---------+--------+------------+---------+
```

You can use the discover slaves feature, if and only if all slaves report their host and port to the master. A sample command to generate a replication health report with discovery is shown below. Note that the option `--discover-slaves-login` cannot be used in conjunction with the `--slaves` option.:

```
shell> mysqlrpladmin --master=root@localhost:3332 --discover-slaves-login=root  health

# Discovering slaves for master at localhost:3332
# Discovering slave at localhost:3331
# Found slave: localhost:3331
# Discovering slave at localhost:3333
# Found slave: localhost:3333
# Discovering slave at localhost:3334
# Found slave: localhost:3334
# Checking privileges.
#
# Replication Topology Health:
+------------+-------+---------+--------+------------+---------+
| host       | port  | role    | state  | gtid_mode  | health  |
+------------+-------+---------+--------+------------+---------+
| localhost  | 3332  | MASTER  | UP     | ON         | OK      |
| localhost  | 3331  | SLAVE   | UP     | ON         | OK      |
| localhost  | 3333  | SLAVE   | UP     | ON         | OK      |
| localhost  | 3334  | SLAVE   | UP     | ON         | OK      |
+------------+-------+---------+--------+------------+---------+
# ...done.
```

PERMISSIONS REQUIRED

The users on the master need the following privileges: SELECT and INSERT privileges on mysql database, REPLICATION SLAVE, REPLICATION CLIENT and GRANT OPTION. The slave users need the SUPER privilege. The repl user, used as the argument for the `--rpl-user` option, is either created automatically or if it exists, it needs the REPLICATION SLAVE privilege.

To run the mysqlrpladmin utility with the health command, the account used on the master needs an extra SUPER privilege.

As for the switchover command all the users need the following privileges: SUPER, GRANT OPTION, SELECT, RELOAD, DROP, CREATE and REPLICATION SLAVE

5.17 mysqlrplcheck — Check Replication Prerequisites

This utility checks the prerequisites for replication between a master and a slave. These checks (called tests) are designed to ensure a healthy replication setup. The utility performs the following tests:

1. Is the binary log enabled on the master?
2. Are there binary logging exceptions (such as `*_do_db` or `*_ignore_db` settings)? If so, display them.
3. Does the replication user exist on the master with the correct privileges?
4. Are there `server_id` conflicts?
5. Is the slave connected to this master? If not, display the master host and port.
6. Are there conflicts between the `master.info` file on the slave and the values shown in **SHOW SLAVE STATUS** on the master?
7. Are the InnoDB configurations compatible (plugin vs. native)?
8. Are the storage engines compatible (have same on slave as master)?
9. Are the `lower_case_tables_names` settings compatible? Warn if there are settings for lowercase/ uppercase table names that can cause problems. See Bug #59240.
10. Is the slave behind the master?

The utility runs each test in turn unless there is a fatal error preventing further testing, such as a loss of connection to the servers.

Each test can complete with one of the following states: pass (the prerequisites are met), fail (the prerequisites were met but one or more errors occurred or there are exceptions to consider), or warn (the test found some unusual settings that should be examined further but may not be in error).

Use the `--verbose` option to see additional information such as server IDs, `lower_case_table_name` settings, and the contents of the master information file on the slave.

To see the values from the **SHOW SLAVE STATUS** statement, use the `--show-slave-status` option.

OPTIONS

mysqlrplcheck accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --master=*source*

  Connection information for the master server.

To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

- Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
- Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
- Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --master-info-file=*`file`*

  The name of the master information file on the slave. The default is `master.info` read from the data directory. Note: This option requires that you run the utility on the slave and that you have appropriate read access for the file.

- --quiet, -q

  Turn off all messages for quiet execution. Note: Errors and warnings are not suppressed.

- --show-slave-status, -s

  Display the values from **SHOW SLAVE STATUS** on the master.

- --slave=*`source`*

  Connection information for the slave server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --suppress

  Suppress warning messages.

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

- --width=*`number`*

  Change the display width of the test report. The default is 75 characters.

NOTES

The login user must have the appropriate permissions to execute **SHOW SLAVE STATUS**, **SHOW MASTER STATUS**, and **SHOW VARIABLES** on the appropriate servers.

Mixing IP and hostnames is not recommended. The replication-specific utilities attempt to compare hostnames and IP addresses as aliases for checking slave connectivity to the master. However, if your installation does not support reverse name lookup, the comparison could fail. Without the ability to do a reverse name lookup, the replication utilities could report a false negative that the slave is (not) connected to the master.

For example, if you setup replication using MASTER_HOST=ubuntu.net on the slave and later connect to the slave with mysqlrplcheck and have the master specified as --master=192.168.0.6 using the valid IP address for ubuntu.net, you must have the ability to do a reverse name lookup to compare the IP (192.168.0.6) and the hostname (ubuntu.net) to determine if they are the same machine.

The path to the MySQL client tools should be included in the PATH environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the my_print_defaults tools which is required to read the login-path values from the login configuration file (.mylogin.cnf).

EXAMPLES

To check the prerequisites of a master and slave that currently are actively performing replication, use the following command:

```
shell> mysqlrplcheck --master=root@host1:3310 --slave=root@host2:3311
# master on host1: ... connected.
# slave on host2: ... connected.
Test Description                                                     Status
------------------------------------------------------------------------
Checking for binary logging on master                                [pass]
Are there binlog exceptions?                                         [pass]
Replication user exists?                                             [pass]
Checking server_id values                                            [pass]
Is slave connected to master?                                        [pass]
Check master information file                                        [pass]
```

```
Checking InnoDB compatibility                                      [pass]
Checking storage engines compatibility                             [pass]
Checking lower_case_table_names settings                           [pass]
Checking slave delay (seconds behind master)                       [pass]
# ...done.
```

As shown in the example, you must provide valid login information for both the master and the slave.

To perform the same command but also display the contents of the master information file on the slave and the values of **SHOW SLAVE STATUS** as well as additional details, use this command:

```
shell> mysqlrplcheck --master=root@host1:3310 --slave=root@host2:3311 \
  --show-slave-status -vv
# master on host1: ... connected.
# slave on host2: ... connected.
Test Description                                                  Status
------------------------------------------------------------------------
Checking for binary logging on master                              [pass]
Are there binlog exceptions?                                       [pass]
Replication user exists?                                           [pass]
Checking server_id values                                          [pass]

 master id = 10
  slave id = 11

Is slave connected to master?                                      [pass]
Check master information file                                      [pass]

#
# Master information file:
#
               Master_Log_File : clone-bin.000001
           Read_Master_Log_Pos : 482
                   Master_Host : host1
                   Master_User : rpl
               Master_Password : XXXX
                   Master_Port : 3310
                 Connect_Retry : 60
            Master_SSL_Allowed : 0
            Master_SSL_CA_File :
            Master_SSL_CA_Path :
               Master_SSL_Cert :
             Master_SSL_Cipher :
                Master_SSL_Key :
 Master_SSL_Verify_Server_Cert : 0

Checking InnoDB compatibility                                      [pass]
Checking storage engines compatibility                             [pass]
Checking lower_case_table_names settings                           [pass]

  Master lower_case_table_names: 2
   Slave lower_case_table_names: 2

Checking slave delay (seconds behind master)                       [pass]

#
# Slave status:
#
                Slave_IO_State : Waiting for master to send event
                   Master_Host : host1
                   Master_User : rpl
                   Master_Port : 3310
                 Connect_Retry : 60
               Master_Log_File : clone-bin.000001
           Read_Master_Log_Pos : 482
                Relay_Log_File : clone-relay-bin.000006
                 Relay_Log_Pos : 251
         Relay_Master_Log_File : clone-bin.000001
              Slave_IO_Running : Yes
             Slave_SQL_Running : Yes
               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 : 482
               Relay_Log_Space : 551
               Until_Condition : None
                Until_Log_File :
                 Until_Log_Pos : 0
            Master_SSL_Allowed : No
            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 : No
                 Last_IO_Errno : 0
                 Last_IO_Error :
                Last_SQL_Errno : 0
                Last_SQL_Error :
# ...done.
```

PERMISSIONS REQUIRED

The users on the master need the following privileges: SELECT and INSERT privileges on mysql database, REPLICATION SLAVE, REPLICATION CLIENT and GRANT OPTION. The slave users need the SUPER privilege.

Also, when using GTIDs, the slave users must also have SELECT privilege over the mysql database.

5.18 `mysqlrplshow` — Show Slaves for Master Server

This utility shows the replication slaves for a master. It prints a graph of the master and the slaves connected labeling each with the host name and port number.

You must specify the `--discover-slaves-login` option to provide the user name and password to discover any slaves in the topology.

The discover slaves option **requires** that all slaves use the `--report-host` and `--report-port` server startup options with the correct hostname and port. If these are missing or report incorrect information, the slave may not be detected and thus not included in the operation of the utility. The discover slaves option ignores any slaves to which it cannot connect.

To explore the slaves for each client, use the `--recurse` option. This causes the utility to connect to each slave found and attempt to determine whether it has any slaves. If slaves are found, the process continues until the slave is found in the list of servers serving as masters (a circular topology). The graph displays the topology with successive indents. A notation is made for circular topologies.

If you use the `--recurse` option, the utility attempts to connect to the slaves using the user name and password provided for the master. By default, if the connection attempt fails, the utility throws an error and stops. To change this behavior, use the `--prompt` option, which permits the utility to prompt for the user name and password for each slave that fails to connect. You can also use the `--num-retries=n` option to reattempt a failed connection 'n' times before the utility fails.

An example graph for a typical topology with relay slaves is shown here:

```
# Replication Topology Graph::

localhost:3311 (MASTER)
   |
   +--- localhost:3310 - (SLAVE)
   |
   +--- localhost:3312 - (SLAVE + MASTER)
       |
       +--- localhost:3313 - (SLAVE)
```

`MASTER`, `SLAVE`, and `SLAVE+MASTER` indicate that a server is a master only, slave only, and both slave and master, respectively.

A circular replication topology is shown like this, where `<-->` indicates circularity:

```
# Replication Topology Graph

localhost:3311 (MASTER)
   |
   +--- localhost:3312 - (SLAVE + MASTER)
       |
       +--- localhost:3313 - (SLAVE + MASTER)
           |
           +--- localhost:3311 <--> (SLAVE)
```

To produce a column list in addition to the graph, specify the `--show-list` option. In this case, to specify how to display the list, use one of the following values with the `--format` option:

- **grid** (default)

  Display output in grid or table format like that of the `mysql` client command-line tool.

- **csv**

  Display output in comma-separated values format.

- **tab**

  Display output in tab-separated format.

- **vertical**

  Display output in single-column format like that of the `\G` command for the `mysql` client command-line tool.

The utility uses of the **SHOW SLAVE HOSTS** statement to determine which slaves the master has. If you want to use the `--recurse` option, slaves **must** have been started with the `--report-host` and `--report-port` options set to their actual host name and port number or the utility may not be able to connect to the slaves to determine their own slaves.

OPTIONS

`mysqlrplshow` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --discover-slaves-login=*`slave-login`*

  Supply the user and password in the form *`user`*[:*`passwd`*] or *`login-path`* for discovering slaves and relay slaves in the topology. For example, --discover=joe:secret uses 'joe' as the user and 'secret' as the password for each discovered slave.

- --format=*`format`*, -f*`format`*

  Specify the display format for column list output. Permitted format values are **grid**, **csv**, **tab**, and **vertical**. The default is **grid**. This option applies only if `--show-list` is given.

- --master=*`source`*

  Connection information for the master server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]

  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]

  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --max-depth=*`N`*

  The maximum recursion depth. This option is valid only if `--recurse` is given.

- --num-retries=*`num_retries`*, -n*`num_retries`*

  The number of retries permitted for failed slave login attempts. This option is valid only if `--prompt` is given.

- --prompt, -p

  Prompt for the slave user and password if different from the master user and password.

  If you give this option, the utility sets `--num-retries` to 1 if that option is not set explicitly. This ensures at least one attempt to retry and prompt for the user name and password should a connection fail.

- --quiet, -q

  Turn off all messages for quiet execution. This option does not suppress errors or warnings.

- --recurse, -r

  Traverse the list of slaves to find additional master/slave connections. User this option to map a replication topology.

- --show-list, -l

Display a column list of the topology.

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --verbose, -v

  Specify how much information to display. If this option is used, the IO thread status of each slave is also displayed. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug. If you use -vvv, the output contains the state of the IO and SQL threads for each slave.

- --version

  Display version information and exit.

NOTES

The login user must have the **REPLICATE SLAVE** and **REPLICATE CLIENT** privileges to successfully execute this utility. Specifically, the login user must have appropriate permissions to execute **SHOW SLAVE STATUS**, **SHOW MASTER STATUS**, and **SHOW SLAVE HOSTS**.

For the `--format` option, the permitted values are not case sensitive. In addition, values may be specified as any unambiguous prefix of a valid value. For example, `--format=g` specifies the grid format. An error occurs if a prefix matches more than one valid value.

Mixing IP and hostnames is not recommended. The replication-specific utilities attempt to compare hostnames and IP addresses as aliases for checking slave connectivity to the master. However, if your installation does not support reverse name lookup, the comparison could fail. Without the ability to do a reverse name lookup, the replication utilities could report a false negative that the slave is (not) connected to the master.

For example, if you setup replication using MASTER_HOST=ubuntu.net on the slave and later connect to the slave with mysqlrplcheck and have the master specified as --master=192.168.0.6 using the valid IP address for ubuntu.net, you must have the ability to do a reverse name lookup to compare the IP (192.168.0.6) and the hostname (ubuntu.net) to determine if they are the same machine.

The path to the MySQL client tools should be included in the PATH environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the my_print_defaults tools which is required to read the login-path values from the login configuration file (.mylogin.cnf).

EXAMPLES

To show the slaves for a master running on port 3311 on the local host, use the following command:

```
shell> mysqlrplshow  --master=root@localhost:3311 --discover-slaves-login=root
# master on localhost: ... connected.
# Finding slaves for master: localhost:3311

# Replication Topology Graph
localhost:3311 (MASTER)
   |
   +--- localhost:3310 - (SLAVE)
   |
   +--- localhost:3312 - (SLAVE)
```

As shown in the example, you must provide valid login information for the master.

To show additional information about the IO thread status (to confirm if the slaves are really connected to the master) use the option `--verbose`:

```
shell> mysqlrplshow  --master=root@localhost:3311 --discover-slaves-login=root --verbose
# master on localhost: ... connected.
# Finding slaves for master: localhost:3311

# Replication Topology Graph
localhost:3311 (MASTER)
   |
   +--- localhost:3310 [IO: Yes, SQL: Yes] - (SLAVE)
   |
   +--- localhost:3312 [IO: Yes, SQL: Yes] - (SLAVE)
```

To show the full replication topology of a master running on the local host, use the following command:

```
shell> mysqlrplshow  --master=root@localhost:3311 --recurse --discover-slaves-login=root
# master on localhost: ... connected.
# Finding slaves for master: localhost:3311

# Replication Topology Graph
localhost:3311 (MASTER)
   |
   +--- localhost:3310 - (SLAVE)
   |
   +--- localhost:3312 - (SLAVE + MASTER)
       |
       +--- localhost:3313 - (SLAVE)
```

To show the full replication topology of a master running on the local host, prompting for the user name and password for slaves that do not have the same user name and password credentials as the master, use the following command:

```
shell> mysqlrplshow --recurse --prompt --num-retries=1 \
          --master=root@localhost:3331 --discover-slaves-login=root

Server localhost:3331 is running on localhost.
# master on localhost: ... connected.
# Finding slaves for master: localhost:3331
Server localhost:3332 is running on localhost.
# master on localhost: ... FAILED.
Connection to localhost:3332 has failed.
Please enter the following information to connect to this server.
User name: root
Password:
# master on localhost: ... connected.
# Finding slaves for master: localhost:3332
Server localhost:3333 is running on localhost.
# master on localhost: ... FAILED.
```

```
Connection to localhost:3333 has failed.
Please enter the following information to connect to this server.
User name: root
Password:
# master on localhost: ... connected.
# Finding slaves for master: localhost:3333
Server localhost:3334 is running on localhost.
# master on localhost: ... FAILED.
Connection to localhost:3334 has failed.
Please enter the following information to connect to this server.
User name: root
Password:
# master on localhost: ... connected.
# Finding slaves for master: localhost:3334

# Replication Topology Graph
localhost:3331 (MASTER)
   |
   +--- localhost:3332 - (SLAVE)
   |
   +--- localhost:3333 - (SLAVE + MASTER)
       |
       +--- localhost:3334 - (SLAVE)
```

PERMISSIONS REQUIRED

The user connected to the master must have the REPLICATION SLAVE privilege.

The user specified with the `--discover-slaves-login` option that logs into each slave must have the REPLICATION CLIENT privilege.

5.19 `mysqlrplsync` — Replication synchronization checker

This utility permits you to check replication servers for synchronization of replicated events. The utility permits users to check data consistency between a master and slaves or between two slaves. The utility reports missing objects as well as missing data. The utility can also be used to synchronize the replicated data on the servers.

The utility can operate on an active replication topology applying a synchronization process to check the data. Those servers where replication is not active can still be checked but the synchronization process is skipped. In that case, it is up to the user to manually synchronize the servers.

The user must provide connection parameters for the servers. That is, the utility requires the master and slaves using the `--master` and `--slaves` options. To compare only slaves, the user need only provide the `--slaves` option.

The utility also provides a feature to discover slaves connected to the master using the `--discover-slaves-login` and `--master` options.

The discover slaves option **requires** that all slaves use the `--report-host` and `--report-port` server startup options with the correct hostname and port. If these are missing or report incorrect information, the slave may not be detected and thus not included in the operation of the utility. The discover slaves option ignores any slaves to which it cannot connect.

By default, all data is included in the comparison. To check specific databases or tables, list each element as a separated argument for the utility using fully qualified names. The user can also choose to exclude some databases or tables from the check using the `--exclude` option.

The utility also provides some important features that allow users to adjust the execution of the consistency check to their system. For example, the user may wish the utility to minimize execution of the synchronization process. To do so, the user uses the `--rpl-timeout` to define the maximum time for each slave to synchronize. More specifically, allow slaves to catch up with the master in order to compare the data. During this waiting step, the slaves status is periodically polled according to a predefined time interval. This polling interval to verify if the slaves are synced can be adjusted with the `--interval` option. A checksum query is used to compare the data of each table between servers. The checksum calculation step is skipped if its execution exceeds a predefined time, avoiding undesirable performance impacts on the target system if it takes too long to execute. The user can change the checksum timeout using the `--checksum-timeout` option.

Users can also use the `--verbose` option to see additional information when the utility executes.

This utility is designed to work exclusively for servers that support global transaction identifiers (GTIDs) and have `gtid_mode=ON`. Servers with GTID disabled are skipped by the utility. See Replication with Global Transaction Identifiers, for more information about GTID.

The utility takes into consideration the use of replication filtering rules on the servers skipping the check for filtered databases and tables according to the defined options. Nevertheless, the use of replication filters can still lead to data consistency issues depending on how statements are evaluated. See How Servers Evaluate Replication Filtering Rules, for more information.

OPTIONS

`mysqlrplsync` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --checksum-timeout=*`checksum_timeout_in_seconds`*

  Maximum timeout in seconds to wait for the checksum query to complete.

  Default = 3 seconds.

- --discover-slaves-login=*`user_login`*

  Detect registered slaves at startup and use the user name and password specified to connect in the format: *`user`* [:*`password`*] or *`login-path`*. For example, --discover-slaves-login=joe:secret uses 'joe' as the user and 'secret' as the password for each discovered slave.

- --exclude=*`databases_tables_to_exclude`*

  Fully qualified name for the databases or tables to exclude: *`db_name`* [.*`tbl_name`*]. List multiple data objects in a comma-separated list.

- --interval=*`interval_in_seconds`*, -i *`interval_in_seconds`*

  Interval in seconds for periodically polling the slaves sync status to verify if the sync point was reached.

  Default = 3 seconds.

- --master=*`master_connection`*

  Connection information for the master server.

To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --rpl-timeout=*`rpl_timeout_in_seconds`*

  Maximum timeout in seconds to wait for synchronization. More precisely, the time to wait for the replication process on a slave to reach a sync point (GTID set).

  Default = 300 seconds.

- --slaves=*`slaves_connections`*

  Connection information for slave servers . List multiple slaves in comma-separated list.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --verbose, -v

Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

NOTES

The data consistency check is performed per table using a checksum on the table. If the calculated checksum differs, it indicates the tables are not synchronized. Nevertheless, since the checksum operation is not collision free, there is a very small probability that two tables with differing data can produce the same checksum.

Mixing IP and hostnames is not recommended. The replication-specific utilities attempt to compare hostnames and IP addresses as aliases for checking slave connectivity to the master. However, if your installation does not support reverse name lookup, the comparison could fail. Without the ability to do a reverse name lookup, the replication utilities could report a false negative that the slave is (not) connected to the master.

For example, if you setup replication using MASTER_HOST=ubuntu.net on the slave and later connect to the slave with mysqlrplcheck and have the master specified as --master=192.168.0.6 using the valid IP address for ubuntu.net, you must have the ability to do a reverse name lookup to compare the IP (192.168.0.6) and the hostname (ubuntu.net) to determine if they are the same machine.

Similarly, in order to avoid issues mixing local IP '127.0.0.1' with 'localhost', the addresse '127.0.0.1' is converted to 'localhost' by the utility.

The path to the MySQL client tools should be included in the PATH environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the my_print_defaults tools which is required to read the login-path values from the login configuration file (.mylogin.cnf).

LIMITATIONS

This utility is designed to work exclusively for servers that support global transaction identifiers (GTIDs) and have `gtid_mode=ON`. Due to known server issues with some operations required for the synchronization process, only MySQL Server versions 5.6.14 and higher are supported by this utility.

Some replication filtering options are not supported by this utility due to known issues on the server side, namely: *replicate_do_db*, *replicate_ignore_db*, and *replicate_wild_do_table*. In case a non supported replication filtering option is detected on a server, the utility issues an appropriate error and exits. This check is performed at the beginning when the utility starts.

EXAMPLES

To check the data consistency on an active replication system explicitly specifying the master and slaves:

```
shell> mysqlrplsync --master=user:pass@localhost:3310 \
          --slaves=rpl:pass@localhost:3311,rpl:pass@localhost:3312
#
# GTID differences between Master and Slaves:
# - Slave 'localhost@3311' is 15 transactions behind Master.
# - Slave 'localhost@3312' is 12 transactions behind Master.
#
# Checking data consistency.
```

```
#
# Using Master 'localhost@3310' as base server for comparison.
# Checking 'test_rplsync_db' database...
# - Checking 't0' table data...
#   [OK] `test_rplsync_db`.`t0` checksum for server 'localhost@3311'.
#   [OK] `test_rplsync_db`.`t0` checksum for server 'localhost@3312'.
# - Checking 't1' table data...
#   [OK] `test_rplsync_db`.`t1` checksum for server 'localhost@3311'.
#   [OK] `test_rplsync_db`.`t1` checksum for server 'localhost@3312'.
# Checking 'test_db' database...
# - Checking 't0' table data...
#   [OK] `test_db`.`t0` checksum for server 'localhost@3311'.
#   [OK] `test_db`.`t0` checksum for server 'localhost@3312'.
# - Checking 't1' table data...
#   [OK] `test_db`.`t1` checksum for server 'localhost@3311'.
#   [OK] `test_db`.`t1` checksum for server 'localhost@3312'.
#
#...done.
#
# SUMMARY: No data consistency issue found.
#
```

To check the data consistency on an active replication system using slave discovery:

```
shell> mysqlrplsync --master=user:pass@localhost:3310 \
          --discover-slaves-login=rpl:pass
# Discovering slaves for master at localhost:3310
# Discovering slave at localhost:3311
# Found slave: localhost:3311
# Discovering slave at localhost:3312
# Found slave: localhost:3312
#
# GTID differences between Master and Slaves:
# - Slave 'localhost@3311' is 15 transactions behind Master.
# - Slave 'localhost@3312' is 15 transactions behind Master.
#
# Checking data consistency.
#
# Using Master 'localhost@3310' as base server for comparison.
# Checking 'test_rplsync_db' database...
# - Checking 't0' table data...
#   [OK] `test_rplsync_db`.`t0` checksum for server 'localhost@3311'.
#   [OK] `test_rplsync_db`.`t0` checksum for server 'localhost@3312'.
# - Checking 't1' table data...
#   [OK] `test_rplsync_db`.`t1` checksum for server 'localhost@3311'.
#   [OK] `test_rplsync_db`.`t1` checksum for server 'localhost@3312'.
# Checking 'test_db' database...
# - Checking 't0' table data...
#   [OK] `test_db`.`t0` checksum for server 'localhost@3311'.
#   [OK] `test_db`.`t0` checksum for server 'localhost@3312'.
# - Checking 't1' table data...
#   [OK] `test_db`.`t1` checksum for server 'localhost@3311'.
#   [OK] `test_db`.`t1` checksum for server 'localhost@3312'.
#
#...done.
#
# SUMMARY: No data consistency issue found.
#
```

To check the data consistency on an active replication system, but only between specific slaves:

```
shell> mysqlrplsync --slaves=rpl:pass@localhost:3311,rpl:pass@localhost:3312
#
# Checking data consistency.
#
```

```
# Using Slave 'localhost@3311' as base server for comparison.
# Checking 'test_rplsync_db' database...
# - Checking 't0' table data...
#   [OK] `test_rplsync_db`.`t0` checksum for server 'localhost@3312'.
# - Checking 't1' table data...
#   [OK] `test_rplsync_db`.`t1` checksum for server 'localhost@3312'.
# Checking 'test_db' database...
# - Checking 't0' table data...
#   [OK] `test_db`.`t0` checksum for server 'localhost@3312'.
# - Checking 't1' table data...
#   [OK] `test_db`.`t1` checksum for server 'localhost@3312'.
#
#...done.
#
# SUMMARY: No data consistency issue found.
#
```

To check the data consistency of a specific database and table on an active replication system:

```
shell> mysqlrplsync --master=user:pass@localhost:3310 \
          --slaves=rpl:pass@localhost:3311,rpl:pass@localhost:3312 \
          test_rplsync_db test_db.t1
#
# GTID differences between Master and Slaves:
# - Slave 'localhost@3311' is 15 transactions behind Master.
# - Slave 'localhost@3312' is 12 transactions behind Master.
#
# Checking data consistency.
#
# Using Master 'localhost@3310' as base server for comparison.
# Checking 'test_rplsync_db' database...
# - Checking 't0' table data...
#   [OK] `test_rplsync_db`.`t0` checksum for server 'localhost@3311'.
#   [OK] `test_rplsync_db`.`t0` checksum for server 'localhost@3312'.
# - Checking 't1' table data...
#   [OK] `test_rplsync_db`.`t1` checksum for server 'localhost@3311'.
#   [OK] `test_rplsync_db`.`t1` checksum for server 'localhost@3312'.
# Checking 'test_db' database...
# - Checking 't1' table data...
#   [OK] `test_db`.`t1` checksum for server 'localhost@3311'.
#   [OK] `test_db`.`t1` checksum for server 'localhost@3312'.
#
#...done.
#
# SUMMARY: No data consistency issue found.
#
```

To check the data consistency on an active replication system excluding a specific database and table:

```
shell> mysqlrplsync --master=user:pass@localhost:3310 \
          --slaves=rpl:pass@localhost:3311,rpl:pass@localhost:3312 \
          --exclude=test_rplsync_db,test_db.t1
#
# GTID differences between Master and Slaves:
# - Slave 'localhost@3311' is 15 transactions behind Master.
# - Slave 'localhost@3312' is 12 transactions behind Master.
#
# Checking data consistency.
#
# Using Master 'localhost@3310' as base server for comparison.
# Checking 'test_db' database...
# - Checking 't0' table data...
#   [OK] `test_db`.`t0` checksum for server 'localhost@3311'.
#   [OK] `test_db`.`t0` checksum for server 'localhost@3312'.
#
```

```
#...done.
#
# SUMMARY: No data consistency issue found.
#
```

The following is an example of a replication check that has data inconsistencies:

```
shell> mysqlrplsync --master=user:pass@localhost:3310 \
          --slaves=rpl:pass@localhost:3311,rpl:pass@localhost:3312
#
# GTID differences between Master and Slaves:
# - Slave 'localhost@3311' is up-to-date.
# - Slave 'localhost@3312' is up-to-date.
#
# Checking data consistency.
#
# Using Master 'localhost@3310' as base server for comparison.
# [DIFF] Database NOT on base server but found on 'localhost@3311': only_on_slave_db
# Checking 'test_rplsync_db' database...
#   [DIFF] Table NOT on base server but found on 'localhost@3311': t3
#   [DIFF] Table NOT on base server but found on 'localhost@3312': t3
#   [DIFF] Table 'test_rplsync_db.t0' NOT on server 'localhost@3311'.
# - Checking 't0' table data...
#   [DIFF] `test_rplsync_db`.`t0` checksum for server 'localhost@3312'.
# - Checking 't1' table data...
#   WARNING: Slave not active 'localhost@3311' - Sync skipped.
#   [DIFF] `test_rplsync_db`.`t1` checksum for server 'localhost@3311'.
#   [OK] `test_rplsync_db`.`t1` checksum for server 'localhost@3312'.
# - Checking 't2' table data...
#   WARNING: Slave not active 'localhost@3311' - Sync skipped.
#   [OK] `test_rplsync_db`.`t2` checksum for server 'localhost@3311'.
#   [OK] `test_rplsync_db`.`t2` checksum for server 'localhost@3312'.
# Checking 'only_on_master_db' database...
#   [DIFF] Database 'only_on_master_db' NOT on server 'localhost@3311'.
#   [DIFF] Database 'only_on_master_db' NOT on server 'localhost@3312'.
#
#...done.
#
# SUMMARY: 8 data consistency issues found.
#
```

Check a replication topology with filtering:

```
shell> mysqlrplsync --master=user:pass@localhost:3310 \
          --slaves=rpl:pass@localhost:3311,rpl:pass@localhost:3312 \
          --verbose
# Checking users permission to perform consistency check.
#
# WARNING: Replication filters found on checked servers. This can lead data consistency issues depending o
# More information: http://dev.mysql.com/doc/en/replication-rules.html
# Master 'localhost@3310':
#   - binlog_do_db: test_rplsync_db1
# Slave 'localhost@3311':
#   - replicate_do_table: test_rplsync_db1.t1
# Slave 'localhost@3312':
#   - replicate_ignore_table: test_rplsync_db1.t2
#   - replicate_wild_ignore_table: test\_rplsync\_db1.%3
#
# GTID differences between Master and Slaves:
# - Slave 'localhost@3311' is up-to-date.
# - Slave 'localhost@3312' is up-to-date.
#
# Checking data consistency.
#
# Using Master 'localhost@3310' as base server for comparison.
# Checking 'test_rplsync_db1' database...
# [SKIP] Table 't0' check for 'localhost@3311' - filtered by replication rule.
# - Checking 't0' table data...
#   Setting data synchronization point for slaves.
#   Compute checksum on slaves (wait to catch up and resume replication).
#   [OK] `test_rplsync_db1`.`t0` checksum for server 'localhost@3312'.
# - Checking 't1' table data...
#   Setting data synchronization point for slaves.
#   Compute checksum on slaves (wait to catch up and resume replication).
#   [OK] `test_rplsync_db1`.`t1` checksum for server 'localhost@3311'.
#   [OK] `test_rplsync_db1`.`t1` checksum for server 'localhost@3312'.
# [SKIP] Table 't2' check for 'localhost@3311' - filtered by replication rule.
# [SKIP] Table 't2' check for 'localhost@3312' - filtered by replication rule.
# [SKIP] Table 't3' check for 'localhost@3311' - filtered by replication rule.
# [SKIP] Table 't3' check for 'localhost@3312' - filtered by replication rule.
# [SKIP] Database 'test_rplsync_db0' check - filtered by replication rule.
# [SKIP] Database 'test_rplsync_db2' check - filtered by replication rule.
# [SKIP] Database 'test_rplsync_db3' check - filtered by replication rule.
#
#...done.
#
# SUMMARY: No data consistency issue found.
#
```

PERMISSIONS REQUIRED

The user for the master must have permissions to lock tables, perform the checksum, and get information about the master status. Specifically, the user used to connect to the master requires the following privileges: SUPER or REPLICATION CLIENT, LOCK TABLES and SELECT.

The user for the slaves must have permissions to start/stop the slave, perform the checksum, and get information about the slave status. More specifically, the login user to connect to slaves requires the following privileges: SUPER and SELECT.

5.20 `mysqlserverclone` — Clone Existing Server to Create New Server

This utility enables you to clone an existing MySQL server instance to create a new server instance on the same host. The utility creates a new datadir (`--new-data`), and, on Unix systems, starts the server with a socket file. You can optionally add a password for the login user account on the new instance.

If the user does not have read and write access to the folder specified by the `--new-data` option, the utility issues an error.

Similarly, if the folder specified by `--new-data` exists and is not empty, the utility does not delete the folder and issues an error message. Users must specify the `--delete-data` option to permit the utility to remove the folder prior to starting the cloned server.

The utility does not copy any data. It merely creates a new running instance of the cloned server with the same options (or additional options if specified). Thus, to create a copy of a server, you must copy the data after the server is cloned.

OPTIONS

`mysqlserverclone` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --delete-data

  Delete the folder specified by `--new-data` if it exists and is not empty.

- --basedir

  The base directory for the MySQL server source, as an alternative to the `--server` option.

  ```
  shell> mysqlserverclone --basedir=/source/mysql-5.6 \
  --new-data=/source/temp_3007 --new-port=3007 --new-id=101 \
  --root=root --mysqld="--log-bin --gtid-mode=on --log-slave-updates \
  --enforce-gtid-consistency --master-info-repository=table \
  --report-host=localhost --report-port=3007" --delete
  ```

- --force

  Ignore the maximum path length and the low space checks for the `--new-data` option.

- --mysqld=*`options`*

  Additional options for `mysqld`. To specify multiple options, separate them by spaces. Use appropriate quoting as necessary. For example, to specify `--log-bin=binlog` and `--general-log-file="mylogfile"`, use:

  If the option --skip-innodb is included when connecting to a MySQL server version 5.7.5 or higher, the option is ignored and a warning is issued.

  ```
  --mysqld="--log-bin=binlog --general-log-file='my log file'"
  ```

- --new-data=*`path_to_new_datadir`*

  The full path to the location of the data directory for the new instance. The path size must be 200 characters or less and it requires at least 120 MB of free space.

- --new-id=*`server_id`*

  The `server_id` value for the new server instance. The default is 2.

- --new-port=*`port`*

  The port number for the new server instance. The default is 3307.

- --quiet, -q

  Turn off all messages for quiet execution.

- --root-password=*`password`*

  The password for the `root` user of the new server instance.

- --server=*`source`*

  Connection information for the server to be cloned.

To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

- Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
- Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
- Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --start-timeout=*`timeout_in_seconds`*

  Number of seconds to wait for server to start. Default = 10 seconds.

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

- --write-command=*`file_name`*, -w*`file_name`*

  Path name of file in which to write the command used to launch the new server instance.

EXAMPLES

The following command demonstrates how to create a new instance of a running server, set the `root` user password and enable binary logging:

```
shell> mkdir /source/test123
shell> mysqlserverclone --server=root:pass@localhost \
    --new-data=/Users/cbell/source/test123 --new-port=3310 \
    --root-password=pass --mysqld=--log-bin=mysql-bin
```

```
# Cloning the MySQL server running on localhost.
# Creating new data directory...
# Configuring new instance...
# Locating mysql tools...
# Setting up empty database and mysql tables...
# Starting new instance of the server...
# Testing connection to new instance...
# Success!
# Setting the root password...
# ...done.
```

PERMISSIONS REQUIRED

The user must have permission to read all databases. Since we are using the root account for these examples (and you typically would), permissions are not generally a problem.

You also need permissions to create the new data directory and write data to it.

5.21 `mysqlserverinfo` — Display Common Diagnostic Information from a Server

This utility displays critical information about a server for use in diagnosing problems. The information displayed includes the following:

- Server connection information
- Server version number
- Data directory path name
- Base directory path name
- Plugin directory path name
- Configuration file location and name
- Current binary log coordinates (filename and position)
- Current relay log coordinates (filename and position)

This utility can be used to see the diagnostic information for servers that are running or offline. If you want to see information about an offline server, the utility starts the server in read-only mode. In this case, you must specify the `--basedir`, `--datadir`, and `--start` options to prevent the utility from starting an offline server accidentally. Note: Be sure to consider the ramifications of starting an offline server on the error and similar logs. It is best to save this information prior to running this utility.

To specify how to display output, use one of the following values with the `--format` option:

- **grid** (default)

  Display output in grid or table format like that of the `mysql` client command-line tool.

- **csv**

  Display output in comma-separated values format.

- **tab**

  Display output in tab-separated format.

- **vertical**

  Display output in single-column format like that of the `\G` command for the `mysql` client command-line tool.

To turn off the headers for **grid**, **csv**, or **tab** display format, specify the `--no-headers` option.

To see the common default settings for the local server's configuration file, use the `--show-defaults` option. This option reads the configuration file on the machine where the utility is run, not the machine for the host that the `--server` option specifies.

To run the utility against several servers, specify the `--server` option multiple times. In this case, the utility attempts to connect to each server and read the information.

To see the MySQL servers running on the local machine, use the `--show-servers` option. This shows all the servers with their process ID and data directory. On Windows, the utility shows only the process ID and port.

OPTIONS

`mysqlserverinfo` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --basedir=*`basedir`*

  The base directory for the server. This option is required for starting an offline server.

  Is also used to access server tools, such as my_print_defaults that is required to read the login-path values from the login configuration file (.mylogin.cnf).

- --datadir=*`datadir`*

  The data directory for the server. This option is required for starting an offline server.

- --format=*`format`*, -f*`format`*

  Specify the output display format. Permitted format values are **grid**, **csv**, **tab**, and **vertical**. The default is **grid**.

- --no-headers, -h

  Do not display column headers. This option applies only for **grid**, **csv**, and **tab** output.

- --port-range=*`start:end`*

  The port range to check for finding running servers. This option applies only to Windows and is ignored unless `--show-servers` is given. The default range is 3306:3333.

- --server=*`server`*

  Connection information for a server. Use this option multiple times to see information for multiple servers.

To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

- Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
- Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
- Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --show-defaults, -d

  Display default settings for `mysqld` from the local configuration file. It uses `my_print_defaults` to obtain the options.

- --show-servers

  Display information about servers running on the local host. The utility examines the host process list to determine which servers are running.

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --start, -s

  Start the server in read-only mode if it is offline. With this option, you must also give the `--basedir` and `--datadir` options.

- --start-timeout

  Number of seconds to wait for the server to be online when started in read-only mode using the `--start` option. The default value is 10 seconds.

  The `--start-timeout` option is available as of MySQL Utilities 1.2.4 / 1.3.3.

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

For the `--format` option, the permitted values are not case sensitive. In addition, values may be specified as any unambiguous prefix of a valid value. For example, `--format=g` specifies the grid format. An error occurs if a prefix matches more than one valid value.

The path to the MySQL client tools should be included in the PATH environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the my_print_defaults tools which is required to read the login-path values from the login configuration file (.mylogin.cnf).

EXAMPLES

To display the server information for the local server and the settings for `mysqld` in the configuration file with the output in a vertical list, use this command:

```
shell> mysqlserverinfo --server=root:pass@localhost -d --format=vertical
# Source on localhost: ... connected.
*************************       1. row *************************
         server: localhost:3306
        version: 5.1.50-log
        datadir: /usr/local/mysql/data/
        basedir: /usr/local/mysql-5.1.50-osx10.6-x86_64/
     plugin_dir: /usr/local/mysql-5.1.50-osx10.6-x86_64/lib/plugin
    config_file: /etc/my.cnf
     binary_log: my_log.000068
 binary_log_pos: 212383
      relay_log: None
  relay_log_pos: None
1 rows.

Defaults for server localhost:3306
  --port=3306
  --basedir=/usr/local/mysql
  --datadir=/usr/local/mysql/data
  --server_id=5
  --log-bin=my_log
  --general_log
  --slow_query_log
  --innodb_data_file_path=ibdata1:778M;ibdata2:50M:autoextend
#...done.
```

PERMISSIONS REQUIRED

The permissions required include the ability to read the mysql database and to have read access to the data directory.

The user must have permissions to read the data directory or use an administrator or super user (sudo) account to obtain access to the data directory.

5.22 `mysqluc` — Command line client for running MySQL Utilities

This utility provides a command line environment for running MySQL Utilities.

The mysqluc utility, hence console, allows users to execute any of the currently installed MySQL Utilities commands (the MySQL Utility scripts such as mysqluserclone). The option `--utildir` is used to provide a path to the MySQL Utilities scripts if the location is different from where the utility is executed.

The console has a list of console or base commands. These allow the user to interact with the features of the console itself. The list of base commands is shown below along with a brief description.

```
Command                 Description
----------------------  ---------------------------------------------------
help utilities          Display list of all utilities supported.
help <utility>          Display help for a specific utility.
help | help commands    Show this list.
exit | quit             Exit the console.
set <variable>=<value>  Store a variable for recall in commands.
show options            Display list of options specified by the user on
                        launch.
show variables          Display list of variables.
<ENTER>                 Press ENTER to execute command.
<ESCAPE>                Press ESCAPE to clear the command entry.
<DOWN>                  Press DOWN to retrieve the previous command.
<UP>                    Press UP to retrieve the next command in history.
<TAB>                   Press TAB for type completion of utility, option,
                        or variable names.
<TAB><TAB>              Press TAB twice for list of matching type
                        completion (context sensitive).
```

One of the most helpful base commands is the ability to see the options for a given utility by typing 'help *utility*'. When the user enters this command, the console displays a list of all of the options for the utility.

The console provides tab completion for all commands, options for utilities, and user-defined variables. Tab completion for commands allows users to specify the starting N characters of a command and press TAB to complete the command. If there are more than one command that matches the prefix, and the user presses TAB twice, a list of all possible matches is displayed.

Tab completion for options is similar. The user must first type a valid MySQL Utility command then types the first N characters of a command and presses TAB, for example –-verb*TAB*. In this case, the console completes the option. For the cases where an option requires a value, the console completes the option name and append the '=' character. Tab completion for options works for both the full name and the alias (if available). If the user presses TAB twice, the console displays a list of matching options. Pressing TAB twice immediately after typing the name of a MySQL Utility displays a list of all options for that utility.

Tab completion for variables works the same as that for options. In this case, the user must first type the '$' character then press TAB. For example, if a variable $SERVER1 exists, when the user types –-server= $SER*TAB*, the console completes the $SERVER variable name. For cases where there are multiple variables, pressing TAB twice displays a list of all matches to the first $+N characters. Pressing TAB twice after typing only the $ character displays a list of all variables.

Note

The 'mysql' prefix is optional in the console. For example, typing 'disku*TAB*' in the console completes the command as 'diskusage '.

Executing utilities is accomplished by typing the complete command and pressing ENTER. The user does not have to type 'python' or provide the '.py' file extension. The console adds these if needed when the command is executed.

The user can also run commands using the option `--execute`. The value for this option is a semi-colon separated list of commands to execute. These can be base commands or MySQL Utility commands. The console executes each command and display the output. All commands to be run by the console must appear inside a quoted string and separated by semi-colons. Commands outside of the quoted string are treated as arguments for the mysqluc utility itself and thus ignored for execution.

Note

In the console, an error in the console or related code stop sexecuting commands at the point of failure. Commands may also be piped into the console using a mechanism such as 'echo "*commands*" | mysqluc'.

The console also allows users to set user-defined variables for commonly used values in options. The syntax is simply 'set VARNAME=VALUE'. The user can see a list of all variables by entering the 'show variables' command. To use the values of these variables in utility commands, the user must prefix the value with a '$'. For example, --server=$SERVER1 substitutes the value of the SERVER1 user-defined variable when the utility is executed.

Note

User-defined variables have a session lifetime. They are not saved from one execution to another in the users console.

User-defined variables may also be set by passing them as arguments to the mysqluc command. For example, to set the SERVER1 variable and launch the console, the user can launch the console using this command.:

```
shell> mysqluc SERVER1=root@localhost
```

The user can provide any number of user-defined variables but they must contain a value and no spaces around the '=' character. Once the console is launched, the user can see all variables using the 'show variables' command.

OPTIONS

- --version

  show program's version number and exit

- --help

  show the program's help page

- --license

  Display license information and exit.

- --verbose, -v

  control how much information is displayed. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug

- --quiet

  suppress all informational messages

- --execute *commands*, -e *commands*

  Execute commands and exit. Multiple commands are separated with semi-colons.

  Note

  Some platforms may require double quotes around the command list.

- --utildir *path*

  location of utilities

- --width *number*

  Display width

NOTES

Using the `--execute` option or piping commands to the console may require quotes or double quotes (for example, on Windows).

EXAMPLES

To launch the console, use this command:

```
shell> mysqluc
```

The following demonstrates launching the console and running the console command 'help utilities' to see a list of all utilities supported. The console executes the command then exits.:

```
shell> mysqluc -e "help utilities"

Utility             Description
----------------    ---------------------------------------------------------
mysqlindexcheck     check for duplicate or redundant indexes
mysqlrplcheck       check replication
mysqluserclone      clone a MySQL user account to one or more new users
mysqldbcompare      compare databases for consistency
mysqldiff           compare object definitions among objects where the
                    difference is how db1.obj1 differs from db2.obj2
mysqldbcopy         copy databases from one server to another
mysqlreplicate      establish replication with a master
mysqldbexport       export metadata and data from databases
mysqldbimport       import metadata and data from files
mysqlmetagrep       search metadata
mysqlprocgrep       search process information
mysqldiskusage      show disk usage for databases
mysqlserverinfo     show server information
mysqlserverclone    start another instance of a running server
```

The following demonstrates launching the console to run several commands using the --execute option to including setting a variable for a server connection and executing a utility using variable substitution.

Note

It may be necessary to escape the '$' on some platforms, such as Linux.

The output below is an excerpt and is representational only:

```
shell> mysqluc -e "set SERVER=root@host123; mysqldiskusage --server=\$SERVER"

# Source on host123: ... connected.

NOTICE: Your user account does not have read access to the datadir. Data
sizes will be calculated and actual file sizes may be omitted. Some features
may be unavailable.
```

```
# Database totals:
+---------------------+--------------+
| db_name             |       total  |
+---------------------+--------------+
...
| world               |           0  |
...
+---------------------+--------------+

Total database disk usage = 1,072,359,052 bytes or 1022.00 MB

#...done.
```

The following demonstrates launching the console using the commands shown above but piped into the console on the command line. The results are the same as above.:

```
shell> echo "set SERVER=root@host123; mysqldiskusage --server=\$SERVER" | mysqluc
```

The following demonstrates launching the console and setting variables via the command line.:

```
shell> mysqluc SERVER=root@host123 VAR_A=57 -e "show variables"

Variable  Value
--------  -----------------------------------------------------------------
SERVER    root@host123
VAR_A     57
```

PERMISSIONS REQUIRED

There are no special permissions required to run `mysqluc` however, you must have the necessary privileges to execute the desired utilities. See the PERMISSIONS REQUIRED section for each command you wish to execute.

5.23 `mysqluserclone` — Clone Existing User to Create New User

This utility uses an existing MySQL user account on one server as a template, and clones it to create one or more new user accounts with the same privileges as the original user. The new users can be created on the original server or a different server.

To list users for a server, specify the `--list` option. This prints a list of the users on the source (no destination is needed). To control how to display list output, use one of the following values with the `--format` option:

- **grid** (default)

  Display output in grid or table format like that of the `mysql` client command-line tool.

- **csv**

  Display output in comma-separated values format.

- **tab**

  Display output in tab-separated format.

- **vertical**

  Display output in single-column format like that of the `\G` command for the `mysql` client command-line tool.

OPTIONS

`mysqluserclone` accepts the following command-line options:

- --help

  Display a help message and exit.

- --license

  Display license information and exit.

- --destination=*`destination`*

  Connection information for the destination server.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]

  - Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]

  - Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --dump, -d

  Display the **GRANT** statements to create the account rather than executing them. In this case, the utility does not connect to the destination server and no `--destination` option is needed.

- --format=*`list_format`*, -f*`list_format`*

  Specify the user display format. Permitted format values are **grid**, **csv**, **tab**, and **vertical**. The default is **grid**. This option is valid only if `--list` is given.

- --force

  Drop the new user account if it exists before creating the new account. Without this option, it is an error to try to create an account that already exists.

- --include-global-privileges

  Include privileges that match `base_user@%` as well as `base_user@host`.

- --list

  List all users on the source server. With this option, a destination server need not be specified.

- --quiet, -q

  Turn off all messages for quiet execution.

- --source=*`source`*

Connection information for the source server.

To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

- Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]
- Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : *`configuration-file-path`*[:*`section`*]
- Specify the data on the command-line (unencrypted, visible). Example : *`user`*[:*`passwd`*]@*`host`*[:*`port`*][:*`socket`*]

- --ssl-ca

  The path to a file that contains a list of trusted SSL CAs.

- --ssl-cert

  The name of the SSL certificate file to use for establishing a secure connection.

- --ssl-key

  The name of the SSL key file to use for establishing a secure connection.

- --ssl

  Specifies if the server connection requires use of SSL. If an encrypted connection cannot be established, the connection attempt fails. Default setting is 0 (SSL not required).

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug.

- --version

  Display version information and exit.

NOTES

For the `--format` option, the permitted values are not case sensitive. In addition, values may be specified as any unambiguous prefix of a valid value. For example, `--format=g` specifies the grid format. An error occurs if a prefix matches more than one valid value.

The path to the MySQL client tools should be included in the PATH environment variable in order to use the authentication mechanism with login-paths. This permits the utility to use the my_print_defaults tools which is required to read the login-path values from the login configuration file (.mylogin.cnf).

EXAMPLES

To clone `joe` as `sam` and `sally` with passwords and logging in as `root` on the local machine, use this command:

```
shell> mysqluserclone --source=root@localhost \
          --destination=root@localhost \
          joe@localhost sam:secret1@localhost sally:secret2@localhost
# Source on localhost: ... connected.
# Destination on localhost: ... connected.
# Cloning 2 users...
# Cloning joe@localhost to user sam:secret1@localhost
# Cloning joe@localhost to user sally:secret2@localhost
# ...done.
```

The following command shows all users on the local server in the most verbose output in CSV format:

```
shell> mysqluserclone --source=root@localhost --list --format=csv -vvv
# Source on localhost: ... connected.
user,host,database
joe,localhost,util_test
rpl,localhost,
sally,localhost,util_test
sam,localhost,util_test
joe,user,util_test
```

PERMISSIONS REQUIRED

The account used on the source server must have privileges to read the **mysql** database. The account used to connect to the destination server must have privileges to execute **CREATE USER** (and **DROP USER** if the `--force` option is given), and privileges to execute **GRANT** for all privileges to be granted to the new accounts.

Chapter 6 Extending MySQL Utilities

Table of Contents

This chapter introduces the architecture for the MySQL Utilities library and demonstrates how to get started building your own utilities.

6.1 Introduction to extending the MySQL Utilities

Administration and maintenance on the MySQL server can at times be complicated. Sometimes tasks require tedious or even repetitive operations that can be time consuming to type and re-type. For these reasons and more, the MySQL Utilities were created to help both beginners and experienced database administrators perform common tasks.

What are the internals of the MySQL Utilities?

MySQL Utilities are designed as a collection of easy to use Python scripts that can be combined to provide more powerful features. Internally, the scripts use the mysql.utilities module library to perform its various tasks. Since a library of common functions is available, it is easy for a database administrator to create scripts for common tasks. These utilities are located in the `/scripts` folder of the installation or source tree.

If you have a task that is not met by these utilities or one that can be met by combining one or more of the utilities or even parts of the utilities, you can easily form your own custom solution. The following sections present an example of a custom utility, discussing first the anatomy of a utility and then what the `mysql.utilities` module library has available.

Anatomy of a MySQL Utility

MySQL Utilities use a three-tier module organization. At the top is the command script, which resides in the `/scripts` folder of the installation or source tree. Included in the script is a command module designed to encapsulate and isolate the bulk of the work performed by the utility. The command module resides in the `/mysql/utilities/command` folder of the source tree. Command modules have names similar to the script. A command module includes classes and methods from one or more common modules where the abstract objects and method groups are kept. The common modules reside in the `/mysql/utilities/common` folder of the source tree. The following illustrates this arrangement using the `mysqlserverinfo` utility:

```
/scripts/mysqlserverinfo.py
    |
    +--- /mysql/utilities/command/serverinfo.py
            |
            +--- /mysql/utilities/common/options.py
            |
            +--- /mysql/utilities/common/server.py
            |
            +--- /mysql/utilities/common/tools.py
            |
            +--- /mysql/utilities/common/format.py
```

Each utility script is designed to process the user input and option settings and pass them on to the command module. Thus, the script contains only such logic for managing and validating options. The work of the operation resides in the command module.

Command modules are designed to be used from other Python applications. For example, one could call the methods in the `serverinfo.py` module from another Python script. This enables developers to create their own interfaces to the utilities. It also permits developers to combine several utilities to form a macro-level utility tailored to a specified need. For example, if there is a need to gather server information as well as disk usage, it is possible to import the `serverinfo.py` and `diskusage.py` modules and create a new utility that performs both operations.

Common modules are the heart of the MySQL Utilities library. These modules contain classes that abstract MySQL objects, devices, and mechanisms. For example, there is a server class that contains operations to be performed on servers, such as connecting (logging in) and running queries.

The MySQL Utilities Library

Although the library is growing, the following lists the current common modules and the major classes and methods as of the 1.0.1 release:

```
Module     Class/Method              Description
---------- ------------------------- ----------------------------------------
database   Database                  Perform database-level operations
dbcompare  get_create_object         Retrieve object create statement
           diff_objects              Diff definitions of two objects
           check_consistency         Check data consistency of two tables
format     format_tabular_list       Format list in either GRID or
                                     delimited format to a file
           format_vertical_list      Format list in a vertical format to
                                     a file
           print_list                Print list based on format (CSV,
                                     GRID, TAB, or VERTICAL)
options    setup_common_options      Set up option parser and options common
                                     to all MySQL Utilities
           add_skip_options          Add common --skip options
           check_skip_options        Check skip options for validity
           check_format_option       Check format option for validity
           add_verbosity             Add verbosity and quiet options
           check_verbosity           Check whether both verbosity and quiet
                                     options are being used
           add_difftype              Add difftype option
           add_engines               Add engine, default-storage-engine
                                     options
           check_engine_options      Check whether storage engines listed
                                     in options exist
           parse_connection          Parse connection values
rpl        Replication               Establish replication connection
                                     between a master and a slave
           get_replication_tests     Return list of replication test function
                                     pointers
server     get_connection_dictionary Get connection dictionary
           find_running_servers      Check whether any servers are
                                     running on the local host
           connect_servers           Connect to source and destination server
           Server                    Connect to running MySQL server
                                     and perform server-level operations
table      Index                     Encapsulate index for a given table
                                     as defined by SHOW INDEXES
           Table                     Encapsulate table for given database
                                     to perform table-level operations
tools      get_tool_path             Search for MySQL tool and return its
```

```
                                     full path
           delete_directory          Remove directory (folder) and contents
user       parse_user_host           Parse user, passwd, host, port from
                                     user:passwd@host
           User                      Clone user and its grants to another
                                     user and perform user-level operations
```

General Interface Specifications and Code Practices

The MySQL Utilities are designed and coded using mainstream coding practices and techniques common to the Python community. Effort has been made to adhere to the most widely accepted specifications and techniques. This includes limiting the choice of libraries used to the default libraries found in the Python distributions. This ensures easier installation, enhanced portability, and fewer problems with missing libraries. Similarly, external libraries that resort to platform-specific native code are also not used.

The class method and function signatures are designed to make use of a small number of required parameters and all optional parameters as a single dictionary. Consider the following method:

```
def do_something_wonderful(position, obj1, obj2, options={}):
    """Does something wonderful

    A fictional method that does something to object 2 based on the
    location of something in object 1.

    position[in]   Position in obj1
    obj1[in]       First object to manipulate
    obj2[in]       Second object to manipulate
    options[in]    Option dictionary
      width        width of printout (default 75)
      iter         max iterations (default 2)
      ok_to_fail   if True, do not throw exception
                   (default True)

    Returns bool - True = success, Fail = failed
    """
```

This example is typical of the methods and classes in the library. Notice that this method has three required parameters and a dictionary of options that may exist.

Each method and function that uses this mechanism defines its own default values for the items in the dictionary. A quick look at the method documentation shows the key names for the dictionary. This can be seen in the preceding example where the dictionary contains three keys and the documentation lists their defaults.

To call this method and pass different values for one or more of the options, the code may look like this:

```
opt_dictionary = {
  'width'      : 100,
  'iter'       : 10,
  'ok_to_fail' : False,
}
result = do_something_wonderful(1, obj_1, obj_2, opt_dictionary)
```

The documentation block for the preceding method is the style used throughout the library.

Example

Now that you are familiar with the MySQL utilities and the supporting library modules, let us take a look at an example that combines some of these modules to solve a problem.

Suppose that you want to develop a new database solution and need to use real world data and user accounts for testing. The `mysqlserverclone` MySQL utility looks like a possibility but it makes only an instance of a running server. It does not copy data. However, mysqldbcopy makes a copy of the data and mysqluserclone clones the users. You could run each of these utilities in sequence, and that would work, but we are lazy at heart and want something that not only copies everything but also finds it for us. That is, we want a one-command solution.

The good news is that this is indeed possible and very easy to do. Let us start by breaking the problem down into its smaller components. In a nutshell, we must perform these tasks:

- Connect to the original server
- Find all of the databases
- Find all of the users
- Make a clone of the original server
- Copy all of the databases
- Copy all of the users

If you look at the utilities and the modules just listed, you see that we have solutions and primitives for each of these operations. So you need not even call the MySQL utilities directly (although you could). Now let us dive into the code for this example.

The first task is to connect to the original server. We use the same connection mechanism as the other MySQL utilities by specifying a --server option like this:

```
parser.add_option("--server", action="store", dest="server",
                  type="string", default="root@localhost:3306",
                  help="connection information for original server in " + \
                  "the form: user:password@host:port:socket")
```

Once we process the options and arguments, connecting to the server is easy: Use the parse_connection method to take the server option values and get a dictionary with the connection values. All of the heavy diagnosis and error handling is done for us, so we just need to check for exceptions:

```
from mysql.utilities.common.options import parse_connection

try:
    conn = parse_connection(opt.server)
except:
    parser.error("Server connection values invalid or cannot be parsed.")
```

Now that we have the connection parameters, we create a class instance of the server using the Server class from the server module and then connect. Once again, we check for exceptions:

```
from mysql.utilities.common.server import Server

server_options = {
    'conn_info' : conn,
    'role'      : "source",
}
server1 = Server(server_options)
try:
    server1.connect()
except UtilError, e:
    print "ERROR:", e.errmsg
```

The next item is to get a list of all of the databases on the server. We use the new server class instance to retrieve all of the databases on the server:

```
db_list = []
```

```
for db in server1.get_all_databases():
    db_list.append((db[0], None))
```

If you wanted to supply your own list of databases, you could use an option like the following. You could also add an `else` clause which would enable you to either get all of the databases by omitting the `--databases` option or supply your own list of databases (for example, `--databases=db1,db2,db3`):

```
parser.add_option("-d", "--databases", action="store", dest="dbs_to_copy",
                  type="string", help="comma-separated list of databases "
                  "to include in the copy (omit for all databases)",
                  default=None)

if opt.dbs_to_copy is None:
    for db in server1.get_all_databases():
        db_list.append((db[0], None))
else:
    for db in opt.dbs_to_copy.split(","):
        db_list.append((db, None))
```

Notice we are creating a list of tuples. This is because the `dbcopy` module uses a list of tuples in the form (*old_db*, *new_db*) to enable you to copy a database to a new name. For our purposes, we do not want a rename so we leave the new name value set to `None`.

Next, we want a list of all of the users. Once again, you could construct the new solution to be flexible by permitting the user to specify the users to copy. We leave this as an exercise.

In this case, we do not have a primitive for getting all users created on a server. But we do have the ability to run a query and process the results. Fortunately, there is a simple SQL statement that can retrieve all of the users on a server. For our purposes, we get all of the users except the root and anonymous users, then add each to a list for processing later:

```
users = server1.exec_query("SELECT user, host "
                           "FROM mysql.user "
                           "WHERE user != 'root' and user != ''")
for user in users:
    user_list.append(user[0]+'@'+user[1])
```

Now we must clone the original server and create a viable running instance. When you examine the `mysqlserverclone` utility code, you see that it calls another module located in the `/mysql/utilities/command` sub folder. These modules are where all of the work done by the utilities take place. This enables you to create new combinations of the utilities by calling the actual operations directly. Let's do that now to clone the server.

The first thing you notice in examining the `serverclone` module is that it takes a number of parameters for the new server instance. We supply those in a similar way as options:

```
parser.add_option("--new-data", action="store", dest="new_data",
                  type="string", help="the full path to the location "
                  "of the data directory for the new instance")
parser.add_option("--new-port", action="store", dest="new_port",
                  type="string", default="3307", help="the new port "
                       "for the new instance - default=%default")
parser.add_option("--new-id", action="store", dest="new_id",
                  type="string", default="2", help="the server_id for "
                       "the new instance - default=%default")

from mysql.utilities.command import serverclone

try:
    res = serverclone.clone_server(conn, opt.new_data, opt.new_port,
                                   opt.new_id, "root", None, False, True)
except exception.UtilError, e:
    print "ERROR:", e.errmsg
    sys.exit()
```

As you can see, the operation is very simple. We just added a few options we needed like `--new-data`, `--new-port`, and `--new-id` (much like `mysqlserverclone`) and supplied some default values for the other parameters.

Next, we need to copy the databases. Once again, we use the command module for `mysqldbcopy` to do all of the work for us. First, we need the connection parameters for the new instance. This is provided in the form of a dictionary. We know the instance is a clone, so some of the values are going to be the same and we use a default root password, so that is also known. Likewise, we specified the data directory and, since we are running on a Linux machine, we know what the socket path is. (For Windows machines, you can leave the socket value None.) We pass this dictionary to the copy method:

```
dest_values = {
    "user"   : conn.get("user"),
    "passwd" : "root",
    "host"   : conn.get("host"),
    "port"   : opt.new_port,
    "unix_socket" : os.path.join(opt.new_data, "mysql.sock")
}
```

In this case, a number of options are needed to control how the copy works (for example, if any objects are skipped). For our purposes, we want all objects to be copied so we supply only the minimal settings and let the library use the defaults. This example shows how you can 'fine tune' the scripts to meet your specific needs without having to specify a lot of additional options in your script. We enable the quiet option on so as not to clutter the screen with messages, and tell the copy to skip databases that do not exist (in case we supply the `--databases` option and provide a database that does not exist):

```
options = {
    "quiet" : True,
    "force" : True
}
```

The actual copy of the databases is easy. Just call the method and supply the list of databases:

```
from mysql.utilities.command import dbcopy

try:
    dbcopy.copy_db(conn, dest_values, db_list, options)
except exception.UtilError, e:
    print "ERROR:", e.errmsg
    sys.exit()
```

Lastly, we copy the user accounts. Once again, we must provide a dictionary of options and call the command module directly. In this case, the `userclone` module provides a method that clones one user to one or more users so we must loop through the users and clone them one at a time:

```
from mysql.utilities.command import userclone

options = {
    "overwrite" : True,
    "quiet"     : True,
    "globals"   : True
}

for user in user_list:
    try:
        res = userclone.clone_user(conn, dest_values, user,
                                   (user,), options)
    except exception.UtilError, e:
        print "ERROR:", e.errmsg
        sys.exit()
```

We are done. As you can see, constructing new solutions from the MySQL utility command and common modules is easy and is limited only by your imagination.

Enhancing the Example

A complete solution for the example named `copy_server.py` is located in the appendix. It is complete in so far as this document explains, but it can be enhanced in a number of ways. The following briefly lists some of the things to consider adding to make this example utility more robust.

- Table locking: Currently, databases are not locked when copied. To achieve a consistent copy of the data on an active server, you may want to add table locking or use transactions (for example, if you are using InnoDB) for a more consistent copy.
- Skip users not associated with the databases being copied.
- Do not copy users with only global privileges.
- Start replication after all of the users are copied (makes this example a clone and replicate scale out solution).
- Stop new client connections to the server during the copy.

Conclusion

If you find some primitives missing or would like to see more specific functionality in the library or scripts, please contact us with your ideas or better still, write them yourselves! We welcome all suggestions in code or text. To file a feature request or bug report, visit http://bugs.mysql.com. For discussions, visit http://forums.mysql.com/list.php?155.

6.2 MySQL Utilities copy_server.py sample

```
#
# Copyright (c) 2010, 2013, Oracle and/or its affiliates. All rights reserved.
#
# This program is free software; you can redistribute it and/or modify
# it under the terms of the GNU General Public License as published by
# the Free Software Foundation; version 2 of the License.
#
# This program is distributed in the hope that it will be useful,
# but WITHOUT ANY WARRANTY; without even the implied warranty of
# MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
# GNU General Public License for more details.
#
# You should have received a copy of the GNU General Public License
# along with this program; if not, write to the Free Software
# Foundation, Inc., 51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA
#

"""
This file contains an example of how to build a customized utility using
the MySQL Utilities scripts and libraries.
"""

import optparse
import os
import sys

from mysql.utilities import VERSION_FRM
from mysql.utilities.command import dbcopy
from mysql.utilities.command import serverclone
from mysql.utilities.command import userclone
from mysql.utilities.common.server import Server
from mysql.utilities.common.options import parse_connection
from mysql.utilities.exception import UtilError

# Constants
NAME = "example - copy_server "
DESCRIPTION = "copy_server - copy an existing server"
USAGE = "%prog --server=user:pass@host:port:socket " \
        "--new-dir=<path> --new-id=<server_id> " \
        "--new-port=<port> --databases=<db list> " \
        "--users=<user list>"

# Setup the command parser
parser = optparse.OptionParser(
    version=VERSION_FRM.format(program=os.path.basename(sys.argv[0])),
    description=DESCRIPTION,
    usage=USAGE,
    add_help_option=False)
parser.add_option("--help", action="help")

# Setup utility-specific options:

# Connection information for the source server
parser.add_option("--server", action="store", dest="server",
                  type="string", default="root@localhost:3306",
                  help="connection information for original server in " + \
                  "the form: <user>:<password>@<host>:<port>:<socket>")

# Data directory for new instance
parser.add_option("--new-data", action="store", dest="new_data",
                  type="string", help="the full path to the location "
                  "of the data directory for the new instance")

# Port for the new instance
parser.add_option("--new-port", action="store", dest="new_port",
                  type="string", default="3307", help="the new port "
                       "for the new instance - default=%default")

# Server id for the new instance
parser.add_option("--new-id", action="store", dest="new_id",
                  type="string", default="2", help="the server_id for "
                       "the new instance - default=%default")

# List of databases
parser.add_option("-d", "--databases", action="store", dest="dbs_to_copy",
                  type="string", help="comma-separated list of databases "
                  "to include in the copy (omit for all databases)",
                  default=None)

# List of users
parser.add_option("-u", "--users", action="store", dest="users_to_copy",
                  type="string", help="comma-separated list of users "
                  "to include in the copy (omit for all users)",
                  default=None)

# Now we process the rest of the arguments.
opt, args = parser.parse_args()

# Parse source connection values
try:
    conn = parse_connection(opt.server)
except:
    parser.error("Server connection values invalid or cannot be parsed.")

# Get a server class instance
print "# Connecting to server..."
server_options = {
    'conn_info' : conn,
    'role'      : "source",
}
server1 = Server(server_options)
try:
    server1.connect()
except UtilError, e:
    print "ERROR:", e.errmsg

# Get list of databases from the server if not specified in options
print "# Getting databases..."
db_list = []
if opt.dbs_to_copy is None:
    for db in server1.get_all_databases():
        db_list.append((db[0], None))
else:
    for db in opt.dbs_to_copy.split(","):
        db_list.append((db, None))

# Get list of all users from the server
print "# Getting users..."
user_list=[]
if opt.users_to_copy is None:
    users = server1.exec_query("SELECT user, host "
                               "FROM mysql.user "
                               "WHERE user != 'root' and user != ''")
    for user in users:
        user_list.append(user[0]+'@'+user[1])
else:
    for user in opt.users_to_copy.split(","):
        user_list.append(user)

# Build options
options = {
    'new_data'       : opt.new_data,
    'new_port'       : opt.new_port,
    'new_id'         : opt.new_id,
    'root_pass'      : 'root',
    'mysqld_options' : '--report-host=localhost --report-port=%s' % opt.new_port,
}

# Clone the server
print "# Cloning server instance..."
try:
    res = serverclone.clone_server(conn, options)
except UtilError, e:
    print "ERROR:", e.errmsg
    sys.exit()

# Set connection values
dest_values = {
    "user"   : conn.get("user"),
    "passwd" : "root",
    "host"   : conn.get("host"),
    "port"   : opt.new_port,
    "unix_socket" : os.path.join(opt.new_data, "mysql.sock")
}

# Build dictionary of options
options = {
    "quiet" : True,
    "force" : True
}

print "# Copying databases..."
try:
    dbcopy.copy_db(conn, dest_values, db_list, options)
except UtilError, e:
    print "ERROR:", e.errmsg
    sys.exit()

# Build dictionary of options
options = {
    "overwrite" : True,
    "quiet"     : True,
    "globals"   : True
}

print "# Cloning the users..."
for user in user_list:
    try:
        res = userclone.clone_user(conn, dest_values, user,
                                   (user,), options)
    except UtilError, e:
        print "ERROR:", e.errmsg
        sys.exit()

print "# ...done."
```

6.3 Specialized Operations

6.3.1 `mysql.utilities.command.grep` — Search Databases for Objects

This module provides utilities to search for objects on a server. The module defines a set of *object types* to be searched. Searches target the *fields* of each object. The notion of an object field is very loosely defined and means any names occurring as part of the object definition. For example, the fields of a table include the table name, the column names, and the partition names (if it is a partitioned table).

Constants

The following constants denote the object types that can be searched.

- `mysql.utilities.command.grep.ROUTINE`
- `mysql.utilities.command.grep.EVENT`
- `mysql.utilities.command.grep.TRIGGER`
- `mysql.utilities.command.grep.TABLE`
- `mysql.utilities.command.grep.DATABASE`
- `mysql.utilities.command.grep.VIEW`
- `mysql.utilities.command.grep.USER`

The following constant is a sequence of all the object types that are available. It can be used to generate a version-independent list of object types that can be searched; for example, options and help texts.

- `mysql.utilities.command.grep.OBJECT_TYPES`

Classes

class mysql.utilities.command.grep.ObjectGrep(pattern[, database_pattern=None, types=OBJECT_TYPES, check_body=False, use_regexp=False])

Search MySQL server instances for objects where the name (or content, for routines, triggers, or events) matches a given pattern.

sql() - string

Return the SQL code for executing the search in the form of a `SELECT` statement.

Returns:	SQL code for executing the operation specified by the options.
Return type:	string

execute(connections[, output=sys.output, connector=mysql.connector])

Execute the search on each of the connections in turn and print an aggregate of the result as a grid table.

Parameters:	• **connections** Sequence of connection specifiers to send the query to • **output** File object to use for writing the result • **connector** Connector to use for connecting to the servers

6.3.2 `mysql.utilities.command.proc` — Search Processes on Servers

This module searches processes on a server and optionally kills either the query or the connection for all matches.

Processes are matched by searching the fields of the `INFORMATION_SCHEMA.PROCESSLIST` table (which is available only for servers from MySQL 5.1.7 and later). Internally, the module operates by constructing a `SELECT` statement for finding matching processes, and then sending it to the server. Instead of performing the search, the module can return the SQL code that performs the query. This can be useful if you want to execute the query later or feed it to some other program that processes SQL queries further.

Constants

The following constants correspond to fields in the `INFORMATION_SCHEMA.PROCESSLIST` table. They indicate which columns to examine when searching for processes matching the search conditions.

- `mysql.utilities.command.proc.ID`
- `mysql.utilities.command.proc.USER`
- `mysql.utilities.command.proc.HOST`
- `mysql.utilities.command.proc.DB`
- `mysql.utilities.command.proc.COMMAND`
- `mysql.utilities.command.proc.TIME`
- `mysql.utilities.command.proc.STATE`
- `mysql.utilities.command.proc.INFO`

The following constants indicate actions to perform on processes that match the search conditions.

- `mysql.utilities.command.proc.KILL_QUERY`

  Kill the process query

- `mysql.utilities.command.proc.KILL_CONNECTION`

  Kill the process connection

- `mysql.utilities.command.proc.PRINT_PROCESS`

  Print the processes

Classes

class mysql.utilities.command.proc.ProcessGrep(matches, actions=[], use_regexp=False)

This class searches the `INFORMATION_SCHEMA.PROCESSLIST` table for processes on MySQL servers and optionally kills them. It can be used to perform a search (and optionally kill), or to generate the SQL statement for doing the same.

For example, to kill all queries with user 'mats', use the following code:

```
>>> from mysql.utilities.command.proc import *
>>> grep = ProcessGrep(matches=[(USER, "mats")], actions=[KILL_QUERY])
>>> grep.execute("root@server-1.example.com", "root@server-2.example.com")
```

Parameters:	• **matches** (List of *(var, pat)* pairs) Sequence of field comparison conditions. In each condition, *var* is one of the constants listed earlier that specify `PROCESSLIST` table fields and *pat* is a pattern. For a process to match, all field conditions must match.

sql([only_body=False])

Return the SQL code for executing the search (and optionally, the kill).

If *only_body* is `True`, only the body of the function is shown. This is useful if the SQL code is to be used with other utilities that generate the routine declaration. If *only_body* is `False`, a complete procedure is generated if there is any kill action supplied, and just a SELECT statement if it is a plain search.

Parameters:	• **only_body** (*boolean*) Show only the body of the procedure. If this is `False`, a complete procedure is returned.
Returns:	SQL code for executing the operation specified by the options.
Return type:	string

execute(connections, ...[, output=sys.stdout, connector=mysql.connector])

Execute the search on each of the connections supplied. If *output* is not `None`, the value is treated as a file object and the result of the execution is printed on that stream. Note that the output and connector arguments *must* be supplied as keyword arguments. All other arguments are treated as connection specifiers.

Parameters:	• **connections** Sequence of connection specifiers to send the search to • **output** File object to use for writing the result • **connector** Connector to use for connecting to the servers

6.4 Parsers

6.4.1 mysql.utilities.parser — Parse MySQL Log Files

This module provides classes for parsing MySQL log files. Currently, *Slow Query Log* and *General Query Log* are supported.

Classes

class mysql.utilities.parser.GeneralQueryLog(stream)

This class parses the MySQL General Query Log. Instances support iteration, but the class does not provide multiple independent iterators.

For example, to read the log and print the entries:

```
>>> general_log = open("/var/lib/mysql/mysql.log")
>>> log = GeneralQueryLog(general_log)
>>> for entry in log:
...     print entry
```

Parameters:	• **stream** (*file type*) – a valid file type; for example, the result of the built-in Python function open()

version

Returns:	Version of the MySQL server that produced the log
Return type:	tuple

program

Returns:	Full path of the MySQL server executable
Return type:	str

port

Returns:	TCP/IP port on which the MySQL server was listening
Return type:	int

socket

Returns:	Full path of the MySQL server Unix socket
Return type:	str

start_datetime

Returns:	Date and time of the first read log entry
Return type:	datetime.datetime

lastseen_datetime

Returns:	Date and time of the last read log entry
Return type:	datetime.datetime

class mysql.utilities.parser.SlowQueryLog(stream)

This class parses the MySQL Slow Query Log. Instances support iteration, but the class does not provide multiple independent iterators.

For example, to read the log and print the entries:

```
>>> slow_log = open("/var/lib/mysql/mysql-slow.log")
>>> log = SlowQueryLog(slow_log)
>>> for entry in log:
...     print entry
```

Parameters:	• **stream** (*file type*) – a valid file type; for example, the result of the built-in Python function open()

version

Returns:	Version of the MySQL server that produced the log
Return type:	tuple

program

Returns:	Full path of the MySQL server executable
Return type:	str

port

Returns:	TCP/IP port on which the MySQL server was listening
Return type:	int

socket

Returns:	Full path of the MySQL server Unix socket
Return type:	str

start_datetime

Returns:	Date and time of the first read log entry
Return type:	datetime.datetime

lastseen_datetime

Returns:	Date and time of the last read log entry
Return type:	datetime.datetime

Chapter 7 MySQL Utilities Testing (MUT)

Table of Contents

7.1 `mut` — MySQL Utilities Testing

This utility executes predefined tests to test the MySQL Utilities. The tests are located under the `/mysql-test` directory and divided into suites (stored as folders). By default, all tests located in the `/t` folder are considered the 'main' suite.

You can select any number of tests to run, select one or more suites to restrict the tests, exclude suites and tests, and specify the location of the utilities and tests.

The utility requires the existence of at least one server to clone for testing purposes. You must specify at least one server, but you may specify multiple servers for tests designed to use additional servers.

The utility has a special test suite named 'performance' where performance-related tests are placed. This suite is not included by default and must be specified with the `--suite` option to execute the performance tests.

OPTIONS

`mut` accepts the following command-line options:

- --help

  Display a help message and exit.

- --do-tests=*`prefix`*

  Execute all tests that begin with *prefix*.

- --force

  Do not abort when a test fails.

- --record

  Record the output of the specified test if successful. With this option, you must specify exactly one test to run.

- --server=*`server`*

  Connection information for the server to use in the tests. Use this option multiple times to specify multiple servers.

  To connect to a server, it is necessary to specify connection parameters such as the user name, host name, password, and either a port or socket. MySQL Utilities provides a number of ways to supply this information. All of the methods require specifying your choice via a command-line option such as --server, --master, --slave, etc. The methods include the following in order of most secure to least secure.

  - Use login-paths from your `.mylogin.cnf` file (encrypted, not visible). Example : *`login-path`*[:*`port`*][:*`socket`*]

- Use a configuration file (unencrypted, not visible) Note: available in release-1.5.0. Example : `configuration-file-path`[:`section`]
- Specify the data on the command-line (unencrypted, visible). Example : `user`[:`passwd`]@`host`[:`port`][:`socket`]

- --skip-long

  Exclude tests that require greater resources or take a long time to run.

- --skip-suite=`name`

  Exclude the named test suite. Use this option multiple times to specify multiple suites.

- --skip-test=`name`

  Exclude the named test. Use this option multiple times to specify multiple tests.

- --skip-tests=`prefix`

  Exclude all tests that begin with *prefix*.

- --sort

  Execute tests sorted by suite.name either ascending (asc) or descending (desc). Default is ascending (asc).

- --start-port=`port`

  The first port to use for spawned servers. If you run the entire test suite, you may see up to 12 new instances created. The default is to use ports 3310 to 3321.

- --start-test=`prefix`

  Start executing tests that begin with *prefix*.

- --stop-test=`prefix`

  Stop executing tests at the first test that begins with *prefix*.

- --suite=`name`

  Execute the named test suite. Use this option multiple times to specify multiple suites.

- --testdir=`path`

  The path to the test directory.

- --utildir=`path`

  The location of the utilities.

- --verbose, -v

  Specify how much information to display. Use this option multiple times to increase the amount of information. For example, `-v` = verbose, `-vv` = more verbose, `-vvv` = debug. To diagnose test execution problems, use `-vvv` to display the actual results of test cases and ignore result processing.

- --version

Display version information and exit.

- --width=*number*

  Specify the display width. The default is 75 characters.

NOTES

The connection specifier must name a valid account for the server.

Any test named *???_template.py* is skipped. This enables the developer to create a base class to import for a collection of tests based on a common code base.

EXAMPLES

The following example demonstrates how to invoke `mut` to execute a subset of the tests using an existing server which is cloned. The example displays the test name, status, and relative time:

```
shell> mut --server=root@localhost --do-tests=clone_user --width=70

MySQL Utilities Testing - MUT

Parameters used:
  Display Width       = 70
  Sorted              = True
  Force               = False
  Test directory      = './t'
  Utilities directory = '../scripts'
  Starting port       = 3310
  Test wildcard       = 'clone_user%'

Servers:
  Connecting to localhost as user root on port 3306: CONNECTED

----------------------------------------------------------------------
TEST NAME                                                STATUS   TIME
======================================================================
main.clone_user                                          [pass]     54
main.clone_user_errors                                   [pass]     27
main.clone_user_parameters                               [pass]     17
----------------------------------------------------------------------
Testing completed: Friday 03 December 2010 09:50:06

All 3 tests passed.
```

PERMISSIONS REQUIRED

There are no special permissions required to run `mysqluc` however, you must have the necessary privileges to execute the desired utilities in the tests. Generally, MUT is run with a root user.

Chapter 8 MySQL Fabric

Table of Contents

MySQL Fabric is a system for managing a farm of MySQL servers. MySQL Fabric provides an extensible and easy to use system for managing a MySQL deployment for sharding and high-availability.

This document describes MySQL Fabric, beginning with a short introduction, providing instructions on how to download and install MySQL Fabric, and a quick-start guide to help you begin using and experimenting with MySQL Fabric. Later sections provide details for MySQL Fabric-aware connectors.

For notes detailing the changes in each release, see the MySQL Utilities Release Notes.

8.1 Introduction to Fabric

To take advantage of Fabric, an application requires an augmented version of a MySQL connector which accesses Fabric using the XML-RPC protocol. Currently, Connector/Python and Connector/J are fabric-aware.

Fabric manages sets of MySQL Servers that have Global Transaction Identifiers (GTIDs) enabled to check and maintain consistency among servers. Sets of servers are called *high-availability groups*. Information about all of the servers and groups is managed by a separate MySQL instance, which cannot be a member of the Fabric high-availability groups. This server instance is called the *backing store*.

Fabric organizes servers in groups (called *high-availability groups*) for managing different shards or simply for providing high availability. For example, if standard asynchronous replication is in use, Fabric may be configured to automatically monitor the status of servers in a group. If the current master in a group fails, it elects a new one if a server in the group can become a master.

Besides the high-availability operations such as failover and switchover, Fabric also permits shard operations such as shard creation and removal.

Fabric is written in Python and includes a special library that implements all of the functionality provided. To interact with Fabric, a special utility named `mysqlfabric` provides a set of commands you can use to create and manage groups, define and manipulate sharding, and much more.

8.1.1 Fabric Prerequisites

Fabric is designed to work with MySQL servers version 5.6.10 and later. The `mysqlfabric` utility requires Python 2 (2.6 or later) and Connector/Python 1.2.1 or later.

You must have a MySQL instance available to install the backing store. This server must not be a member of a Fabric group.

Note

The backing store must be a MySQL server 5.6 or later.

To utilize Fabric in your applications, you must have a Fabric-aware connector installed on the system where the application is running. For more information about using a connector with Fabric, see the appropriate connector-specific section (Section 8.8, “Using Connector/Python with MySQL Fabric”, Section 8.9, “Using Connector/J with MySQL Fabric”).

In summary, the following items indicate the prerequisites for using MySQL Fabric:

- MySQL Server 5.6.10 or later for MySQL servers managed by Fabric. MySQL Server requirements: gtid_mode (GTID), bin_log (binary logging), and log_slave_updates enabled, with server_id properly configured.
- MySQL server 5.6.x or later for the backing store.
- Python 2 (2.6 or later) for the `mysqlfabric` utility.
- A Fabric-aware connector to use Fabric in applications. Permitted connectors and versions are:
  - Connector/Python 1.2.1 or later
  - Connector/J 5.1.27 or later

8.1.2 Fabric Concepts

This section describes some of the concepts used in Fabric.

A *high-availability group*, or simply *group*, is a collection of servers. It is used to associate the servers in a set. This association may be a set of replication-enabled servers, the servers participating in a sharding solution, and so forth.

A *group identifier* is the name we give a group or members of the group. A group identifier is a name that matches the regular expression `[a-zA-Z0-9_-]+`. Examples of legal identifiers are `my_group`, `employees`, and `shard1`.

A *global group* stores all updates that must be propogated to all shards that are part of a sharding scheme.

A *node* or *fabric node* is an instance of the Fabric system running on a server. To use the features of Fabric, at least one Fabric node must be running.

Sharding refers to the Fabric feature that permits the distribution of data across several servers. There are many uses of sharding but the most effective use of sharding enables distributing the work of writing across several servers for improved write speeds.

A *shard* is a horizontal partition or segment of data in a table.

Primary refers to a member of a group that is designated as master in the sense that it can accept read-write transactions.

Secondary refers to a member of a group that can be a candidate to replace the master during switchover or failover and that can accept read-only transactions.

8.2 Installing and Configuring MySQL Fabric

To use MySQL Fabric, you must have a set of MySQL server instances running MySQL 5.6.10 or higher. One server is required for the backing store and at least one server must be added to a group. To use the replication features of MySQL Fabric, a replication topology of a master and at least one slave is required. To use the sharding features of MySQL Fabric, you should have the number of servers corresponding to the depth of the shards (the number of segments).

Note

The configuration system changed in Fabric 1.5.5. The current system is documented here, and the old system is documented under Section 8.2.5, “Old Configuration System”.

For instructions on how to download and install MySQL server, see the online MySQL reference manual (Installing and Upgrading MySQL).

8.2.1 Downloading MySQL Fabric

Download a version of MySQL Fabric from the MySQL Developer Zone website (http://dev.mysql.com/downloads/utilities/). Packaged downloads are available for a variety of servers. Download the package that matches your platform and extract the files.

The above website also provides the MySQL Fabric-aware connectors. Download the connector you want to use with a MySQL Fabric application. For more information about how to install and get started using MySQL Fabric in your applications, see the appropriate connector-specific section (Section 8.8, “Using Connector/Python with MySQL Fabric”, Section 8.9, “Using Connector/J with MySQL Fabric”).

8.2.2 Installing MySQL Fabric

To install MySQL Fabric, install MySQL Utilities 1.5.6. For more information, see Chapter 1, *How to Install MySQL Utilities*.

8.2.3 Configuring MySQL Fabric

Configuring MySQL Fabric requires creating separate MySQL users to access the backing store and managed MySQL servers, and editing the configuration file with the MySQL user details for all of these users.

Each managed MySQL Server has the following requirements: gtid_mode (GTID), bin_log (binary logging), and log_slave_updates enabled, with server_id properly configured.

Note

The configuration system changed in MySQL Fabric 1.5.5. For information about the previous configuration system, see Section 8.2.5, “Old Configuration System”.

8.2.3.1 Create the Associated MySQL Users

Fabric uses four different types of users, each with a different set of required privileges.

Note

The backup and restore users were added in Fabric 1.5.5.

- **Backing store user**: stores Fabric specific information, and is only created on the Fabric backing store MySQL server. For additional information, see Section 8.6, “Backing Store”
- **Server user**: accesses the managed MySQL servers, and is created on each managed MySQL server.
- **Backup user**: executes backup operations, such as `mysqldump`, and is created on each managed MySQL server.
- **Restore user**: executes restore operations that typically use the `mysql` client, and is created on each managed MySQL server.

Privileges

It is possible to use the same MySQL account for the server user, backup user, and restore user, but in this case the user would have the sum of privileges of the three users. This would result in a very powerful user and is therefore not recommended for production use.

However, for a quick and simple temporary trial, it may be easiest to set the users for all accounts using the same user name and password, such as root.

The Backing Store (Fabric) User

The first thing you must have is a user account on the MySQL server that you plan to use for your backing store. The user account information is stored in the Fabric configuration file.

The backing store database and its associated user are defined under the **[storage]** using *user* for the user name and *password* as the password.

The Fabric user account on the backing store requires the following privileges on the backing store database:

```
ALTER                  - alter some database objects
CREATE                 - create most database objects
CREATE VIEW            - create views
DELETE                 - delete rows
DROP                   - drop most database objects
EVENT                  - manage events
REFERENCES             - foreign keys
INDEX                  - create indexes
INSERT                 - insert rows
SELECT                 - select rows
UPDATE                 - update rows
```

Example statements to create this user, to be executed on the backing store MySQL server:

Note

MySQL Fabric creates this database based on `fabric.cfg`, which in our example is named *mysql_fabric*. In other words, do not execute *CREATE database mysql_fabric;* here.

```
CREATE USER 'fabric_store'@'localhost'
   IDENTIFIED BY 'secret';

GRANT ALTER, CREATE, CREATE VIEW, DELETE, DROP, EVENT,
   INDEX, INSERT, REFERENCES, SELECT, UPDATE ON mysql_fabric.*
   TO 'fabric_store'@'localhost';
```

Note

The "REFERENCES" privilege is only required when working with MySQL 5.7 and above. MySQL Fabric does not check for this privilege on earlier versions.

For additional information about using and setting up the backing store, see Section 8.6, “Backing Store”.

The Server User

MySQL Fabric uses the server user account to access all MySQL servers that it manages. In other words, this user must be created on all managed MySQL servers.

The server account is defined under the **[servers]** section using *user* for the user name and *password* as the password.

The Fabric server user account on the managed MySQL servers requires the following privileges in global scope:

```
DELETE               - prune_shard
PROCESS              - list sessions to kill
RELOAD               - RESET SLAVE
REPLICATION CLIENT - SHOW SLAVE STATUS
REPLICATION SLAVE  - SHOW SLAVE HOSTS
```

The Fabric server user account on the managed MySQL servers requires the following privileges on **mysql_fabric.***:

```
ALTER                - alter some database objects
CREATE               - create most database objects
DELETE               - delete rows
DROP                 - drop most database objects
INSERT               - insert rows
SELECT               - select rows
UPDATE               - update rows
```

Example statements to create the server user, to be executed on each managed MySQL server:

```
CREATE USER 'fabric_server'@'localhost'
  IDENTIFIED BY 'secret';

GRANT DELETE, PROCESS, RELOAD, REPLICATION CLIENT,
  REPLICATION SLAVE, SELECT, SUPER, TRIGGER ON *.*
  TO 'fabric_server'@'localhost';

GRANT ALTER, CREATE, DELETE, DROP, INSERT, SELECT, UPDATE
   ON mysql_fabric.* TO 'fabric_server'@'localhost';
```

The Backup User

If you want to use sharding, or clone a MySQL server with the intention to add it to a High-Availability (HA) group, then you must define restore and backup users. Like the server user, these users must be created on all managed servers.

The backup account is defined under the **[servers]** section using *backup_user* for the user name and *backup_password* as the password.

The backup account on the managed MySQL servers requires the following privileges in global scope if `mysqldump` is used:

```
EVENT                - show event information
EXECUTE              - show routine information inside views
REFERENCES           - foreign keys
SELECT               - read data
SHOW VIEW            - SHOW CREATE VIEW
TRIGGER              - show trigger information
```

Example statements to create the backup user, to be executed on each managed MySQL server:

```
CREATE USER 'fabric_backup'@'localhost'
  IDENTIFIED BY 'secret';

GRANT EVENT, EXECUTE, REFERENCES, SELECT, SHOW VIEW, TRIGGER ON *.*
  TO 'fabric_backup'@'localhost';
```

Note

The "REFERENCES" privilege is only required when working with MySQL 5.7 and above. MySQL Fabric does not check for this privilege on earlier versions.

The Restore User

If you want to use sharding, or clone a server with the intention to add it to a High-Availability (HA) group, then you must define restore and backup users. Like the server user, these users must be created on all managed servers.

The restore account is defined under the **[servers]** section using *restore_user* for the user name and *restore_password* as the password.

The restore account on the managed MySQL servers requires the following privileges in global scope if mysqldump is used:

```
ALTER                - ALTER DATABASE
ALTER ROUTINE        - ALTER {PROCEDURE|FUNCTION}
CREATE               - CREATE TABLE
CREATE ROUTINE       - CREATE {PROCEDURE|FUNCTION}
CREATE TABLESPACE    - CREATE TABLESPACE
CREATE VIEW          - CREATE VIEW
DROP                 - DROP TABLE (used before CREATE TABLE)
EVENT                - DROP/CREATE EVENT
INSERT               - write data
LOCK TABLES          - LOCK TABLES (--single-transaction)
REFERENCES           - Create tables with foreign keys
SELECT               - LOCK TABLES (--single-transaction)
SUPER                - SET @@SESSION.SQL_LOG_BIN = 0
TRIGGER              - CREATE TRIGGER
```

Note

Although the "CREATE TABLESPACE" and "REFERENCES" privileges are only required when working with MySQL 5.7 and above, MySQL Fabric still checks for them to help simplify the upgrade process to MySQL 5.7.

Example statements to create the restore user, to be executed on each managed MySQL server:

```
CREATE USER 'fabric_restore'@'localhost'
  IDENTIFIED BY 'secret';

GRANT ALTER, ALTER ROUTINE, CREATE, CREATE ROUTINE, CREATE TABLESPACE, CREATE VIEW,
  DROP, EVENT, INSERT, LOCK TABLES, REFERENCES, SELECT, SUPER,
  TRIGGER ON *.* TO 'fabric_restore'@'localhost';
```

8.2.3.2 Configuration File

The location of the MySQL Fabric configuration file varies depending on the operating system it is installed on and how you installed it. The table below lists the default configuration file locations for pre-built packages from http://dev.mysql.com/downloads/utilities/. Alternatively, the optional `--config` option accepts to use a path to a Fabric configuration file, and if defined, the file is loaded and used instead of the default configuration file location.

Table 8.1 Default MySQL Fabric configuration file location

Platform	Package	Location
Microsoft Windows	mysql-utilities-1.5.6-win32.msi	*UTILITIES_INSTALLDIR*/etc/mysql/fabric.cfg
Ubuntu Linux 14.04	mysql-utilities_1.5.6-1ubuntu14.04_all.deb	`/etc/mysql/fabric.cfg`

Platform	Package	Location
Debian Linux 6.0	mysql-utilities_1.5.6-1debian6.0_all.deb	`/etc/mysql/fabric.cfg`
Red Hat Enterprise Linux 6 / Oracle Linux 6	mysql-utilities-1.5.6-1.el6.noarch.rpm	`/etc/mysql/fabric.cfg`
OS X	mysql-utilities-1.5.6-osx10.9.dmg	`/etc/mysql/fabric.cfg`

Modify the configuration file and include the users and passwords defined in the previous step (Section 8.2.3.1, "Create the Associated MySQL Users"), here is an example Fabric configuration file:

```
[DEFAULT]
prefix = /usr/local
sysconfdir = /usr/local/etc
logdir = /var/log

[storage]
address = localhost:3306
user = fabric_store
password = secret
database = mysql_fabric
auth_plugin = mysql_native_password
connection_timeout = 6
connection_attempts = 6
connection_delay = 1

[servers]
user = fabric_server
password = secret
backup_user = fabric_backup
backup_password = secret
restore_user = fabric_restore
restore_password = secret
unreachable_timeout = 5

[protocol.xmlrpc]
address = localhost:32274
threads = 5
user = admin
password = secret
disable_authentication = no
realm = MySQL Fabric
ssl_ca =
ssl_cert =
ssl_key =

[protocol.mysql]
address = localhost:32275
user = admin
password = secret
disable_authentication = no
ssl_ca =
ssl_cert =
ssl_key =

[executor]
executors = 5

[logging]
level = INFO
url = file:///var/log/fabric.log

[sharding]
mysqldump_program = /usr/bin/mysqldump
```

```
mysqlclient_program = /usr/bin/mysql

[statistics]
prune_time = 3600

[failure_tracking]
notifications = 300
notification_clients = 50
notification_interval = 60
failover_interval = 0
detections = 3
detection_interval = 6
detection_timeout = 1
prune_time = 3600

[connector]
ttl = 1
```

Each section has one or more variables defined that provide key information to the MySQL Fabric system libraries. You might not have to change any of these variables other than the users and passwords. For more information on the sections and variables in the configuration file, see Section 8.2.3.3, "Configuration File Sections".

8.2.3.3 Configuration File Sections

The MySQL Fabric configuration file contains all the information necessary to run the MySQL Fabric utility. In addition, it serves as a configuration file for the utilities from within MySQL Fabric.

Each section has one or more variables defined that provide key information to the MySQL Fabric system libraries.

Note

The **[client]** section was removed in MySQL Fabric 1.5.5. Instead, use the *restore_user*, *restore_password*, *backup_user*, and *backup_password* under the [servers] section to configure users for the backup and restore utilities, such as `mysqldump` and the `mysql` client.

Section DEFAULT

The `DEFAULT` section contains information on the installation paths for MySQL Fabric. This section is generated as part of the installation and should normally not be modified.

`prefix`	The installation prefix used when installing the `mysql.fabric` package and the binaries.
`sysconfdir`	The location of the system configuration files. Normally located in the `etc` directory under the directory given in `prefix`, but in some situations this might be different.
`logdir`	Configures the directory where log files are located by default. Normally, the logging URL contains the absolute path, but in the event that the path is relative, it is relative to this directory.

Section storage

This section contains information that the MySQL Fabric node uses for the connection to the backing store. For more information on the backing store, see Section 8.6, "Backing Store".

`address`	This is the address of the backing store in the form *`host`*`:`*`port`*. The port is optional and if not provided, defaults to 3306.
`user`	User name to use when connecting to the backing store.
`password`	The password to use when connecting to the backing store. If no password option is in the configuration file, a password is required on the terminal when the MySQL Fabric node is started. Although it is possible to set an empty password by not providing a value to the option, it is not recommended.
`database`	The database where the tables containing information about the MySQL Fabric farm is stored, typically `fabric`.
`auth_plugin`	The authentication plugin to use when connecting to the backing store. This option is passed to the connector when connecting to the backing store. For more information on authentication plugins, see Connector/Python Connection Arguments.
`connection_timeout`	Timeout for the connection to the backing store, in seconds. This option is passed to the connector when connecting to the backing store. This is the maximum amount of time that MySQL Fabric waits for access to the backing store to complete before aborting. For more information on authentication plugins, see Connector/Python Connection Arguments.
`connection_attempts`	The number of attempts to reconnect to the backing store before giving up. This is the maximum number of times MySQL Fabric attempts to create a connection to the backing store before aborting. The default is 0 retries.
`connection_delay`	The delay between attempts to connect to the backing store in seconds. The default is 0 seconds.

Section servers

This section contains information that MySQL Fabric uses to connect to the servers being managed.

Note

The *backup_user*, *backup_password*, *restore_user*, and *restore_password* options were added in MySQL Fabric 1.5.5.

user	User name to use when connecting to the managed server.
password	Password to use when connecting to the managed servers.
backup_user	User name to use when backing up the MySQL server.
backup_password	Password to use when backing up the MySQL servers with the **backup_user** user.
restore_user	User name to use when restoring the MySQL server.
restore_password	Password to use when restoring the MySQL servers with the **restore_user** user.
unreachable_timeout	Used for the connection timeout when checking faulty servers, or servers that are new to the farm. Hence, for servers that can potentially be unreachable. Defaults to 5, can be a value between 1-60.

Section protocol.xmlrpc

This section contains information about how the client connects to a MySQL Fabric node and configuration parameters for the XML-RPC protocol on the server.

address	Host and port of XML-RPC server. The host is only used by the client when connecting to the MySQL Fabric node, but the port is used by the server when starting the protocol server and by the client when reading how to connect to the XML-RPC server. The port number is typically 32274, and the host is typically `localhost`.
threads	Number of threads that the XML-RPC server uses for processing requests. This determines the number of concurrent requests that MySQL Fabric accepts.
user	User that the client uses to connect to the XML-RPC server.
password	Password used when the client connects to the server. If no password is provided, the client requests a password on the command-line.
`disable_authentication`	Whether to disable authentication or not. Disabling authentication can be useful when experimenting in a closed environment, it is *not* recommended for normal usage. Alternatives are `yes` or `no` and are case-insensitive.
realm	The realm (as defined in RFC 2617) the XML-RPC server identifies as when authenticating.
ssl_ca	Path to a file containing a list of trusted SSL certification authorities (CAs).
ssl_cert	The name of the SSL certificate file to use for establishing a secure connection.
ssl_key	The name of the SSL key file to use for establishing a secure connection.

Section protocol.mysql

This section contains information about how the client connects to a MySQL Fabric node using the MySQL Client/Server protocol.

address	Host and port of a MySQL Fabric node. The port number is typically 32275, and the host is typically `localhost`.
user	User that the client uses to connect to the MySQL Fabric node.
password	Password used when the client connects to the MySQL Fabric node. If no password is provided, the client requests a password on the command-line.
`disable_authentication`	Whether to disable authentication or not. Disabling authentication can be useful when experimenting in a closed environment, it is *not* recommended for normal usage. Alternatives are `yes` or `no` and are case-insensitive.
ssl_ca	Path to a file containing a list of trusted SSL certification authorities (CAs).

ssl_cert	The name of the SSL certificate file to use for establishing a secure connection.
ssl_key	The name of the SSL key file to use for establishing a secure connection.

Section executor

This section contains parameters to configure the executor. The executor executes procedures in a serial order, which guarantees that requests do not conflict. The requests received are mapped to procedures which can be executed directly or scheduled through the executor. Procedures scheduled through the executor are processed within the context of threads spawned by the executor. Usually, read operations are immediately executed by the XML-RPC session thread and write operations are scheduled and executed through the executor.

executors	The number of executor threads that the executor uses when processing requests.
working_directory	The directory Fabric uses by default to store files. If the option is not found, the working directory is the directory from where the process was launched. **Note** This option was added in Fabric 1.5.7.

Section logging

MySQL Fabric logs information about its activities to the standard output when started as a regular process. However, when started as a daemon, it writes information to a file configured by the the option Fabric URL used for logging.

level	The log level to use when generating the log. Acceptable values are `CRITICAL`, `ERROR`, `WARNING`, `INFO`, and `DEBUG`. The default is `INFO`.
url	The URL to use for logging. Supported protocols are currently `file` and `syslog`. The `file` protocol creates a rotating file handler, while the `syslog` protocol logs messages using the system logger `syslogd` . The `file` handler accepts either a relative path or an absolute path. If a relative path is provided, it is relative to Configure default log directory. The `syslog` handler accepts either a path (for example `syslog:///dev/log`) or a hostname and an optional port (for example, `syslog://localhost:555`, and `syslog://my.example.com`). If no port is provided, it defaults to 541, which is the default port for the syslog daemon.

Section sharding

To perform operations such as moving and splitting shards, MySQL Fabric relies on the `mysqldump` and `mysql` client programs. These programs can be installed in different locations and if they are not in the path for the MySQL Fabric node, this section configures where they can be found.

mysqldump_program	Path to the `mysqldump` program.
mysqlclient_program	Path to the `mysql` program.

Section statistics

Connectors and other external entities log any errors while accessing servers so that MySQL Fabric can monitor server health and act accordingly. For example, MySQL Fabric promotes a new master after receiving `notifications` from the number of clients configured in `notification_clients`) within the time interval configured in `notification_interval`. If a server is considered unstable but it is not a master, it is simply marked as faulty. To avoid making the system unstable, a new master can only be automatically promoted after the `failover_interval` has been elapsed since the last promotion. In order to ease the adoption of MySQL Fabric, a built-in failure detector is provided. If the failure detector is enabled to monitor a group, a new master is promoted after `3` failed successive attempts to access the current master within the time interval configured in `failover_interval`. The failure detection routine tries to connect to servers in a group and uses the value configured in `detection_timeout` as timeout.

prune_time	How often the internal event log is pruned, in seconds and also the age of events in the event log that is used to present statistics.
notifications	Number of issues before the server is considered unstable.
notification_clients	Number of different sources that should report issues on a server before it is considered unstable.
notification_interval	Amount of time in seconds that is used when deciding if a server is unstable. Issues older than this are not considered when deciding.
failover_interval	Minimum time in seconds between subsequent automatic promotions. This parameter is used to prevent the system entering a sequence of promotions that could disable the system.
detections	Number of successive failed attempts to contact the server after which the built-in failure detector considers the server unstable.
detection_timeout	Timeout in seconds used when contacting the server. If the server does not respond within this time period, it is recorded as a failed attempt to contact the server.
prune_time	Maximum age in seconds for reported issues in the error log. Issues older than this are removed from the error log.

Section failure_tracking

This section contains parameters for the failure management system.

notifications	The notification threshold. If more than this number of notifications arrive in the notification interval and the number of distinct notification clients are over the notification client threshold, the server is considered dead and failover is triggered.
notification_clients	The number of distinct notification clients that need to report. If more than this number of distinct notification clients are over the notification client threshold and the number of notifications above the notification threshold arrive in the notification interval, the server is considered dead and failover is triggered.
notification_interval	The notification interval in seconds. Only notifications arriving within this time frame can trigger a failover.
failover_interval	The minimum interval between failover operations in seconds. In order to avoid making the system unstable, failover operations are

	not triggered unless at least this much time has expired since the last failover.
detections	This parameter is for the built-in failure detector. If more than this number of failures to contact the server occurs during the detection interval, the server is considered unstable and a failover is triggered.
detection_interval	This parameter configures the detection interval for the built-in failure detector, in seconds.
detection_timeout	This parameter configures the detection timeout used when attempting to contact the servers in the group.
prune_time	This is the maximum age of events in the failure detector's error log and is also the interval for how often the error log is pruned.

Section connector

Connectors that are MySQL Fabric-aware contact MySQL Fabric to fetch information on groups, shards, and servers, and then cache the results locally for a time period to improve performance. This section contains configuration parameters passed to the connectors.

ttl	The Time To Live (TTL), measured in seconds, is passed together with other information to the connector. This is used by the connector to invalidate the caches, and reload them from a MySQL Fabric node, after the TTL has expired.

8.2.3.4 The Configuration Parameter (--param)

The `--param` option allows you to override configuration options at runtime. The syntax is `--param=section.option=value`. For example:

```
shell> mysqlfabric manage setup --param=storage.user=fabric_store --param=storage.password=secret
shell> mysqlfabric --param=storage.user=fabric_store --param=storage.password=secret manage setup

shell> mysqlfabric manage setup --param=storage.address=localhost:13000 \
  --param=storage.user=root --param=protocol.xmlrpc.password=secret
```

For additional information about the available options, see Section 8.2.3.2, “Configuration File”.

8.2.4 Starting and Stopping MySQL Fabric Nodes

To start or stop MySQL Fabric nodes, use the `mysqlfabric` command (see Section 8.4, “The `mysqlfabric` Utility”). This command requires that MySQL Fabric and Connector/Python be installed, and assumes that you have set up the backing store.

The following command starts a MySQL Fabric node and should be run on one of the servers listed in the `[protocol.xmlrpc]` section in the configuration file.

```
shell> mysqlfabric manage start
```

This command starts a MySQL Fabric node on the machine where it is executed and prints the log to standard output. Thus, this is the machine where you installed the MySQL Fabric and Connector/Python software and is also the machine listed in the configuration file `[protocol.xmlrpc]` section. To follow the examples in the quick-start section, you must use `localhost` for the host name.

To put the MySQL Fabric node in the background, add the `--daemonize` option. However, this diverts the log to the syslog file. While experimenting with MySQL Fabric, you may find it more convenient not to use `--daemonize` so that the log is written to your terminal.

Use this command to stop a MySQL Fabric node:

```
shell> mysqlfabric manage stop
```

This command contacts the MySQL Fabric server running at the address mentioned in the `[protocol.xmlrpc]` section and instructs it to stop.

8.2.5 Old Configuration System

Important

This documentation describes the MySQL Fabric configuration before version 1.5.5. The previous configuration documentation is archived here for informational and upgrade purposes.

Configuring MySQL Fabric requires creating a MySQL user to access the backing store, and editing the configuration file with the MySQL user details. This section assumes you have already set up the backing store. See Section 8.6, “Backing Store” for more information.

Create a MySQL User

The first thing you must have is a user account on the MySQL server that you plan to use for your backing store. The user account information is stored in the configuration file.

The user account must have full privileges for the database named `fabric`. To create the user and grant the privileges needed, use the following statements:

```
CREATE USER 'fabric'@'localhost' IDENTIFIED BY 'secret';
GRANT ALL ON fabric.* TO 'fabric'@'localhost';
```

In the preceding example, substitute a password of your choice (replace `'secret'`). Also, if you are going to run MySQL Fabric on a host other than where the backing store resides, substitute the `'localhost'` for the host name.

MySQL Fabric uses the same user account, who must have all privileges on all databases, to access all MySQL servers that it manages. The user and password are defined in the configuration file as shown below. To create this user and grant all the necessary privileges, execute the following command on all MySQL servers:

```
CREATE USER 'fabric'@'localhost' IDENTIFIED BY 'secret';
GRANT ALL ON *.* TO 'fabric'@'localhost';
```

In the preceding example, substitute a password of your choice (replace `'secret'`). Also, if you are going to run MySQL Fabric on a host other than where the managed MySQL servers reside, substitute the `'localhost'` for the Fabric's host name.

Configuration File

The next step is to modify the configuration file with the user and password we defined in the previous step. Open the configuration file:

MySQL Fabric configuration file location

Table 8.2 MySQL Fabric configuration file location

Platform	Package	Location
Microsoft Windows	mysql-utilities-1.5.6-win32.msi	*UTILITIES_INSTALLDIR*/etc/mysql/fabric.cfg
Ubuntu Linux 14.04	mysql-utilities_1.5.6-1ubuntu14.04_all.deb	/etc/mysql/fabric.cfg
Debian Linux 6.0	mysql-utilities_1.5.6-1debian6.0_all.deb	/etc/mysql/fabric.cfg
Red Hat Enterprise Linux 6 / Oracle Linux 6	mysql-utilities-1.5.6-1.el6.noarch.rpm	/etc/mysql/fabric.cfg

The following shows the content of the configuration file and the modifications necessary. In the [storage] section, store the user and password of the user created in the previous step.

```
[DEFAULT]
prefix = /usr/local
sysconfdir = /usr/local/etc
logdir = /var/log

[storage]
address = localhost:3306
user = fabric
password = secret
database = fabric
auth_plugin = mysql_native_password
connection_timeout = 6
connection_attempts = 6
connection_delay = 1

[servers]
user = fabric
password =
backup_user = fabric
backup_password =
restore_user = fabric
restore_password =
unreachable_timeout = 5

[protocol.xmlrpc]
address = localhost:32274
threads = 5
user = admin
password =
disable_authentication = no
realm = MySQL Fabric
ssl_ca =
ssl_cert =
ssl_key =

[protocol.mysql]
address = localhost:32275
user = admin
password =
disable_authentication = no
ssl_ca =
ssl_cert =
ssl_key =
[executor]
executors = 5

[logging]
level = INFO
url = file:///var/log/fabric.log

[sharding]
mysqldump_program = /usr/bin/mysqldump
mysqlclient_program = /usr/bin/mysql

[statistics]
prune_time = 3600

[failure_tracking]
notifications = 300
notification_clients = 50
notification_interval = 60
failover_interval = 0
detections = 3
detection_interval = 6
detection_timeout = 1
prune_time = 3600

[connector]
ttl = 1
```

Each section has one or more variables defined that provide key information to the MySQL Fabric system libraries. You should not have to change any of these variables other than the user and password for the backing store (in the `storage` section).

8.3 Quick Start

This section demonstrates how to get started using MySQL Fabric. Two examples are included in this section: one for using MySQL Fabric with replication to demonstrate how Fabric reduces the overhead of directing reads and writes from applications, and another showing how Fabric makes using sharding much easier.

If you have not installed and configured Fabric, please refer to the previous sections before proceeding with the examples.

8.3.1 Example: Fabric and Replication

This section presents a quick start for using MySQL replication features in Fabric. To run this example, you should have four server instances (running MySQL version 5.6.10 or later). The commands in this example are executed on the same server host as the backing store (which happens to be the same host where Fabric was installed). You must also have a Fabric node started on that host.

The replication features in Fabric focus on providing high availability. While these features continue to evolve, the most unique feature of Fabric replication is the ability to use a Fabric-aware connector to seamlessly direct reads and writes to the appropriate servers.

This redirection is achieved through the use of one of the central concepts in Fabric: a high-availability group that uses a high-availability solution for providing resilience to failures. Currently, only asynchronous primary backup replication is supported. As long as the primary is alive and running, it handles all write operations. Secondaries replicate everything from the primary to stay up to date and might be used to scale out read operations.

Creating a High-Availability Group

The first step consists of creating a group, here designated `my_group`. After doing so, you can add servers to the group. In this case, we add three servers, `localhost:3307`, `localhost:3308`, and `localhost:3309`.

Fabric accesses each added server using the user and password provided in the configuration file to guarantee that they are alive and accessible. If these requirements are not fulfilled, the operation fails and the server is not added to the group.

Note

Each managed MySQL Server has the following requirements: gtid_mode (GTID), bin_log (binary logging), and log_slave_updates enabled, with server_id properly configured.

The following demonstrates the commands to execute these steps.

```
shell> mysqlfabric group create my_group
Procedure :
{ uuid        = d4e60ed4-fd36-4df6-8004-d034202c3698,
  finished    = True,
  success     = True,
  return      = True,
  activities  =
}
shell> mysqlfabric group add my_group localhost:3307
Procedure :
{ uuid        = 6a33ed29-ccf8-437f-b436-daf07db7a1fc,
  finished    = True,
  success     = True,
  return      = True,
  activities  =
}
shell> mysqlfabric group add my_group localhost:3308
Procedure :
{ uuid        = 6892bc49-3ab7-4bc2-891d-57c4a1577081,
  finished    = True,
  success     = True,
  return      = True,
  activities  =
}
shell> mysqlfabric group add my_group localhost:3309
Procedure :
{ uuid        = 7943b27f-2da5-4dcf-a1a4-24aed8066bb4,
  finished    = True,
  success     = True,
  return      = True,
  activities  =
}
```

To show information about the set of servers in a group, use this command:

```
shell> mysqlfabric group lookup_servers my_group
```

To get detailed information about the group health, use this command:

```
shell> mysqlfabric group health my_group
```

Promoting and Demoting Servers

After executing the steps in setting up a high-availability group, Fabric does not become aware of any replication topology that was already in place. It is necessary to promote one of them to primary (that is, master) and make the remaining servers secondaries (that is, slaves). To do so, execute this command:

```
shell> mysqlfabric group promote my_group
```

If there is a primary in a group, any server added subsequently is automatically set as secondary. Setting a different server as primary can be done through the same command, which demotes the current primary and elects a new one. If the current primary has failed, the same command (which can be triggered either manually or automatically) can be used to elect a new one.

Note

A server marked as "faulty" cannot be promoted to a secondary or primary status in one step. The faulty server status must first be changed to the "spare" status. For example, use `mysqlfabric server set_status` *`server-address`* `spare`.

Activating or Deactivating a Failure Detector

If the primary fails, you may want to automatically promote one of the secondaries as primary and redirect the remaining secondaries to the new primary. To do this, execute the following command:

```
shell> mysqlfabric group activate my_group
```

If the failure detector discovers that a primary has crashed, it marks it as faulty and triggers a failover routine. This is not done automatically because there may be users who prefer to use an external failure detector or want to do things manually. To deactivate the failure detector, execute the following command:

```
shell> mysqlfabric group deactivate my_group
```

Executing Updates and Queries

Executing queries with a Fabric-aware connector is easy. The following example shows a section of code designed to add employees and search for them. Notice that we simply import the fabric package from the Connector/Python library and provide the Fabric connection parameters such as the location of the Fabric node (as specified in the `[protocol.xmlrpc]` configuration file section) and user credentials.

```
import mysql.connector
from mysql.connector import fabric

def add_employee(conn, emp_no, first_name, last_name):
    conn.set_property(group="my_group", mode=fabric.MODE_READWRITE)
    cur = conn.cursor()
    cur.execute("USE employees")
    cur.execute(
        "INSERT INTO employees VALUES (%s, %s, %s)",
        (emp_no, first_name, last_name)
        )
    # We need to keep track of what we have executed in order to,
    # at least, read our own updates from a slave.
    cur.execute("SELECT @@global.gtid_executed")
    for row in cur:
        print "Transactions executed on the master", row[0]
        return row[0]

def find_employee(conn, emp_no, gtid_executed):
    conn.set_property(group="my_group", mode=fabric.MODE_READONLY)
    cur = conn.cursor()
    # Guarantee that a slave has applied our own updates before
    # reading anything.
    cur.execute(
        "SELECT WAIT_UNTIL_SQL_THREAD_AFTER_GTIDS('%s', 0)" %
        (gtid_executed, )
    )
    for row in cur:
        print "Had to synchronize", row, "transactions."
    cur.execute("USE employees")
    cur.execute(
        "SELECT first_name, last_name FROM employees "
        "WHERE emp_no = %s", (emp_no, )
        )
    for row in cur:
        print "Retrieved", row

# Address of the Fabric, not the host we are going to connect to.
conn = mysql.connector.connect(
    fabric={"host" : "localhost", "port" : 32274,
            "username": "admin", "password" : "adminpass"
           },
    user="webuser", password="webpass", autocommit=True
    )

conn.set_property(group="my_group", mode=fabric.MODE_READWRITE)
cur = conn.cursor()
cur.execute("CREATE DATABASE IF NOT EXISTS employees")
cur.execute("USE employees")
cur.execute("DROP TABLE IF EXISTS employees")
cur.execute(
    "CREATE TABLE employees ("
    "   emp_no INT, "
    "   first_name CHAR(40), "
    "   last_name CHAR(40)"
    ")"
    )

gtid_executed = add_employee(conn, 12, "John", "Doe")
find_employee(conn, 12, gtid_executed)
```

You can copy this code into a Python module named `test_fabric_query.py` and execute it with the following command:

```
shell> python ./test_fabric_query.py
(u'John', u'Doe')
```

Group Maintenance

To find out which servers are in a group, use this command:

```
shell> mysqlfabric group lookup_servers my_group
Command :
{ success     = True
  return      = [
      {'status': 'PRIMARY', 'server_uuid': 'bbe6f7c1-b6c3-11e3-aaa2-58946b051f64',
       'mode': 'READ_WRITE', 'weight': 1.0, 'address': 'localhost:3307'
      },
      {'status': 'SECONDARY', 'server_uuid': '0c9e67d0-8194-11e2-8a7c-f0def124dcc5',
       'mode': 'READ_ONLY', 'weight': 1.0, 'address': 'localhost:3308'
      },
      {'status': 'SECONDARY', 'server_uuid': '0c67e5b1-8194-11e2-8a7c-f0def124dcc5',
       'mode': 'READ_ONLY', 'weight': 1.0, 'address': 'localhost:3309'
      },
  ]
  activities  =
}
```

In this example, there are three servers identified by their UUID values. The server running at `localhost:3307` is a primary, whereas the other servers are secondaries.

It is sometimes necessary to take secondaries offline for maintenance. However, before stopping a server, it is important to remove it from the group to avoid having the Fabric failure detector trigger any action. This can be done through the following commands. *`server_uuid`* should be replaced with a server UUID value (a value of the form `d2369bc9-2009-11e3-93c6-f0def14a00f4`).

```
shell> mysqlfabric group remove my_group server_uuid
```

A primary cannot be removed from a group. To disable any primary in a group, execute this command:

```
shell> mysqlfabric group demote my_group
```

If a group contains no servers, it is empty and can be destroyed (removed) with this command:

```
shell> mysqlfabric group destroy my_group
```

It is also possible to force removal of a nonempty group by specifying the parameter `--force`. This command removes all servers from `my_group` and removes the group.

```
shell> mysqlfabric group destroy my_group --force
```

8.3.2 Example: Fabric and Sharding

This example explores sharding. The essence of a sharding solution that uses MySQL involves partitioning the data into independent sets (independent MySQL Servers) and directing each client to the partition (MySQL Server) that has the data the client wants to modify.

This architecture scales the write operations for a given dataset since resource demands are distributed across the partitions (MySQL Servers) of the data set. Each partition is referred to as a shard.

8.3.2.1 Introduction to Sharding

The Fabric sharding implementation requires you to provide the sharding key explicitly while executing a query. To define sharding over a set of tables using the sharding mechanism built into Fabric, it is important to understand two concepts and how they relate.

Shard Mapping

A shard mapping serves to bring a database object (a database table) into the Fabric sharding system. The mapping is a way of informing Fabric that we want a particular sharding scheme (range, hash, list, and so forth.) to be used on a database table, using a value in a particular column. Create a shard mapping as follows:

1. Define a shard mapping, to tell Fabric the kind of sharding mechanism to use.
2. Add a relation between the mapping and a database object, to register the database table and a column in the table with the shard mapping.

Once these operations have been completed, we can describe how the shard mapping should split the tables. This is done while creating the shards.

Shards

These are the partitions on the table. Since sharding is done on a database table, using an attribute (column) in the table, the values in the column influence how the shards are created. To explain this further, assume that we have two tables we wish to shard.

- employees
- Salary

Assume further that both tables are to be sharded by the employee ID that is part of their columns. Where a row is placed is based on the value in the employee ID column. Hence, in a range-based sharding scheme, a shard is nothing but a range of employee ID values.

8.3.2.2 Sharding Scenario

In the sections that follow, we take the example of a employee table that must be sharded across three MySQL groups. The following procedure lists the sequence of commands to run to perform each step.

Unsharded Data

Assume that we have an unsharded table named `employees` that contains Employee IDs, on which we want to create the following shards. Each of these ranges is placed in one shard:

- `1-99999`: shard-1
- `100000-199999`: shard-2
- `200000-`: shard-3

In addition to creating the ranges themselves (in a range based sharding scheme) we also must define where this range of values should reside.

Starting Multiple MySQL Servers

MySQL Servers must be started on the directories that were copied. Assume that MySQL servers are started on the following hosts and ports:

- `localhost:3307`
- `localhost:3308`
- `localhost:3309`
- `localhost:3310`
- `localhost:3311`
- `localhost:3312`
- `localhost:3313`
- `localhost:3314`

Creating the Groups in Fabric

A logical group in Fabric maps to a shard. So as a first step to sharding we must implement the Fabric groups that store the shards. This can be done as follows:

```
shell> mysqlfabric group create group_id-1
shell> mysqlfabric group create group_id-2
shell> mysqlfabric group create group_id-3
```

The preceding commands create three high-availability groups: `group_id-1`, `group_id-2`, and `group_id-3`. Each group stores a shard.

Then we must define a global group which is used to propagate schema updates to all tables in the sharding setup and updates to global tables throughout the sharding scheme.

```
shell> mysqlfabric group create group_id-global
```

Registering the Servers

The MySQL servers must be registered with the groups. Each group contains two servers.

3307, 3308 belong to group_id-1

```
shell> mysqlfabric group add group_id-1 localhost:3307
shell> mysqlfabric group add group_id-1 localhost:3308
```

3309, 3310 belong to group_id-2

```
shell> mysqlfabric group add group_id-2 localhost:3309
shell> mysqlfabric group add group_id-2 localhost:3310
```

3311, 3312 belong to group_id-3

```
shell> mysqlfabric group add group_id-3 localhost:3311
shell> mysqlfabric group add group_id-3 localhost:3312
```

3313, 3314 belong to group_id-global

```
shell> mysqlfabric group add group_id-global localhost:3313
shell> mysqlfabric group add group_id-global localhost:3314
```

Then promote one server to master in each group:

```
shell> mysqlfabric group promote group_id-global
shell> mysqlfabric group promote group_id-1
shell> mysqlfabric group promote group_id-2
shell> mysqlfabric group promote group_id-3
```

Define a Shard Mapping

When we define a shard mapping, we basically do three things:

1. Define the type of sharding scheme we want to use (RANGE or HASH).
2. Define a global group that stores all the updates that must be propagated to all the shards that are part of this sharding scheme.
3. We generate a unique shard mapping id to which we can later associate database objects (tables).

```
shell> mysqlfabric sharding create_definition RANGE group_id-global
```

```
Procedure:
{ uuid        = 195bca1e-c552-464b-b4e3-1fa15e9b49d5,
  finished    = True,
  success     = True,
  return      = 1,
  activities  =
}
```

Add Tables to Defined Shard Mappings

Add the database table to the shard mapping defined previously.

```
shell> mysqlfabric sharding add_table 1 employees.employees emp_no
```

Add Shards for the Registered Tables

```
shell> mysqlfabric sharding add_shard 1 "group_id-1/1, group_id-2/100000, group_id-2/200000" --state=ENABLED
```

Executing Updates and Queries

Now you can write some example code for querying the sharded system.

```
import random
import mysql.connector
from mysql.connector import fabric

def prepare_synchronization(cur):
    # We need to keep track of what we have executed so far to guarantee
    # that the employees.employees table exists at all shards.
    gtid_executed = None
    cur.execute("SELECT @@global.gtid_executed")
    for row in cur:
        gtid_executed = row[0]
    return gtid_executed

def synchronize(cur, gtid_executed):
    # Guarantee that a slave has created the employees.employees table
    # before reading anything.
    cur.execute(
        "SELECT WAIT_UNTIL_SQL_THREAD_AFTER_GTIDS('%s', 0)" %
        (gtid_executed, )
    )
    cur.fetchall()

def add_employee(conn, emp_no, first_name, last_name, gtid_executed):
    conn.set_property(tables=["employees.employees"], key=emp_no,
                      mode=fabric.MODE_READWRITE)
    cur = conn.cursor()
    synchronize(cur, gtid_executed)
    cur.execute("USE employees")
    cur.execute(
        "INSERT INTO employees VALUES (%s, %s, %s)",
        (emp_no, first_name, last_name)
    )

def find_employee(conn, emp_no, gtid_executed):
    conn.set_property(tables=["employees.employees"], key=emp_no,
                      mode=fabric.MODE_READONLY)
    cur = conn.cursor()
    synchronize(cur, gtid_executed)
    cur.execute("USE employees")
    for row in cur:
        print "Had to synchronize", row, "transactions."
    cur.execute(
        "SELECT first_name, last_name FROM employees "
        "WHERE emp_no = %s", (emp_no, )
    )
    for row in cur:
        print row

def pick_shard_key():
    shard = random.randint(0, 2)
    shard_range = shard * 100000
    shard_range = shard_range if shard != 0 else shard_range + 1
    shift_within_shard = random.randint(0, 99999)
    return shard_range + shift_within_shard

# Address of the Fabric, not the host we are going to connect to.
conn = mysql.connector.connect(
    fabric={"host" : "localhost", "port" : 32274,
            "username": "admin", "password" : "adminpass"
           },
    user="webuser", password="webpass", autocommit=True
)

conn.set_property(tables=["employees.employees"], scope=fabric.SCOPE_GLOBAL,
                  mode=fabric.MODE_READWRITE)
cur = conn.cursor()
cur.execute("CREATE DATABASE IF NOT EXISTS employees")
cur.execute("USE employees")
cur.execute("DROP TABLE IF EXISTS employees")
cur.execute(
    "CREATE TABLE employees ("
    "   emp_no INT, "
    "   first_name CHAR(40), "
    "   last_name CHAR(40)"
    ")"
)
gtid_executed = prepare_synchronization(cur)

conn.set_property(scope=fabric.SCOPE_LOCAL)

first_names = ["John", "Buffalo", "Michael", "Kate", "Deep", "Genesis"]
last_names = ["Doe", "Bill", "Jackson", "Bush", "Purple"]

list_emp_no = []
for count in range(10):
    emp_no = pick_shard_key()
    list_emp_no.append(emp_no)
    add_employee(conn, emp_no,
                 first_names[emp_no % len(first_names)],
                 last_names[emp_no % len(last_names)],
                 gtid_executed
    )

for emp_no in list_emp_no:
    find_employee(conn, emp_no, gtid_executed)
```

Shard Move

If the current set of servers for a shard is not powerful enough, we can move the shard to a more powerful server set.

The shard-move functionality can be used to move a shard from one group to another. These are the steps necessary to move a shard.

1. Set up the required group or groups.

```
shell> mysqlfabric group create group_id-MOVE
shell> mysqlfabric group add group_id-MOVE localhost:3315
shell> mysqlfabric group add group_id-MOVE localhost:3316
shell> mysqlfabric group promote group_id-MOVE
```

2. Execute the shard move.

```
shell> mysqlfabric sharding move_shard 1 group_id-MOVE
```

3. Verify that the move has happened.

```
shell> mysqlfabric sharding lookup_servers employees.employees 4
```

Shard Split

If the shard becomes overloaded, we may need to split the shard into another group. The shard-split feature can be used to split the data in a given shard into another shard. The following demonstrates how to do this.

1. *Set up the required group or groups.*

```
shell> mysqlfabric group create group_id-SPLIT
shell> mysqlfabric group add group_id-SPLIT localhost:3317
shell> mysqlfabric group add group_id-SPLIT localhost:3318
shell> mysqlfabric group promote group_id-SPLIT
```

2. *Execute the shard split.*

```
shell> mysqlfabric sharding split_shard 2 group_id-SPLIT --split_value=150
```

3. *Verify that the shard Split happened.*

```
shell> mysqlfabric sharding lookup_servers employees.employees 152
shell> mysqlfabric sharding lookup_servers employees.employees 103
```

8.4 The `mysqlfabric` Utility

This section describes the `mysqlfabric` utility including examples of most commands. For a quick reference guide for all of the commands, see Section 8.5, “Fabric Utility Command Matrix”.

Fabric commands are organized in categories that include dump, event, group, manage, provider, role, server, sharding, snapshot, statistics threat, and user.

8.4.1 Getting Help

- `mysqlfabric help`: Show syntax information and the help commands.
- `mysqlfabric help commands`: List the available commands and their description.
- `mysqlfabric help groups`: List the available groups.
- `mysqlfabric help [group] [command]`: Provide detailed information on a command.

```
shell> mysqlfabric help group create
group create group_id  [--description=NONE] [--synchronous]
```

```
Create a group.
```

```
shell> mysqlfabric help
Usage: mysqlfabric [--param, --config] <grp> <cmd> [arg, ...].

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Options:
  --version             show program's version number and exit
  -h, --help            show this help message and exit
  --param=CONFIG_PARAMS
                        Override a configuration parameter.
  --config=FILE         Read configuration from FILE.

Basic commands:
    help <grp> <cmd>  Show help for command
    help commands     List all commands
    help groups       List all groups
```

8.4.2 Dump Commands

The dump commands are designed to be used by the connectors to retrieve information on shards, high-availability groups and their servers.

- `Command: dump shard_maps`: Return information about all shard mappings matching any of the provided patterns. If no patterns are provided, dump information about all shard mappings.

  ```
  Usage:
    mysqlfabric  dump shard_maps [--connector_version=CONNECTOR_VERSION]
                 [--patterns=]

  Options:
    --connector_version=CONNECTOR_VERSION
                          The connectors version of the data. By default None.
    --patterns=PATTERNS  shard mapping pattern. By default "".
  ```

- `Command: dump servers`: Return information about the index for all mappings matching any of the patterns provided. If no pattern is provided, dump the entire index. The lower_bound that is returned is a string that is a md-5 hash of the group-id in which the data is stored.

  ```
  Usage:
    mysqlfabric  dump servers [--connector_version=CONNECTOR_VERSION]
                 [--patterns=]

  Options:
    --connector_version=CONNECTOR_VERSION
                          The connectors version of the data. By default None.
    --patterns=PATTERNS  group pattern. By default "".
  ```

- `Command: dump shard_index`: Return information about servers. The servers might belong to any group that matches any of the provided patterns, or all servers if no patterns are provided.

  ```
  Usage:
    mysqlfabric  dump shard_index [--connector_version=CONNECTOR_VERSION]
                 [--patterns=]

  Options:
    --connector_version=CONNECTOR_VERSION
                          The connectors version of the data. By default None.
    --patterns=PATTERNS  group pattern. By default "".
  ```

- `Command: dump sharding_information`: Return information about all shard mappings matching any of the provided patterns. If no patterns are provided, dump information about all shard mappings.

```
Usage:
  mysqlfabric  dump shard_maps [--connector_version=CONNECTOR_VERSION]
               [--patterns=]

Options:
  --connector_version=CONNECTOR_VERSION
                       The connectors version of the data. By default None.
  --patterns=PATTERNS  shard mapping pattern. By default "".
```

- `Command: dump shard_tables`: Return information about all tables belonging to mappings matching any of the provided patterns. If no patterns are provided, dump information about all tables.

```
Usage:
  mysqlfabric  dump shard_tables [--connector_version=CONNECTOR_VERSION]
               [--patterns=]

Description:


Options:
  --connector_version=CONNECTOR_VERSION
                       The connectors version of the data. By default None.
  --patterns=PATTERNS  shard mapping pattern. By default "".
```

- `Command: dump fabric_nodes`: Return a list of Fabric Nodes (i.e. addresses). Specifically, the host and port are returned. If the protocol is not specified, it assumes the 'protocol.xmlrpc'. Currently, the 'protocol.xmlrpc' and 'protocol.mysql' are valid options.

```
Usage:
  mysqlfabric  dump fabric_nodes [--protocol=PROTOCOL]

Options:
  --protocol=PROTOCOL  MySQL Fabric might support different protocols which
                       have different addresses. By default None.

Return:
  List with existing Fabric Servers. ["host:port", ...]
```

8.4.3 Event Commands

The event commands are used to define events for tailoring the Fabric system to your needs for controlling applications.

- `Command: event trigger`: Trigger an event.

```
Usage:
  mysqlfabric  event trigger <event> [--locks=LOCKS] [--args=ARGS]
               [--kwargs=KWARGS]

Parameters:
  <event>  Event's identification. Accepted values: String

Options:
  --locks=LOCKS    By default None.
  --args=ARGS      Event's non-keyworded arguments. By default None.
  --kwargs=KWARGS  Event's keyworded arguments. By default None.

Return:
  :class:`CommandResult` instance with UUID of the procedures that were
  triggered.
```

- `Command: event wait_for_procedures`: Wait until procedures, which are identified through their uuid in a list and separated by comma, finish their execution. If a procedure is not found an error is returned.

```
Usage:
  mysqlfabric  event wait_for_procedures [--proc_uuids=PROC_UUIDS]

Options:
  --proc_uuids=PROC_UUIDS
            Iterable with procedures' UUIDs. By default None.
```

8.4.4 Group Commands

The group commands are used to define, modify, and control groups.

- `Command: activate`: Activate failure detector for server(s) in a group. By default the failure detector is disabled.

```
Usage:
  mysqlfabric  group activate <group_id> [--synchronous]

Parameters:
  <group_id>  Group's id.

Options:
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.

Return:
  Tuple with job's uuid and status.
```

- `Command: add`: Add a server into group. If users just want to update the state store and skip provisioning steps such as configuring replication, the update_only parameter must be set to true. Note that the current implementation has a simple provisioning step that makes the server point to the master if there is any.

```
Usage:
  mysqlfabric  group add <group_id> <address> [--timeout=TIMEOUT]
               [--update_only] [--synchronous]

Parameters:
  <group_id>  Group's id.
  <address>   Server's address.

Options:
  --timeout=TIMEOUT  Time in seconds after which an error is reported if one
                     cannot access the server. By default None.
  --update_only=UPDATE_ONLY
                     By default False.
  --synchronous=SYNCHRONOUS
                     Whether one should wait until the execution finishes or
                     not. By default True.

Return:
  Tuple with job's uuid and status.
```

- `Command: create`: Create a group.

```
Usage:
  mysqlfabric  group create <group_id> [--description=DESCRIPTION]
               [--synchronous]

Parameters:
  <group_id>  Group's id.

Options:
  --description=DESCRIPTION
            Group's description. By default None.
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.

Return:
  Tuple with job's uuid and status.
```

- `Command: deactivate`: Deactivate failure detector for server(s) in a group. By default the failure detector is disabled.

```
Usage:
  mysqlfabric  group deactivate <group_id> [--synchronous]

Parameters:
  <group_id>  Group's id.

Options:
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.

Return:
  Tuple with job's uuid and status.
```

- `Command: demote`: Demote the current master if there is one. If users just want to update the state store and skip provisioning steps such as configuring replication, the update_only parameter must be set to true. Otherwise any write access to the master is blocked, slaves are synchronized with the master, stopped and their replication configuration reset. Note that no slave is promoted as master.

```
Usage:
  mysqlfabric  group demote <group_id> [--update_only] [--synchronous]

Parameters:
  <group_id>

Options:
  --update_only=UPDATE_ONLY
            Only update the state store and skip provisioning. By default
            False.
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.
```

- `Command: description`: Update a group's description.

```
Usage:
  mysqlfabric  group description <group_id> [--description=DESCRIPTION]
               [--synchronous]

Parameters:
  <group_id>  Group's id.
```

```
Options:
  --description=DESCRIPTION
            Group's description. By default None.
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.

Return:
  Tuple with job's uuid and status.
```

- `Command: destroy`: Remove a group.

```
Usage:
  mysqlfabric  group destroy <group_id> [--synchronous]

Parameters:
  <group_id>  Group's id.

Options:
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.

Return:
  Tuple with job's uuid and status.
```

- `Command: health`: Check if any server within a group has failed and report health information.

```
Usage:
  mysqlfabric  group health <group_id> [--timeout=TIMEOUT]

Parameters:
  <group_id>  Timeout value after which a server is considered unreachable. If
              None is provided, it assumes the default value in the
              configuration file.

Options:
  --timeout=TIMEOUT  By default None.
```

- `Command: lookup_groups`: Return information on existing group(s).

```
Usage:
  mysqlfabric  group lookup_groups [--group_id=GROUP_ID]

Options:
  --group_id=GROUP_ID  None if one wants to list the existing groups or
                       group's id if one wants information on a group. By
                       default None.

Return:
  List with {"group_id" : group_id, "failure_detector": ON/OFF, "description"
  : description}.
```

- `Command: lookup_servers`: Return information on existing server(s) in a group.

```
Usage:
  mysqlfabric  group lookup_servers <group_id> [--server_id=SERVER_ID]
               [--status=STATUS] [--mode=MODE]

Parameters:
  <group_id>  Group's id.
```

```
Options:
  --server_id=SERVER_ID
                   None if one wants to list the existing servers in a group
                   or server's id if one wants information on a server in a
                   group. Accepted values: Servers's UUID or HOST:PORT. By
                   default None.
  --status=STATUS  Server's status one is searching for. By default None.
  --mode=MODE      Server's mode one is searching for. By default None.

Return:
  Information on servers. List with [uuid, address, status, mode, weight]
```

- `Command: promote`: Promote a server into master.

  If users just want to update the state store and skip provisioning steps such as configuring replication, the update_only parameter must be set to true. Otherwise, the following happens.

  If the master within a group fails, a new master is either automatically or manually selected among the slaves in the group. The process of selecting and setting up a new master after detecting that the current master failed is known as failover.

  It is also possible to switch to a new master when the current one is still alive and kicking. The process is known as switchover and may be used, for example, when one wants to take the current master off-line for maintenance.

  If a slave is not provided, the best candidate to become the new master is found. Any candidate must have the binary log enabled, should have logged the updates executed through the SQL Thread and both candidate and master must belong to the same group. The smaller the lag between slave and the master the better. So the candidate which satisfies the requirements and has the smaller lag is chosen to become the new master.

  In the failover operation, after choosing a candidate, one makes the slaves point to the new master and updates the state store setting the new master.

  In the switchover operation, after choosing a candidate, any write access to the current master is disabled and the slaves are synchronized with it. Failures during the synchronization that do not involve the candidate slave are ignored. Then slaves are stopped and configured to point to the new master and the state store is updated setting the new master.

```
Usage:
  mysqlfabric  group promote <group_id> [--slave_id=SLAVE_ID] [--update_only]
               [--synchronous]

Parameters:
  <group_id>

Options:
  --slave_id=SLAVE_ID  Candidate's UUID or HOST:PORT. By default None.
  --update_only=UPDATE_ONLY
                       Only update the state store and skip provisioning. By
                       default False.
  --synchronous=SYNCHRONOUS
                       Whether one should wait until the execution finishes or
                       not. By default True.
```

- `Command: remove`: Remove a server from a group.

```
Usage:
  mysqlfabric  group remove <group_id> <server_id> [--synchronous]
```

```
Parameters:
  <group_id>   Group's id.
  <server_id>  Servers's UUID or HOST:PORT.

Options:
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.

Return:
  Tuple with job's uuid and status.
```

8.4.5 Manage Commands

- `Command: logging_level`: Set logging level.

```
Usage:
  mysqlfabric manage logging_level <module> <level>

Parameters:
  <module> Module that will have its logging level changed.
  <level>   The logging level that will be set.
```

- `Command: ping`: Check whether the Fabric server is running or not.

```
Usage:
  mysqlfabric manage ping
```

- `Command: setup`: Setup Fabric Storage System. Create a database and necessary objects.

```
Usage:
  mysqlfabric manage setup [--read_pw_from_stdin]

Options:
  --read_pw_from_stdin=READ_PW_FROM_STDIN
            Whether to read passwords from stdin instead of from the
            controlling tty. By default False.
```

- `Command: start`: Start the Fabric server.

```
Usage:
  mysqlfabric manage start [--foreground] [--disable_clustering] [--bootstrap]
               [--cluster_seed=CLUSTER_SEED] [--cluster_uuid=CLUSTER_UUID]
               [--cluster_timeout=5] [--read_pw_from_stdin]

Options:
  --foreground=FOREGROUND
            Whether it should be started as background process or not. Default
            is False. By default False.
  --disable_clustering=DISABLE_CLUSTERING
            Whether it should start with its clustering capabilities disabled
            and never join a cluster. By default False.
  --bootstrap=BOOTSTRAP
            Whether the node will be used to bootstrap the cluster or not.
            Default is False. By default False.
  --cluster_seed=CLUSTER_SEED
            Information that will be used to discover members of the cluster
            and eventually try to join it. By default None.
  --cluster_uuid=CLUSTER_UUID
            Cluster Identifier. Used to ensure that the node does not connect
            to the wrong cluster. By default None.
  --cluster_timeout=CLUSTER_TIMEOUT
```

```
            Timeout after which the node will stop trying to join the cluster.
            By default 5.
  --read_pw_from_stdin=READ_PW_FROM_STDIN
            Whether to read passwords from stdin instead of from the
            controlling tty. By default False.
```

- `Command: stop`: Stop the Fabric server.

```
Usage:
  mysqlfabric manage stop
```

- `Command: teardown`: Tear down Fabric Storage System. Drop database and its objects.

Note

A teardown removes the backing store contents, therefore all configuration information is lost. It's the contrary of **`manage setup`**.

```
Usage:
  mysqlfabric manage teardown [--read_pw_from_stdin]

Options:
  --read_pw_from_stdin=READ_PW_FROM_STDIN
            Whether to read passwords from stdin instead of from the
            controlling tty. By default False.
```

8.4.6 Provider Commands

The provider commands are used to manage cloud providers.

- `Command: list`: Return information on existing provider(s).

```
Usage:
  mysqlfabric  provider list [--provider_id=PROVIDER_ID]

Options:
  --provider_id=PROVIDER_ID
            None if one wants to list the existing providers or provider's id
            if one wants information on a provider. By default None.
```

- `Command: register`: Register a provider.

```
Usage:
  mysqlfabric  provider register <provider_id> <url> [--tenant=TENANT]
               [--provider_type=OPENSTACK] [--default_image=DEFAULT_IMAGE]
               [--default_flavor=DEFAULT_FLAVOR] [--extra=EXTRA]
               [--synchronous]

Parameters:
  <provider_id>  Provider's Id.
  <url>          URL that is used as an access point.

Options:
  --tenant=TENANT  Tenant's name, i.e. who will access resources in the cloud.
                   By default None.
  --provider_type=PROVIDER_TYPE
                   Provider type. By default OPENSTACK.
  --default_image=DEFAULT_IMAGE
                   By default None.
  --default_flavor=DEFAULT_FLAVOR
```

```
                    By default None.
  --extra=EXTRA     Define parameters that are specific to a provider. By
                    default None.
  --synchronous=SYNCHRONOUS
                    Whether one should wait until the execution finishes or
                    not. By default True.

Return:
  Tuple with job's uuid and status.
```

- `Command: unregister`: Unregister a provider.

```

Usage:
  mysqlfabric  provider unregister <provider_id> [--synchronous]

Parameters:
  <provider_id>  Provider's Id.

Options:
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.

Return:
  Tuple with job's uuid and status.
```

8.4.7 Role Commands

The role commands are used to display information about an user's role as description and permissions.

- `Command: list`: List roles and associated permissions.

```

Usage:
  mysqlfabric  role list [--name=NAME]

Options:
  --name=NAME  Role's name. By default None.
```

8.4.8 Server Commands

The server commands are used to get information about servers and set their properties, namely status, mode and weight.

- `Command: clone`: Clone the objects of a given server into a destination server.

```

Usage:
  mysqlfabric  server clone <group_id> <destn_address> [--source_id=SOURCE_ID]
               [--timeout=TIMEOUT] [--synchronous]

Parameters:
  <group_id>       The ID of the source group.
  <destn_address>  The address of the destination MySQL Server.

Options:
  --source_id=SOURCE_ID
                     The address or UUID of the source MySQL Server. By
                     default None.
  --timeout=TIMEOUT  Time in seconds after which an error is reported if the
                     destination server is unreachable. By default None.
  --synchronous=SYNCHRONOUS
                     Whether one should wait until the execution finishes or
                     not. By default True.
```

- `Command: create`: Create a virtual machine instance.

  Usage examples:

```
shell> mysqlfabric server create provider --image name=image-mysql \
  --flavor name=vm-template --meta db=mysql --meta=version=5.6

shell> mysqlfabric server create provider --image name=image-mysql \
  --flavor name=vm-template --security_groups grp_fabric, grp_ham
```

  Options that accept a list are defined by providing the same option multiple times in the command-line. The image, flavor, files, meta and scheduler_hints are those which might be defined multiple times. Note the the security_groups option might be defined only once but it accept a string with a list of security groups.

```
Usage:
  mysqlfabric  server create <provider_id> [--image=IMAGE] [--flavor=FLAVOR]
               [--number_machines=1] [--availability_zone=AVAILABILITY_ZONE]
               [--key_name=KEY_NAME] [--security_groups=SECURITY_GROUPS]
               [--private_network=PRIVATE_NETWORK]
               [--public_network=PUBLIC_NETWORK] [--userdata=USERDATA]
               [--swap=SWAP] [--scheduler_hints=SCHEDULER_HINTS] [--meta=META]
               [--datastore=DATASTORE] [--datastore_version=DATASTORE_VERSION]
               [--size=SIZE] [--databases=DATABASES] [--users=USERS]
               [--configuration=CONFIGURATION] [--security=SECURITY]
               [--skip_store] [--wait_spawning] [--synchronous]

Parameters:
  <provider_id>  Provider's Id.

Options:
  --image=IMAGE        Image's properties. (e.g. name=image-mysql). Accepted
                       values: list of key/value pairs. By default None.
  --flavor=FLAVOR      Flavor's properties (e.g. name=vm-template). Accepted
                       values: list of key/value pairs. By default None.
  --number_machines=NUMBER_MACHINES
                       Number of machines to be created. Accepted values:
                       integer. By default 1.
  --availability_zone=AVAILABILITY_ZONE
                       Name of availability zone. Accepted values: string. By
                       default None.
  --key_name=KEY_NAME  Name of the key previously created. Accepted values:
                       string. By default None.
  --security_groups=SECURITY_GROUPS
                       Security groups to have access to the machine(s).
                       Accepted values: string with a list of security groups.
                       By default None.
  --private_network=PRIVATE_NETWORK
                       Name of the private network where the machine(s) will
                       be placed to. By default None.
  --public_network=PUBLIC_NETWORK
                       Name of the public network which will provide a public
                       address. By default None.
  --userdata=USERDATA  Script that to be used to configure the machine(s).
                       Accepted values: path to a file. By default None.
  --swap=SWAP          Size of the swap space in megabyte. Accepted values:
                       integer. By default None.
  --scheduler_hints=SCHEDULER_HINTS
                       Information on which host(s) the machine(s) will be
                       created in. Accepted values: list of key/value pairs.
                       By default None.
  --meta=META          Metadata on the machine(s). Accepted values: list of
```

```
                       key/value pairs. By default None.
  --datastore=DATASTORE
                       Database Technology (.e.g. MySLQ). Accepted values:
                       string. By default None.
  --datastore_version=DATASTORE_VERSION
                       Datastore version (.e.g. 5.6). Accepted values: string.
                       By default None.
  --size=SIZE          Storage area reserved to the data store. Accepted
                       values: string in Gigabytes. By default None.
  --databases=DATABASES
                       Database objects that will be created. Accepted values:
                       List of strings separated by comma. By default None.
  --users=USERS        By default None.
  --configuration=CONFIGURATION
                       Configuration attached to the database. Accepted
                       values: string. By default None.
  --security=SECURITY  By default 0.0.0.0/0 is set. Users who want a differnt
                       permission should specify a different value. Accepted
                       values: string. By default None.
  --skip_store=SKIP_STORE
                       Do not store information on machine(s) into the state
                       store. Default is False. By default False.
  --wait_spawning=WAIT_SPAWNING
                       Whether one should wait until the provider finishes its
                       task or not. By default True.
  --synchronous=SYNCHRONOUS
                       Whether one should wait until the execution finishes or
                       not. By default True.
```

- `Command: destroy`: Destroy a virtual machine instance.

```
Usage:
  mysqlfabric  server destroy <provider_id> <machine_uuid> [--force]
               [--skip_store] [--synchronous]

Parameters:
  <provider_id>   Provider's Id.
  <machine_uuid>  Machine's uuid.

Options:
  --force=FORCE  Ignore errors while accessing the cloud provider. By default
                 False.
  --skip_store=SKIP_STORE
                 Proceed anyway if there is no information on the machine in
                 the state store. Default is False. By default False.
  --synchronous=SYNCHRONOUS
                 Whether one should wait until the execution finishes or not.
                 By default True.

Return:
  Tuple with job's uuid and status.
```

- `Command: list`: Return information on existing machine(s) created by a provider.

```
Usage:
  mysqlfabric  server list <provider_id> [--generic_filters=GENERIC_FILTERS]
               [--meta_filters=META_FILTERS] [--skip_store]

Parameters:
  <provider_id>  Provider's Id.

Options:
  --generic_filters=GENERIC_FILTERS
            Set of key-value pairs that are used to filter the list of
            returned machines. By default None.
  --meta_filters=META_FILTERS
            Set of key-value pairs that are used to filter the list of
            returned machines. By default None.
  --skip_store=SKIP_STORE
            Don't check the list of machines from the state store. By default
            False.
```

- `Command: lookup_uuid`: Return server's uuid.

```
Usage:
  mysqlfabric  server lookup_uuid <address> [--timeout=TIMEOUT]

Parameters:
  <address>  Server's address.

Options:
  --timeout=TIMEOUT  Time in seconds after which an error is reported if the
                     UUID is not retrieved. By default None.

Return:
  UUID.
```

- `server set_mode`: Set a server's mode, which determines whether it can process read_only, read_write, or both transaction types. It can also be set to offline meaning that the server does not process any kind of user's request.

```
Usage:
  mysqlfabric  server set_mode <server_id> <mode> [--synchronous]

Parameters:
  <server_id>  Servers's UUID or HOST:PORT.
  <mode>

Options:
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.
```

- `Command: server set_status`: Set a server's status.

  Any server added into a group has to be alive and kicking and its status is automatically set to SECONDARY. If the failure detector is activate and the server is not reachable, it is automatically set to FAULTY.

  Users can also manually change the server's status. Usually, a user may change a slave's mode to SPARE to avoid write and read access and guarantee that it is not chosen when a failover or switchover routine is executed.

  By default replication is automatically configured when a server has its status changed. In order to skip this, users must set the update_only parameter to true. If done so, only the state store is updated with information on the new status.

```
Usage:
  mysqlfabric  server set_status <server_id> <status> [--update_only]
               [--synchronous]
Parameters:
  <server_id>  Servers's UUID or HOST:PORT.
  <status>     Server's status.

Options:
  --update_only=UPDATE_ONLY
            By default False.
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.
```

- `Command: server set_weight`: Set a server's weight.

  `server set_weight`: Set a server's weight, which helps determine its likelihood of being chosen to process requests or replace a failed master. The value must be greater than `0.0` and lower or equal to `1.0`.

  Note

  This option was implemented in Fabric 1.5.7.

```
Usage:
  mysqlfabric  server set_weight <server_id> <weight> [--synchronous]

Parameters:
  <server_id>  Servers's UUID or HOST:PORT.
  <weight>     Server's weight.

Options:
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.
```

8.4.9 Sharding Commands

The sharding commands are used to define, modify, and control sharding.

- `Command: add_shard`: Add a shard.

```
Usage:
  mysqlfabric  sharding add_shard <shard_mapping_id> <groupid_lb_list>
               [--state=DISABLED] [--update_only] [--synchronous]
Parameters:
  <shard_mapping_id>  The unique identification for a shard mapping.
  <groupid_lb_list>   The list of group_id, lower_bounds pairs in the format,
                      group_id/lower_bound, group_id/lower_bound...

Options:
  --state=STATE  Indicates whether a given shard is ENABLED or DISABLED. By
                 default DISABLED.
  --update_only=UPDATE_ONLY
                 Only update the state store and skip adding range checks. By
                 default False.
  --synchronous=SYNCHRONOUS
                 Whether one should wait until the execution finishes or not.
                 By default True.

Return:
  A dictionary representing the current Range specification.
```

- `Command: add_table`: Add a table to a shard mapping.

```
Usage:
  mysqlfabric  sharding add_table <shard_mapping_id> <table_name>
               <column_name> [--range_check] [--update_only] [--synchronous]
```

```
Parameters:
  <shard_mapping_id>  The shard mapping id to which the input table is
                      attached.
  <table_name>        The table being sharded.
  <column_name>       The column whose value is used in the sharding scheme
                      being applied

Options:
  --range_check=RANGE_CHECK
            Indicates if range check should be turned on for this table. By
            default False.
  --update_only=UPDATE_ONLY
            Only update the state store and skip adding range checks. By
            default False.
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.
```

- `Command: create_definition`: Define a shard mapping.

```
Usage:
  mysqlfabric  sharding create_definition <type_name> <group_id>
               [--synchronous]

Parameters:
  <type_name>  The type of sharding scheme - RANGE or HASH
  <group_id>   Every shard mapping is associated with a global group that
               stores the global updates and the schema changes for this shard
               mapping and dissipates these to the shards.

Options:
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.
```

- `Command: disable_shard`: Disable a shard.

```
Usage:
  mysqlfabric  sharding disable_shard <shard_id> [--synchronous]

Parameters:
  <shard_id>  The shard ID of the shard that needs to be removed.

Options:
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.
```

- `Command: enable_shard`: Enable a shard.

```
Usage:
  mysqlfabric  sharding enable_shard <shard_id> [--synchronous]

Parameters:
  <shard_id>  The shard ID of the shard that needs to be removed.

Options:
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.
```

- `Command: list_definitions`: Lists all the shard mapping definitions.

```
Usage:
  mysqlfabric  sharding list_definitions

Return:
  A list of shard mapping definitions An Empty List if no shard mapping
  definition is found.
```

- `Command: list_tables`: Returns all the shard mappings of a particular sharding_type

```
Usage:
  mysqlfabric  sharding list_tables <sharding_type>

Parameters:
  <sharding_type>  The sharding type for which the sharding specification
                   needs to be returned.

Return:
  A list of dictionaries of shard mappings that are of the sharding type An
  empty list of the sharding type is valid but no shard mapping definition is
  found An error if the sharding type is invalid.
```

- `Command: lookup_servers`: Lookup a shard based on the give sharding key.

```
Usage:
  mysqlfabric  sharding lookup_servers <table_name> <key> [--hint=LOCAL]

Parameters:
  <table_name>  The table whose sharding specification needs to be looked up.
  <key>         The key value that needs to be looked up

Options:
  --hint=HINT  A hint indicates if the query is LOCAL or GLOBAL. By default
               LOCAL.

Return:
  The Group UUID that contains the range in which the key belongs.
```

- `Command: lookup_table`: Fetch the shard specification mapping for the given table.

```
Usage:
  mysqlfabric  sharding lookup_table <table_name>

Parameters:
  <table_name>  The name of the table for which the sharding specification is
                being queried.

Return:
  The a dictionary that contains the shard mapping information for the given
  table.
```

- `Command: move_shard`: Move the shard represented by the shard_id to the destination group.

  By default this operation takes a backup, restores it on the destination group and guarantees that source and destination groups are synchronized before pointing the shard to the new group. If users just want to update the state store and skip these provisioning steps, the update_only parameter must be set to true.

```
Usage:
  mysqlfabric  sharding move_shard <shard_id> <group_id> [--update_only]
               [--synchronous]

Parameters:
  <shard_id>  The ID of the shard that needs to be moved.
  <group_id>  The ID of the group to which the shard needs to be moved.

Options:
  --update_only=UPDATE_ONLY
            By default False.
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.
```

- `Command: prune_shard`: Given the table name prune the tables according to the defined sharding specification for the table.

```
Usage:
  mysqlfabric  sharding prune_shard <table_name> [--synchronous]

Parameters:
  <table_name>  The table that needs to be sharded.

Options:
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.
```

- `Command: remove_definition`: Remove the shard mapping definition represented by the Shard Mapping ID.

```
Usage:
  mysqlfabric  sharding remove_definition <shard_mapping_id> [--synchronous]

Parameters:
  <shard_mapping_id>  The shard mapping ID of the shard mapping definition
                      that needs to be removed.

Options:
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.
```

- `Command: remove_shard`: Remove a shard.

```
Usage:
  mysqlfabric  sharding remove_shard <shard_id> [--synchronous]

Parameters:
  <shard_id>  The shard ID of the shard that needs to be removed.

Options:
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.
```

- `Command: remove_table`: Remove the shard mapping represented by the Shard Mapping object.

```
Usage:
  mysqlfabric  sharding remove_table <table_name> [--synchronous]

Parameters:
  <table_name>  The name of the table whose sharding specification is being
                removed.

Options:
  --synchronous=SYNCHRONOUS
```

```
            Whether one should wait until the execution finishes or not. By
            default True.
```

- `Command: split_shard`: Split the shard represented by the shard_id into the destination group.

  By default this operation takes a backup, restores it on the destination group and guarantees that source and destination groups are synchronized before pointing the shard to the new group. If users just want to update the state store and skip these provisioning steps, the update_only parameter must be set to true.

```
Usage:
  mysqlfabric  sharding split_shard <shard_id> <group_id>
               [--split_value=SPLIT_VALUE] [--update_only] [--synchronous]

Parameters:
  <shard_id>  The shard_id of the shard that needs to be split.
  <group_id>  The ID of the group into which the split data needs to be moved.

Options:
  --split_value=SPLIT_VALUE
            The value at which the range needs to be split. By default None.
  --update_only=UPDATE_ONLY
            By default False.
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes. By default
            True.
```

8.4.10 Snapshot Commands

The snapshot commands are related to the creation or destruction of machine snapshots.

- `Command: create`: Create a snapshot image from a machine.

```
Usage:
  mysqlfabric  snapshot create <provider_id> <machine_uuid> [--skip_store]
               [--wait_spawning] [--synchronous]

Parameters:
  <provider_id>   Provider's Id.
  <machine_uuid>  Machine's uuid.

Options:
  --skip_store=SKIP_STORE
            Proceed anyway if there is no information on the machine in the
            state store. Default is False. By default False.
  --wait_spawning=WAIT_SPAWNING
            By default True.
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.

Return:
  Tuple with job's uuid and status.
```

- `Command: destroy`: Destroy snapshot images associated to a machine.

```
Usage:
  mysqlfabric  snapshot destroy <provider_id> <machine_uuid> [--skip_store]
               [--synchronous]
Parameters:
  <provider_id>   Provider's Id.
  <machine_uuid>  Machine's uuid.
```

```
Options:
  --skip_store=SKIP_STORE
            Proceed anyway if there is no information on the machine in the
            state store. Default is False. By default False.
  --synchronous=SYNCHRONOUS
            Whether one should wait until the execution finishes or not. By
            default True.

Return:
  Tuple with job's uuid and status.
```

8.4.11 Statistics Commands

The statistics commands are used to Retrieve statistics at note, group or procedure level.

- `Command: group`: Retrieve statistics on Groups.

```
Usage:
  mysqlfabric  statistics group [--group_id=GROUP_ID]

Options:
  --group_id=GROUP_ID  Group one wants to retrieve information on. By default
                       None.
```

- `Command: node`: Retrieve statistics on the Fabric node.

```
Usage:
  mysqlfabric  statistics node
```

- `Command: procedure`: Retrieve statistics on Procedures.

```
Usage:
  mysqlfabric  statistics procedure [--procedure_name=PROCEDURE_NAME]

Options:
  --procedure_name=PROCEDURE_NAME
            Procedure one wants to retrieve information on. By default None.
```

8.4.12 Threat Commands

The threat commands are used to report that a server is not working properly for any reason, these commands can be used by external entities (e.g. connectors) and MySQL Fabric itself.

- `Command: report_error`: Report a server error. If there are many issues reported by different servers within a period of time, the server is marked as faulty. Should the server be a primary, the failover mechanism is triggered. Users who only want to set the server's status to faulty after getting enough notifications from different clients must set the update_only parameter to true. By default its value is false.

```
Usage:
  mysqlfabric  threat report_error <server_id> [--reporter=UNKNOWN]
               [--error=UNKNOWN] [--update_only] [--synchronous]

Parameters:
  <server_id>  Servers's UUID or HOST:PORT.

Options:
  --reporter=REPORTER  Who has reported the issue, usually an IP address or a
                       host name. By default unknown.
  --error=ERROR         Error that has been reported. By default unknown.
  --update_only=UPDATE_ONLY
                        Only update the state store and skip provisioning. By
                        default False.
  --synchronous=SYNCHRONOUS
                        By default True.
```

- `Command: report_failure`: Report with certainty that a server has failed or is unreachable. Should the server be a primary, the failover mechanism is triggered. Users who only want to set the server's status to faulty must set the update_only parameter to True. By default its value is false.

```
Usage:
  mysqlfabric  threat report_failure <server_id> [--reporter=UNKNOWN]
               [--error=UNKNOWN] [--update_only] [--synchronous]

Parameters:
  <server_id>  Servers's UUID or HOST:PORT.

Options:
  --reporter=REPORTER  Who has reported the issue, usually an IP address or a
                        host name. By default unknown.
  --error=ERROR         Error that has been reported. By default unknown.
  --update_only=UPDATE_ONLY
                        Only update the state store and skip provisioning. By
                        default False.
  --synchronous=SYNCHRONOUS
                        By default True.
```

8.4.13 User Commands

The user commands are used to manage the Fabric user.

- `Command: add`: Add a new Fabric user.

```
Usage:
  mysqlfabric  user add <username> [--protocol=PROTOCOL] [--roles=ROLES]

Parameters:
  <username>  The username account to add.

Options:
  --protocol=PROTOCOL  Protocol of the user (for example 'xmlrpc'). By default
                        None.
  --roles=ROLES        Comma separated list of roles, IDs or names (see `role
                        list`). By default None.
```

- `Command: delete`: Delete a Fabric user.

```
Usage:
  mysqlfabric  user delete <username> [--protocol=PROTOCOL] [--force]

Parameters:
  <username>  The username account to delete.

Options:
  --protocol=PROTOCOL  Protocol of the user (for example 'xmlrpc'). By default
                        None.
  --force=FORCE        Do not ask for confirmation. By default False.
```

- `Command: list`: List users and their roles.

```
Usage:
  mysqlfabric  user list [--name=NAME]

Options:
  --name=NAME  User's name. By default None.
```

• `Command: password`: Change password for a Fabric user.

```
Usage:
  mysqlfabric  user password <username> [--protocol=PROTOCOL]

Parameters:
  <username>  The username to change the password of.

Options:
  --protocol=PROTOCOL  Protocol of the user (for example 'xmlrpc'). By default
                       None.
```

• `Command: roles`: Change roles for a Fabric user.

```
Usage:
  mysqlfabric  user roles <username> [--protocol=PROTOCOL] [--roles=ROLES]

Parameters:
  <username>  The username to change the roles of.

Options:
  --protocol=PROTOCOL  Protocol of the user (for example 'xmlrpc'). By default
                       None.
  --roles=ROLES        Comma separated list of roles, IDs or names (see `role
                       list`). By default None.
```

8.5 Fabric Utility Command Matrix

The following table lists all of the commands available in the `mysqlfabric` utility. The table is sorted by group and command to make it easier to find things. Each group and command is listed with all available options and parameters. Below each is a short description of the task.

Table 8.3 Fabric Commands

Group	Command	Parameters	Options
dump	*fabric_nodes*		*--protocol=PROTOCOL*
dump	*servers*		*--connector_version=CONNECTOR_VE* *--patterns=PATTERNS*
dump	*shard_index*		*--connector_version=CONNECTOR_VE* *--patterns=PATTERNS*
dump	*shard_maps*		*--connector_version=CONNECTOR_VE* *--patterns=PATTERNS*
dump	*shard_tables*		*--connector_version=CONNECTOR_VE* *--patterns=PATTERNS*
event	*trigger*	*event*	*--args=ARGS, --kwargs=KWARGS, --locks=LOCKS*

Group	Command	Parameters	Options
group	*activate*	*group_id*	*-- synchronous=SYNCHRONOUS*
group	*add*	*address, group_id*	*-- synchronous=SYNCHRONOUS, --timeout=TIMEOUT, -- update_only=UPDATE_ONLY*
group	*create*	*group_id*	*-- description=DESCRIPTION, -- synchronous=SYNCHRONOUS*
group	*deactivate*	*group_id*	*-- synchronous=SYNCHRONOUS*
group	*demote*	*group_id*	*-- synchronous=SYNCHRONOUS, -- update_only=UPDATE_ONLY*
group	*description*	*group_id*	*-- description=DESCRIPTION, -- synchronous=SYNCHRONOUS*
group	*destroy*	*group_id*	*-- synchronous=SYNCHRONOUS*
group	*health*	*group_id*	*--timeout=TIMEOUT*
group	*lookup_groups*		*--group_id=GROUP_ID*
group	*lookup_servers*	*group_id*	*--mode=MODE, -- server_id=SERVER_ID, --status=STATUS*
group	*promote*	*group_id*	*--slave_id=SLAVE_ID, -- synchronous=SYNCHRONOUS, -- update_only=UPDATE_ONLY*
group	*remove*	*group_id, server_id*	*-- synchronous=SYNCHRONOUS*
manage	*logging_level*	*level, module*	
manage	*ping*		
manage	*setup*		*-- read_pw_from_stdin=READ_PW_*
manage	*start*		*-- bootstrap=BOOTSTRAP, -- cluster_seed=CLUSTER_SEED, -- cluster_timeout=CLUSTER_TIME -- cluster_uuid=CLUSTER_UUID, --*

Group	Command	Parameters	Options
			disable_clustering=DISABLE_CLUSTE --foreground=FOREGROUND, --read_pw_from_stdin=READ_PW_FRO
manage	stop		
manage	teardown		--read_pw_from_stdin=READ_PW_FRO
provider	list		--provider_id=PROVIDER_ID
provider	register	provider_id, url	--default_flavor=DEFAULT_FLAVOR, --default_image=DEFAULT_IMAGE, --extra=EXTRA, --provider_type=PROVIDER_TYPE, --synchronous=SYNCHRONOUS, --tenant=TENANT
provider	unregister	provider_id	--synchronous=SYNCHRONOUS
role	list		--name=NAME
server	clone	destn_address, group_id	--source_id=SOURCE_ID, --synchronous=SYNCHRONOUS, --timeout=TIMEOUT
server	create	provider_id	--availability_zone=AVAILABILITY_ZON --configuration=CONFIGURATION, --databases=DATABASES, --datastore=DATASTORE, --datastore_version=DATASTORE_VER --flavor=FLAVOR, --image=IMAGE, --key_name=KEY_NAME, --meta=META, --number_machines=NUMBER_MACHI --private_network=PRIVATE_NETWOR --public_network=PUBLIC_NETWORK, --scheduler_hints=SCHEDULER_HINTS --security=SECURITY, --

Group	Command	Parameters	Options
			security_groups=SECURITY_GRO --size=SIZE, -- skip_store=SKIP_STORE, --swap=SWAP, -- synchronous=SYNCHRONOUS, --userdata=USERDATA, --users=USERS, -- wait_spawning=WAIT_SPAWNING
server	destroy	machine_uuid, provider_id	--force=FORCE, -- skip_store=SKIP_STORE, -- synchronous=SYNCHRONOUS
server	list	provider_id	-- generic_filters=GENERIC_FILTER -- meta_filters=META_FILTERS, -- skip_store=SKIP_STORE
server	lookup_uuid	address	--timeout=TIMEOUT
server	set_mode	mode, server_id	-- synchronous=SYNCHRONOUS
server	set_status	server_id, status	-- synchronous=SYNCHRONOUS, -- update_only=UPDATE_ONLY
server	set_weight	server_id, weight	-- synchronous=SYNCHRONOUS
sharding	add_shard	groupid_lb_list, shard_mapping_id	--state=STATE, -- synchronous=SYNCHRONOUS, -- update_only=UPDATE_ONLY
sharding	add_table	column_name, column_name, shard_mapping_id, table_name	-- range_check=RANGE_CHECK, -- synchronous=SYNCHRONOUS, -- update_only=UPDATE_ONLY
sharding	create_definition	group_id, type_name	-- synchronous=SYNCHRONOUS
sharding	disable_shard	shard_id	-- synchronous=SYNCHRONOUS
sharding	enable_shard	shard_id	-- synchronous=SYNCHRONOUS
sharding	list_definitions		
sharding	list_tables	sharding_type	
sharding	lookup_servers	key, table_name	--hint=HINT

Group	Command	Parameters	Options
sharding	lookup_table	table_name	
sharding	move_shard	group_id, shard_id	--synchronous=SYNCHRONOUS, --update_only=UPDATE_ONLY
sharding	prune_shard	table_name	--synchronous=SYNCHRONOUS
sharding	remove_definition	shard_mapping_id	--synchronous=SYNCHRONOUS
sharding	remove_shard	shard_id	--synchronous=SYNCHRONOUS
sharding	remove_table	table_name	--synchronous=SYNCHRONOUS
sharding	split_shard	group_id, shard_id	--split_value=SPLIT_VALUE, --synchronous=SYNCHRONOUS, --update_only=UPDATE_ONLY
snapshot	create	machine_uuid, provider_id	--skip_store=SKIP_STORE, --synchronous=SYNCHRONOUS, --wait_spawning=WAIT_SPAWNING
snapshot	destroy	machine_uuid, provider_id	--skip_store=SKIP_STORE, --synchronous=SYNCHRONOUS
statistics	group		--group_id=GROUP_ID
statistics	node		
statistics	procedure		--procedure_name=PROCEDURE_NAM
threat	report_error	server_id	--error=ERROR, --reporter=REPORTER, --synchronous=SYNCHRONOUS, --update_only=UPDATE_ONLY
threat	report_failure	server_id	--error=ERROR, --reporter=REPORTER, --synchronous=SYNCHRONOUS, --update_only=UPDATE_ONLY
user	add	username	--protocol=PROTOCOL, --roles=ROLES

Group	Command	Parameters	Options
user	*delete*	*username*	*--force=FORCE, --protocol=PROTOCOL*
user	*list*		*--name=NAME*
user	*password*	*username*	*--protocol=PROTOCOL*
user	*roles*	*username*	*--protocol=PROTOCOL, --roles=ROLES*

8.6 Backing Store

The backing store feature requires a MySQL instance. This server should be the same version as your other servers and MySQL version 5.6.10 or later. This section explains how to set up the backing store and provides information about some of the tables created.

To set up the backing store, use the `mysqlfabric` command. The `--param` options specify the user and password we created in Section 8.2.3.1, "Create the Associated MySQL Users" so that the utility can connect to the backing store and create the database and tables. We show the resulting tables in the new `fabric` database below.

```
shell> mysqlfabric manage setup --param=storage.user=fabric --param=storage.password=secret
[INFO] 1379444563.457977 - MainThread - Initializing persister:
user (fabric), server (localhost:3306), database (fabric).
shell> mysqlshow -ufabric -psecret fabric
+-------------------+
|      Tables       |
+-------------------+
| checkpoints       |
| error_log         |
| group_replication |
| groups            |
| permissions       |
| role_permissions  |
| roles             |
| servers           |
| shard_maps        |
| shard_ranges      |
| shard_tables      |
| shards            |
| user_roles        |
| users             |
+-------------------+
```

Note

The tables described here are subject to change in future versions of Fabric.

8.6.1 Backing Store Tables

The `checkpoints` table stores information on procedures' executions and is used to safely resume executing a procedure after a crash and recovery:

Table 8.4 checkpoints

Column	Type	Comment
proc_uuid	varchar(40)	The procedure's unique identification
lockable_objects	blob	Set of objects locked by the procedure

Column	Type	Comment
job_uuid	varchar(60)	The job's unique identification
sequence	int(11)	The job's sequence in the execution
action_fqn	text	Reference to the fully qualified name of the function to be executed on behalf of the job
param_args	blob	Positional arguments to the job's function
param_kwargs	blob	Keyword arguments to the job's function
started	double(16,6)	When the job started
finished	double(16,6)	When the job finished

The `error_log` table contains information on servers' errors reported.

Table 8.5 error_log

Column	Type	Comment
server_uuid	varchar(40)	The `server_uuid` value from the server that has raised an error
reported	timestamp(6)	When the error was reported
reporter	varchar(64)	Who reported the error: IP address, host name
error	text	Error message or code reported

The `group_replication` table defines replication among global groups and groups used in shards. They are used primarily for shard splitting, moving, and global updates.

Table 8.6 group_replication

Column	Type
master_group_id	varchar(64)
slave_group_id	varchar(64)

The `groups` table contains information about the groups being managed.

Table 8.7 groups

Column	Type	Comment
group_id	varchar(64)	The identifier for the group
description	varchar(256)	A description of the group
master_uuid	varchar(40)	The `server_uuid` value from the master server
master_defined	timestamp(6)	When the current master was defined.
status	bit(1)	1 if the group is being monitored, 0 otherwise

The `permissions` table contains information on rights to access the different sub-systems in Fabric. Currently, a `core` sub-system is formally defined:

Table 8.8 permissions

Column	Type	Comment
permission_id	int(10) unsigned	Permission's ID
subsystem	varchar(60)	Sub-system identification
component	varchar(60)	Sub-system component
function	varchar(60)	Sub-system function. Currently, this is not used
description	varchar(1000)	Description

The `roles` table contains information on possible roles a user may have and by consequence his/her permissions:

Table 8.9 roles

Column	Type	Comment
role_id	int(10) unsigned	Roles' ID
name	varchar(80)	Role's name
description	varchar(1000)	Role's description

The `role_permissions` table associates roles and permissions:

Table 8.10 role_permissions

Column	Type	Comment
role_id	int(10) unsigned	Roles' ID
permission_id	int(10) unsigned	Permission's ID

The `servers` table contains a list of all servers managed by Fabric.

Table 8.11 servers

Column	Type	Comment
server_uuid	varchar(40)	UUID of the server
server_address	varchar(128)	Address of the server
mode	int(11)	Mode of the server (OFFLINE, READ_ONLY, WRITE_ONLY, READ_WRITE)
status	int(11)	Status of the server (FAULTY, SPARE, SECONDARY, PRIMARY)
weight	float	Likelihood of receiving a request
group_id	varchar(64)	Group the server belongs to

The `shard_maps` table contains the names and properties of the shard maps.

Table 8.12 shard_maps

Column	Type	Comment
shard_mapping_id	int(11)	Shard map identifier
type_name	enum('RANGE','HASH')	Shard map type

Column	Type	Comment
global_group	varchar(64)	Name of the global group (likely to go away in the next revision)

The `shard_ranges` table is the sharding index and is used to map a sharding key to a shard.

Table 8.13 shard_ranges

Column	Type	Comment
shard_mapping_id	int(11)	Shard map identifier
lower_bound	varbinary(16)	Lower bound for the range encoded as a binary string
shard_id	int(11)	Shard identifier (a number)

The `shard_tables` table lists all tables that are sharded and what sharding map each belongs to. It also names the column by which it is sharded.

Table 8.14 shard_tables

Column	Type	Comment
shard_mapping_id	int(11)	Shard map identifier
table_name	varchar(64)	Fully qualified table name
column_name	varchar(64)	Column name that is the sharding key

The `shards` table names the groups where each shard identifier is stored.

Table 8.15 shards

Column	Type	Comment
shard_id	int(11)	Shard identifier
group_id	varchar(64)	Group identifier (a dotted-name)
state	enum('DISABLED','ENABLED')	Status of the shard; `DISABLED` means that it is not available for use

The `users` table identifies the users that might have permission to access the functions in the different sub-systems:

Table 8.16 users

Column	Type	Comment
user_id	int(10) unsigned	User's internal ID
username	varchar(100)	User's name
protocol	varchar(200)	Protocol that the user is allowed to use to access Fabric and its sub-systems
password	varchar(128)	Hashed user's password

8.6.2 Protecting the Backing Store

The backing store is very important to Fabric. You should take steps to ensure the database is backed up and the server where it resides is stable and well maintained. For the purposes of backup, it is sufficient to make periodic backups using either the `mysqldump` client or `mysqldbexport` utility in MySQL Utilities.

8.7 Using MySQL Fabric with Pacemaker and Corosync

There are a number of ways to make the MySQL Fabric node and its status and configuration data highly available; this section describes one such approach, but other alternatives are possible. This section can be used as a set of guidelines to build your own framework to add fault tolerance.

Note

The described Pacemaker setup is not currently a solution that has been through QA.

8.7.1 Introduction

A MySQL Fabric instance is composed of a MySQL Fabric process together with a MySQL server. The MySQL Fabric node contains the protocols and the executor, but is in itself *stateless* in that if it for some reason crashes, re-starting permits it to continue where it left off. The configuration and state information about the farm is instead stored in a separate MySQL server.

To provide a highly available solution, both components must be redundant. From a failure viewpoint, these two components are treated as a single unit, meaning that each pair is collocated on a machine, and if one of them fails, the stack on that machine fails.

There are two MySQL Fabric instances working in active and stand-by mode. The data stored in the MySQL server is replicated through the Distributed Replicated Block Device, or simply DRBD. The MySQL Fabric process is stateless though and must simply be started in the stand-by node in the event of a failure.

Pacemaker and CoroSync are used to monitor whether the instances are running properly, and to automate the failover and switchover operations. Pacemaker is responsible for monitoring components, such as the MySQL Fabric Process, MySQL server, and DRBD, and also for executing the failover and switchover operations. CoroSync is the communication infrastructure used by Pacemaker to exchange massages between the two nodes.

Applications accessing this cluster do so through a Virtual IP address that is assigned to the active node, specifically to the MySQL Fabric process, and is automatically migrated to the stand-by node during a failover or switchover operation.

This section aims to describe how to set up this highly available cluster.

8.7.2 Pre-requisites

Two servers or virtual machines with:

- A Linux distribution. This guide is based on Ubuntu 14.04, but any other distribution should work equally well.
- Unpartitioned space on the local disk to create a DRBD partition.
- Network connectivity
- Both hosts must be accessible through `ssh`.
- User "mysql" and group "mysql" that have the same ids at the different nodes.

Linux is used because Pacemaker, Corosync, and DRBD are commonly available on this platform.

Note

Pacemaker, Corosync, and DRBD are not include with MySQL Fabric and need to be installed separately for the target platform.

If Virtual Machines are used, make sure they run in different physical servers to avoid a single point of failure. If possible, also make the network connectivity redundant.

8.7.3 Target Configuration

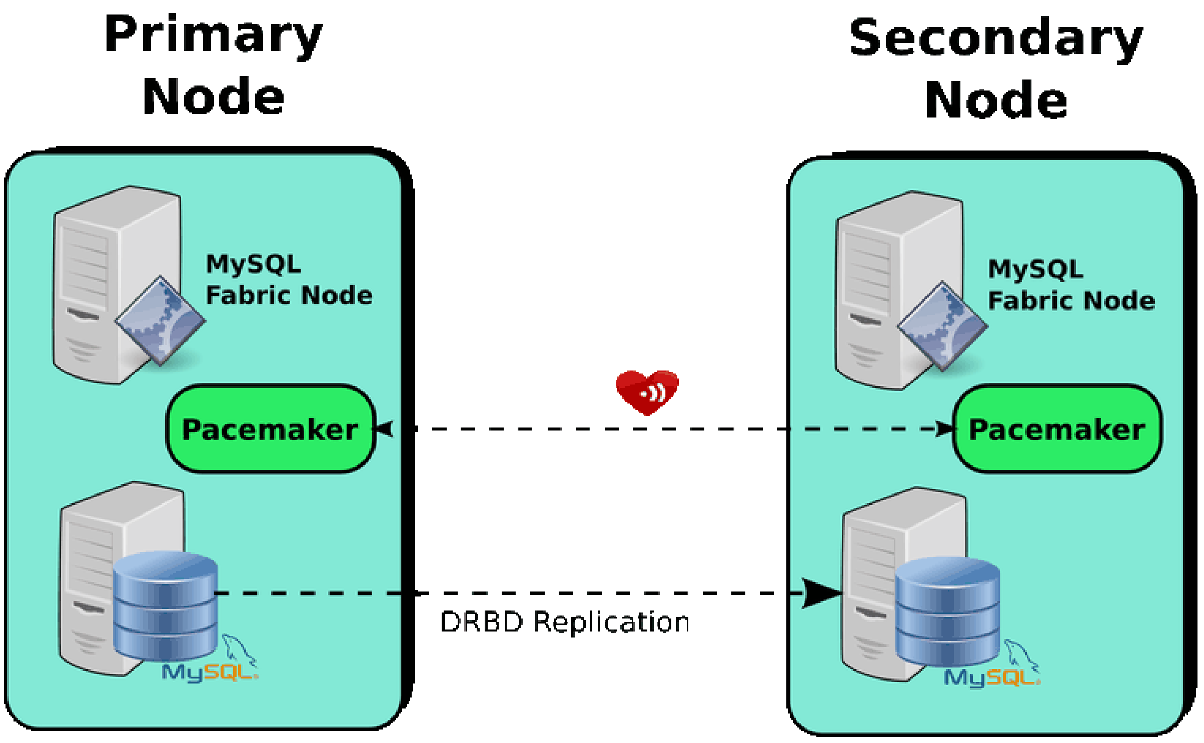
The two physical hosts are `host1.localdomain` (`192.168.1.101`) and `host2.localdomain` (`192.168.1.102`). It is recommended that you do not rely on an external DNS service (as that is an additional point of failure) and so these mappings should be configured on each host in the `/etc/hosts` file.

A single Virtual IP (VIP) is shown in the figure (`192.168.1.200`) and this is the address that the application connects to when accessing the MySQL Fabric. Pacemaker is responsible for migrating this between the two hosts.

One of the final steps in configuring Pacemaker is to add network connectivity monitoring in order to attempt to have an isolated host stop its MySQL services to avoid a split-brain scenario. This is achieved by having each host ping an external (not one part of the cluster) IP addresses - in this case the network router (`192.168.1.1`).

All the necessary software (i.e. binaries) must be installed in a regular partition, independent on each node. MySQL socket (`mysql.sock`) and process-id (`mysql.pid`) files are stored in a regular partition as well. The MySQL Server configuration file (`my.cnf`), the database files (`data/*`) and the MySQL Fabric configuration file (`fabric.cfg`) are stored in a DRBD controlled file system that at any point in time is only available on one of the two hosts.

Figure 8.1 MySQL Fabric Setup using DRBD and Pacemaker



8.7.4 Setting up and testing your system

8.7.4.1 Configure Network

It is recommended that you do not rely on DNS to resolve host names and so the following configuration files should be updated:

Example 8.1 /etc/hosts (Host 1)

```
127.0.0.1 localhost localhost.localdomain
::1 localhost localhost.localdomain
192.168.1.102 host2 host2.localdomain
```

Example 8.2 /etc/hosts (Host 2)

```
127.0.0.1 localhost localhost.localdomain
::1 localhost localhost.localdomain
192.168.1.101 host1 host1.localdomain
```

8.7.4.2 Install all packages

Install the necessary packages through the apt-get repositories:

```
[root@host1]# apt-get install drbd8-utils corosync pacemaker sysv-rc-conf libaio1
[root@host2]# apt-get install drbd8-utils corosync pacemaker sysv-rc-conf libaio1
```

Download and install the common, server, and client components on both hosts. Our example downloads and installs the bundled binaries from dev.mysql.com. Download the latest MySQL Server release bundle and install it on *both* machines using the following commands:

```
[root@host1]# dpkg -i mysql-common_*ubuntu14.04_amd64.deb
[root@host1]# dpkg -i mysql-community-server_*ubuntu14.04_amd64.deb
[root@host1]# dpkg -i mysql-community-client_*ubuntu14.04_amd64.deb

[root@host2]# dpkg -i mysql-common_*ubuntu14.04_amd64.deb
[root@host2]# dpkg -i mysql-community-server_*ubuntu14.04_amd64.deb
[root@host2]# dpkg -i mysql-community-client_*ubuntu14.04_amd64.deb
```

Next, install MySQL Fabric. Download MySQL Fabric by downloading the MySQL Utilities and install it using the following commands on each machine:

```
shell> unzip mysql-utilities-*.zip
shell> cd mysql-utilities-*
shell> python setup.py install
```

The script required to run MySQL Fabric with Pacemaker is not distributed with the packages and you need to manually download and install the script on each machine:

```
[root@host1]# cp mysql-fabric /usr/lib/ocf/resource.d/heartbeat/.
[root@host1]# chmod 755 /usr/lib/ocf/resource.d/heartbeat/mysql-fabric
```

```
[root@host2]# cp mysql-fabric /usr/lib/ocf/resource.d/heartbeat/.
[root@host2]# chmod 755 /usr/lib/ocf/resource.d/heartbeat/mysql-fabric
```

8.7.4.3 Configure DRBD

If your nodes do not already have an empty partition that you plan to use for the DRBD, then create one. If you are using a Virtual Machine, you can add a new storage to your machine. These details go beyond the scope of this guide.

This partition is used as a resource, managed (and synchronized between nodes by DRBD); in order for DRBD to be able to do this a new configuration file (in this case called `clusterdb_res.res`) must be created in the `/etc/drbd.d/` directory; the contents should look similar to:

```
resource clusterdb_res {
  protocol C;
  handlers {
    pri-on-incon-degr "/usr/lib/drbd/notify-pri-on-incon-degr.sh; /usr/lib/drbd/notify-emergency-reboot.sh; ec
    pri-lost-after-sb "/usr/lib/drbd/notify-pri-lost-after-sb.sh; /usr/lib/drbd/notify-emergency-reboot.sh; ec
    local-io-error "/usr/lib/drbd/notify-io-error.sh; /usr/lib/drbd/notify-emergency-shutdown.sh; echo o > /pr
    fence-peer "/usr/lib/drbd/crm-fence-peer.sh";
  }
  startup {
    degr-wfc-timeout 120;    # 2 minutes
    outdated-wfc-timeout 2;  # 2 seconds
  }
  disk {
    on-io-error detach;
  }
  net {
    cram-hmac-alg "sha1";
    shared-secret "clusterdb";
    after-sb-0pri disconnect;
    after-sb-1pri disconnect;
    after-sb-2pri disconnect;
    rr-conflict disconnect;
  }
  syncer {
    rate 10M;
    al-extents 257;
    on-no-data-accessible io-error;
  }
  on host1 {
    device /dev/drbd0;
    disk /dev/sdb;
    address 192.168.1.101:7788;
    flexible-meta-disk internal;
  }
  on host2 {
    device /dev/drbd0;
    disk /dev/sdb;
    address 192.168.1.102:7788;
    meta-disk internal;
  }
}
```

The IP addresses and disk locations should be specific to the hosts that the cluster are using. In this example the device that DRBD creates is located at `/dev/drbd0` - it is this device that is swapped back and forth between the hosts by DRBD. This resource configuration file should be copied over to the same location on the second host:

```
[root@host1]# scp clusterdb_res.res host2:/etc/drbd.d/
```

The configuration file previously presented uses DRBD 8.3 dialect. Although DRBD 8.4 is the newest version, some distributions might still contain DRBD 8.3. If you have installed DRBD 8.4 do not worry though because it understands the DRBD 8.3 configuration file.

Before starting the DRBD daemon, meta data must be created for the new resource (`clusterdb_res`) on each host using the command:

```
[root@host1]# drbdadm create-md clusterdb_res

[root@host2]# drbdadm create-md clusterdb_res
```

It is now possible to start the DRBD daemon on each host:

```
[root@host1]# /etc/init.d/drbd start

[root@host2]# /etc/init.d/drbd start
```

At this point the DRBD service is running on both hosts but neither host is the "primary" and so the resource (block device) cannot be accessed on either host; this can be confirmed by querying the status of the service:

```
[root@host1]# /etc/init.d/drbd status

[root@host2]# /etc/init.d/drbd status
```

In order to create the file systems (and go on to storing useful data in it), one of the hosts must be made the primary for the `clusterdb_res` resource, so execute the following on **host1**

```
[root@host1]# drbdadm -- --overwrite-data-of-peer primary all
[root@host1]# /etc/init.d/drbd status
```

The status output also shows the progress of the block-level syncing of the device from the new primary (host1) to the secondary (host2). This initial sync can take some time but it should not be necessary to wait for it to complete in order to complete the other steps.

Now that the device is available on **host1**, it is possible to create a file system on it:

```
[root@host1]# mkfs -t ext4 /dev/drbd0
```

Note

The above does not need to be repeated on the second host as DRBD handles the syncing of the raw disk data

In order for the DRBD file system to be mounted, the `/var/lib/mysql_drbd` directory should be created on both hosts:

```
[root@host1]# mkdir /var/lib/mysql_drbd
[root@host1]# chown mysql /var/lib/mysql_drbd
[root@host1]# chgrp mysql /var/lib/mysql_drbd

[root@host2]# mkdir /var/lib/mysql_drbd
[root@host2]# chown mysql /var/lib/mysql_drbd
[root@host2]# chgrp mysql /var/lib/mysql_drbd
```

On just the one (DRBD active) host, the DRBD file system must be temporarily mounted:

```
[root@host1]# mount /dev/drbd0 /var/lib/mysql_drbd
```

8.7.4.4 Configure MySQL Server

First, we have to stop the MySQL Server on both hosts and update configuration files and create new data files. First, stop the MySQL server on both hosts using the command:

```
shell> /etc/init.d/mysql stop
```

Note

If you are using an Ubuntu distribution you need change the `/etc/apparmor.d/usr.sbin.mysqld` on both hosts according to the following diff:

```
@@ -40,8 +40,8 @@
   /usr/share/mysql/** r,
 # Allow data dir access
-  /var/lib/mysql/ r,
-  /var/lib/mysql/** rwk,
+  /var/lib/mysql_drbd/ r,
+  /var/lib/mysql_drbd/** rwk,
 # Allow log file access
   /var/log/mysql/ r,
```

If you do not do that, the MySQL server may not be able to access files in the new location and you may get strange errors since AppArmor prevents reading and writing from the new locations.

To avoid any mismatches, the configuration file can be copied from **host1** to **host2** :

```
shell> scp /etc/apparmor.d/usr.sbin.mysqld host2:/etc/apparmor.d/usr.sbin.mysqld
```

Then restart AppArmor on both hosts using:

```
shell> /etc/init.d/apparmor restart
```

Edit the `/etc/mysql/my.cnf` file and set `datadir /var/lib/mysql_drbd/data` in the `[mysqld]` section on both hosts.

To avoid any mismatches, the configuration file can be copied from **host1** to **host2** :

```
shell> scp /etc/mysql/my.cnf host2:/etc/mysql/my.cnf
```

Now the configuration file can be copied and the default database files populated on **host1** using:

```
shell> cp /etc/mysql/my.cnf /var/lib/mysql_drbd/my.cnf
shell> mkdir /var/lib/mysql_drbd/data
shell> mysql_install_db --no-defaults --datadir=/var/lib/mysql_drbd/data --user=mysql
```

Configure some permissions on **host1** :

```
shell> chmod -R uog+rw /var/lib/mysql_drbd
shell> chown -R mysql /var/lib/mysql_drbd
shell> chmod 644 /var/lib/mysql_drbd/my.cnf
```

Start MySQL Server and configure users and access:

```
shell> /etc/init.d/mysql start
```

```
shell> mysql -u root -e "GRANT ALL ON *.* to 'root'@'%';"
shell> mysql -u root -e "CREATE USER 'fabric'@'localhost' IDENTIFIED BY 'secret';"
shell> mysql -u root -e "GRANT ALL ON fabric.* TO 'fabric'@'localhost';"
```

8.7.4.5 Configure MySQL Fabric

On just the one (DRBD active) host, do the following:

```
shell> cp /etc/mysql/fabric.cfg /var/lib/mysql_drbd/fabric.cfg
shell> chmod 600 /var/lib/mysql_drbd/fabric.cfg
shell> chown root:root /var/lib/mysql_drbd/fabric.cfg
```

Edit the `/var/lib/mysql_drbd/fabric.cfg`:

1. Set **address** to `192.168.1.200:32274` in the `[protocol.xmlrpc]` section
2. Set **password** to `password` in the `[protocol.xmlrpc]` section
3. Set **address** to `192.168.1.200:32275` in the **[protocol.mysql]** section
4. Set the **password** to `password` in the `[protocol.mysql]` section
5. Set the **password** to `secret` in the `[storage]` section

Warning

Do *not* change the address in the `[storage]` section.

Take the opportunity to set the other options if you need/want to do so, specially the user/password in the `[servers]` and `[client]` sections. Finally, create MySQL Fabric's state store as follows:

```
[root@host1]# mysqlfabric --config /var/lib/mysql_drbd/fabric.cfg \
   --param protocol.xmlrpc.address=localhost:32274 \
   --param protocol.mysql.address=localhost:32275 manage setup
```

From this point onwards all resources are managed by the clustering software so they have to be stopped:

```
[root@host1]# /etc/init.d/mysql stop
[root@host1]# umount /var/lib/mysql_drbd
[root@host1]# drbdadm secondary clusterdb_res
```

Then DRBD should be stopped as well:

```
[root@host1]# /etc/init.d/drbd stop
[root@host2]# /etc/init.d/drbd stop
```

8.7.4.6 Configure Corosync and Pacemaker

At this point, the DRBD file system is configured and initialized and both MySQL Fabric and MySQL Server has been installed and the required files set up on the replicated DRBD file system. Pacemaker and Corosync are installed but they are not yet managing the MySQL Fabric Process, MySQL Server and DRBD resources to provide a clustered solution - the next step is to set that up.

Firstly, set up some network-specific parameters from the Linux command line and also in the Corosync configuration file. The multi-cast address should be unique in your network but the port can be left at 5405. The IP address should be based on the IP addresses being used by the servers but should take the form of XX.YY.ZZ.0.

Copy an example to make your life easier:

```
shell> cp /etc/corosync/corosync.conf.example /etc/corosync/corosync.conf
```

After editing it, it should have a content similar to what follows:

```
 totem {
         version: 2
         crypto_cipher: none
         crypto_hash: none
         interface {
                 ringnumber: 0
                 bindnetaddr: 192.168.1.0
                 mcastaddr: 239.255.1.1
                 mcastport: 5405
                 ttl: 1
         }
 }
 logging {
         to_syslog: yes
 }
 quorum {
     provider: corosync_votequorum
     two_node: 1
     wait_for_all: 1
 }
 nodelist {
     node {
         ring0_addr: 192.168.1.101
         nodeid: 1
     }
     node {
         ring0_addr: 192.168.1.102
         nodeid: 2
     }
 }
```

Be careful while setting up the network address that the Corosync binds to. For example, according to the Corosync documentation, if the local interface is 192.168.5.92 with netmask 255.255.255.0, set bindnetaddr to 192.168.5.0. If the local interface is 192.168.5.92 with netmask 255.255.255.192, set bindnetaddr to 192.168.5.64, and so forth.

This makes Corosync automatically pick the network interface based on the network address provided. It is also possible to set up a specific address, such as 192.168.5.92, but in this case the configuration file is different per machine.

Create the `/etc/corosync/service.d/pcmk` file to tell the Corosync to load the Pacemaker plug-in:

```
service {
  # Load the Pacemaker Cluster Resource Manager
  name: pacemaker
  ver: 1
}
```

Change the `/etc/default/corosync` file as follows:

```
# start corosync at boot [yes|no]
START=yes
```

To avoid any mismatches, the configuration file can be copied across by using these commands on **host1**:

```
shell> scp /etc/corosync/corosync.conf host2:/etc/corosync/corosync.conf
shell> scp /etc/corosync/service.d/pcmk host2:/etc/corosync/service.d/pcmk
shell> scp /etc/default/corosync host2:/etc/default/corosync
```

Start Corosync on both hosts using:

```
shell> /etc/init.d/corosync start
```

Run `tpcdump` to check whether Corosync is working or not:

```
shell> tcpdump -i eth0 -n port 5405
```

To start the Pacemaker on **host1**, execute the following command:

```
shell> /etc/init.d/pacemaker start
```

Run Pacemaker's cluster resource monitoring command on **host1** to view the status of the cluster:

```
shell> crm_mon --one-shot -V
```

As we are configuring a cluster made up of just 2 hosts, when one host fails (or loses contact with the other) there is no node majority (quorum) left and so by default the surviving node (or both if they are still running but isolated from each other) would be shut down by Pacemaker. This is not the desired behavior as it does not offer High Availability and so that default should be overridden (we later add an extra behavior whereby each node shuts itself down if it cannot ping a 3 node that is external to the cluster, thus preventing a split brain situation):

```
[root@host1]# crm configure property no-quorum-policy=ignore
```

We turn STONITH (Shoot The Other Node In The Head) off as this solution relies on each node shutting itself down in the event that it loses connectivity with the independent host:

```
[root@host1]# crm configure property stonith-enabled=false
```

Roughly speaking, STONITH refers to one node trying to kill another in the even that it believes the other has partially failed and should be stopped in order to avoid any risk of a split-brain scenario. To prevent a healthy resource from being moved around the cluster when a node is brought back on-line, Pacemaker has the concept of resource stickiness which controls how much a service prefers to stay running where it is.

```
[root@host1]# crm configure rsc_defaults resource-stickiness=100
```

In the next steps, we describe how to configure the different resources as a cluster:

```
[root@host1]# crm configure edit
```

This opens your default text editor, and you should use it to add the following lines into the cluster configuration:

```
primitive p_drbd_mysql ocf:linbit:drbd \
        params drbd_resource="clusterdb_res" \
        op monitor interval="15s"
primitive p_fabric_mysql ocf:heartbeat:mysql-fabric \
        params binary="/usr/local/bin/mysqlfabric" \
               config="/var/lib/mysql_drbd/fabric.cfg" \
        op start timeout="120s" interval="0" \
        op stop timeout="120s" interval="0" \
        op monitor interval="20s" timeout="30s"
primitive p_fs_mysql ocf:heartbeat:Filesystem \
        params device="/dev/drbd0" directory="/var/lib/mysql_drbd" \
               fstype="ext4"
primitive p_ip_mysql ocf:heartbeat:IPaddr2 \
        params ip="192.168.1.200" cidr_netmask="24" nic="eth0"
primitive p_mysql ocf:heartbeat:mysql \
        params binary="/usr/sbin/mysqld" \
               config="/var/lib/mysql_drbd/my.cnf" \
               datadir="/var/lib/mysql_drbd/data" \
               pid="/var/run/mysqld/mysqld.pid" \
               socket="/var/run/mysqld/mysqld.sock \
               user="mysql" group="mysql" \
               additional_parameters="--bind-address=localhost" \
        op start timeout="120s" interval="0" \
        op stop timeout="120s" interval="0" \
        op monitor interval="20s" timeout="30s"
group g_mysql p_fs_mysql p_ip_mysql p_mysql p_fabric_mysql
ms ms_drbd_mysql p_drbd_mysql \
        meta master-max="1" master-node-max="1" clone-max="2" \
             clone-node-max="1" notify="true"
colocation c_mysql_on_drbd inf: g_mysql ms_drbd_mysql:Master
order o_drbd_before_mysql inf: ms_drbd_mysql:promote g_mysql:start
primitive p_ping ocf:pacemaker:ping params name="ping" \
          multiplier="1000" host_list="192.168.1.1" \
          op monitor interval="15s" timeout="60s" start timeout="60s"
clone cl_ping p_ping meta interleave="true"
location l_drbd_master_on_ping ms_drbd_mysql rule $role="Master" \
    -inf: not_defined ping or ping number:lte 0
```

As the MySQL service (group) has a dependency on the host it is running on being the DRBD master, that relationship is added by defining a co-location and an ordering constraint to ensure that the MySQL group is co-located with the DRBD master and that the DRBD promotion of the host to the master must happen before the MySQL group can be started:

```
colocation c_mysql_on_drbd inf: g_mysql ms_drbd_mysql:Master
order o_drbd_before_mysql inf: ms_drbd_mysql:promote g_mysql:start
```

In order to prevent a split-brain scenario in the event of network partitioning, Pacemaker can ping independent network resources (such as a network router) and then prevent the host from being the DRBD master in the event that it becomes isolated:

```
primitive p_ping ocf:pacemaker:ping params name="ping" multiplier="1000" \
        host_list="192.168.1.1" \
        op monitor interval="15s" timeout="60s" start timeout="60s"
clone cl_ping p_ping meta interleave="true"
location l_drbd_master_on_ping ms_drbd_mysql rule $role="Master" \
        -inf: not_defined ping or ping number:lte 0
```

Check if everything is running fine using the following command:

```
[root@host1]# crm_mon --one-shot -V
```

Ensure the correct daemons are started at system boot

At this point, a reliable MySQL service is in place but it is also important to check that the correct cluster services are started automatically as part of the servers' system startup. It is necessary for the Linux startup to start the Corosync and Pacemaker services but not DRBD or MySQL Process and MySQL Server as those services are started on the correct server by Pacemaker. To this end, execute the following commands on each host:

```
[root@host1] sysv-rc-conf drbd off
[root@host1] sysv-rc-conf corosync on
[root@host1] sysv-rc-conf  mysql off
[root@host1] sysv-rc-conf  pacemaker on

[root@host2] sysv-rc-conf drbd off
[root@host2] sysv-rc-conf corosync on
[root@host2] sysv-rc-conf  mysql off
[root@host2] sysv-rc-conf  pacemaker on
```

Note

MySQL Fabric is not installed as a service so there is nothing to do here for it.

8.7.5 Key administrative tasks

The cluster management tool can then be used to migrate the resources between machines:

```
[root@host1 ~]#  crm resource migrate g_mysql host2
```

Specifying the `g_mysql` group migrates all resources in the group and implicitly any colocated resources as well. If for any reason a resource cannot be properly started up or shut down, it becomes unmanaged. In this case, we have to manually put it back to a managed state. For example, this could mean that we would have to fix an issue that blocked the shutdown, kill or stop some processes, and run the following command:

```
[root@host1 ~]# crm resource cleanup 'resource'
```

The components of this stack are designed to cope with component failures but there may be cases where a sequence of multiple failures could result in DRBD not being confident that the data on the two hosts is consistent. In the event that this happens DRBD breaks the connection. Should this happen, we need to identify which of the two hosts has the correct data and then have DRBD resynchronize the data; for the steps below, it is assumed that host1 has the correct data:

```
[root@host2]# drbdadm secondary clusterdb_res
[root@host2]# drbdadm -- --discard-my-data connect clusterdb_res

[root@host1]# drbdadm primary clusterdb_res
```

```
[root@host1]# drbdadm connect clusterdb_res
```

Before executing these steps, it is advised to check the error log(s) and run the following command to identify the DRBD's status:

```
shell> /etc/init.d/drbd status
```

8.8 Using Connector/Python with MySQL Fabric

MySQL Fabric provides data distribution and high-availability features for a set of MySQL database servers.

Developers using Connector/Python can take advantage of its features to work with a set of servers managed by MySQL Fabric. Connector/Python supports the following MySQL Fabric capabilities:

- Automatic node selection based on application-provided *shard* information (tables and key)
- Read/write splitting within a MySQL Fabric *high-availability group*

More specifically, Connector/Python Fabric support provides these features:

- Requesting a connection to a MySQL server managed by Fabric is as transparent as possible to users already familiar with Connector/Python.
- Connector/Python is able to get a MySQL server connection given a high-availability group and a mode specifying whether the connection is read-only or also permits updates (read-write).
- Connector/Python supports sharding and is able to find the correct MySQL server for a given table or tables and key based on scope (local or global) and mode (read-only or read-write). `RANGE` and `HASH` mechanisms are supported transparently to the user.
- Among secondary MySQL servers in the same group, read-only connections are load balanced. Load balancing is based on a weight set for each MySQL server, using a Weighted Round-Robin algorithm.
- Faulty MySQL servers are reported to Fabric, and failover is supported when failure occurs for a server in a group.
- To speed up operations, Connector/Python caches information obtained from Fabric, such as group and sharding information. Each time Connector/Python looks up data, it first checks its cache. When information in the cache is too old, it is invalidated. By default, the time-to-live (TTL) for cached information is 1 minute. However, Fabric itself can provide this TTL for its clients and this value is used instead if greater than zero.

  Cache information is also invalidated when failures occur, such as when a connection to a MySQL server fails (invalidation applies to the group to which the server belongs).
- Fabric support applies to versions of Python supported by Connector/Python itself (see Connector/Python Versions). In particular, you can use Connector/Python with Python 3.1 and later to establish Fabric connections, even though Fabric does not support Python 3.

Connector/Python support for Fabric comprises the following module and classes:

- Module `mysql.connector.fabric`: All classes, functions, and constants related to MySQL Fabric.
- Class `fabric.MySQLFabricConnection`: Similar to `MySQLConnection`, it creates a connection to the MySQL server based on application-provided information.

- Class `fabric.Fabric`: Manages the connection with a MySQL Fabric node; used by `MySQLFabricConnection`.
- Other helper classes for caching information.

8.8.1 Installing Connector/Python with MySQL Fabric Support

Fabric support in Connector/Python requires version 1.2.0 or greater. Downloads are available at http://dev.mysql.com/downloads/connector/python/ in various packages such as Zip archives, compressed `tar` archives, RPM packages, Debian packages, and Windows Installer packages.

Using the compressed `tar` package, you can install MySQL Connector/Python as follows:

```
shell> tar xzf mysql-connector-python-1.2.3.tar.gz
shell> cd mysql-connector-python-1.2.3
shell> python setup.py install
```

For more information, see Connector/Python Installation.

8.8.2 Requesting a Fabric Connection

The modules related to Fabric are located under `mysql.connector.fabric`. Importing `fabric` provides access to everything needed to use Fabric:

```
import mysql.connector
from mysql.connector import fabric
```

Traditionally, a MySQL connection is set up using the `mysql.connector.connect()` method using the connection arguments described at Connector/Python Connection Arguments, and the connection is established immediately.

A request for a Fabric connection, by contrast, does not immediately connect. Instead, pass a `fabric` argument to the `connect()` call. This argument must be a dictionary. When Fabric connects to the MySQL server that it provides, it uses the connection arguments other than the `fabric` argument (except that the `unix_socket` connection argument is not supported).

To prepare a connection with Fabric, do this:

```
fabric_config = {
  'host': 'fabric.example.com',
}
fcnx = mysql.connector.connect(fabric=fabric_config, user='webuser',
                               password='webpass', database='employees')
```

If you prefer to pass a dictionary to `connect()`, do this:

```
config = {
  'fabric': {
    'host': 'fabric.example.com',
  },
  'user': 'webuser',
  'password': 'webpass',
  'database': 'employees',
}
fcnx = mysql.connector.connect(**config)
```

The `fabric` dictionary argument permits these values:

- host: The host to connect to (required).
- port: The TCP/IP port number to connect to on the specified host (optional; default 32274).
- username: The user name of the account to use (optional).
- password: The password of the account to use (optional).
- connect_attempts: The number of connection attempts to make before giving up (optional; default 3).
- connect_delay: The delay in seconds between attempts (optional; default 1).
- report_errors: Whether to report errors to Fabric while accessing a MySQL instance. (optional; default False).
- ssl_ca: The file containing the SSL certificate authority (optional).
- ssl_cert: The file containing the SSL certificate file (optional).
- ssl_key: The file containing the SSL key (optional).
- protocol: The connection protocol to use (optional; default xmlrpc). Permitted values are xmlrpc (use XML-RPC protocol) and mysql (use MySQL client/server protocol). If a value of mysql is specified, the default port becomes 32275, although that can be changed with an explicit port value.

The username, password, report_errors, ssl_ca, ssl_cert and ssl_key options were added in Connector/Python 1.2.1. It is possible to establish an SSL connection using only the ssl_ca argument. The ssl_key and ssl_cert arguments are optional. However, when either is given, both must be given or an AttributeError is raised.

The protocol option was added in Connector/Python2 2.1.2.

It is also possible to pass a Fabric() object instance as the fabric argument:

```
fabric_config = {
  'host': 'fabric.example.com',
}
fabinst = Fabric(**fabric_config)
fcnx = mysql.connector.connect(fabric=fabinst, user='webuser',
                               password='webpass', database='employees')
```

Or:

```
fabric_config = {
  'host': 'fabric.example.com',
}
fabinst = Fabric(**fabric_config)
config = {
  'fabric': fabinst,
  'user': 'webuser',
  'password': 'webpass',
  'database': 'employees',
}
fcnx = mysql.connector.connect(**config)
```

Once a Fabric() object is used, it is cached and reused.

Another (less preferred) way to establish a Fabric connection is pass configuration information to the MySQLFabricConnection class to create a connection with a Fabric node. This is similar to using the `mysql.connector.connect()` method or `MySQLConnection()` class with the addition of the required `fabric` argument:

```
config = {
  'fabric': {
    'host': 'fabric.example.com',
  },
  'user': 'webuser',
  'password': 'webpass',
}

fcnx = fabric.MySQLFabricConnection(**config)
```

Error Reporting

Connector/Python can report errors to Fabric that occur while accessing a MySQL instance. The information can be used to update the backing store and trigger a failover operation, provided that the instance is a primary server and Fabric has received a sufficient number of problem reports from different connectors.

- The `fabric` dictionary argument to the `connect()` method accepts a `report_errors` value. Its default value is `False`; pass a value of `True` to enable error reporting to Fabric.
- To define which errors to report, use the `extra_failure_report()` function:

```
from mysql.connector.fabric import extra_failure_report
extra_failure_report([error_code_0, error_code_1, ...])
```

8.8.3 Providing Information to Choose a MySQL Server

If you create a Fabric connection without providing any information about which data to access, the connection cannot function. To access a database, you must provide the driver with either of these types of information:

- The name of a *high-availability group* known by the MySQL Fabric instance to which you've connected. In such a group, one server is the master (the primary) and the others are slaves (secondaries).
- A *shard table*, and optionally a *shard key*, to guide Connector/Python in selecting a high-availability group.

The following discussion describes both ways of providing information. You do this by setting one or more properties of the Fabric connection object using its `set_property()` method, so the discussion begins by setting forth the sharding-related properties.. In the examples, `fcnx` represents the Fabric connection object, created as shown in Section 8.8.2, “Requesting a Fabric Connection”.

Note

`set_property()` does not connect. The connection is opened when a cursor is requested from the Fabric connection object or when its `cmd_query()` or `cmd_query_iter()` method is invoked.

These `set_property()` arguments are shard-related:

- `group`: A high-availability group name
- `tables`: The sharding table or tables
- `mode`: Whether operations are read/write or read only

- `scope`: Whether operations are local or global
- `key`: The key that identifies which row to affect

`group` and `tables` are mutually exclusive, so you specify only one of them. Applicability of the remaining arguments depends on which of `group` or `tables` you use:

If you specify `group`:

- `mode` is optional. The default is `fabric.MODE_READWRITE` if this property is omitted.
- `scope` is inapplicable. Do not specify it.
- `key` is inapplicable. Do not specify it.

If you specify `tables`:

- `mode` is optional. The default is `fabric.MODE_READWRITE` if this property is omitted.
- `scope` is optional. The default is `fabric.SCOPE_LOCAL` if this property is omitted.
- `key`: If `scope` is `fabric.SCOPE_LOCAL`, `key` is required to indicate which row to affect. If `scope` is `fabric.SCOPE_GLOBAL`, `key` is inapplicable; do not specify it.

When the `mode` argument is applicable, these values are permitted:

- `fabric.MODE_READWRITE`: Connect to a master server. This is the default.
- `fabric.MODE_READONLY`: Connect to a slave if one is available, to the master otherwise. If there are multiple secondary MySQL servers, load balancing is used to obtain the server information.

When the `scope` argument is applicable, these values are permitted:

- `fabric.SCOPE_LOCAL`: Local operation that affects the row with a given key. This is the default.
- `fabric.SCOPE_GLOBAL`: Global operation that affects all rows.

Providing the name of a high-availability group specifies that we know exactly the set of database servers that with which to interact. To do this, set the `group` property using the `set_property()` method:

```
fcnx.set_property(group='myGroup')
```

Providing *shard* information avoids the need to choose a high-availability group manually and permits Connector/Python to do so based on information from the MySQL Fabric server.

Whether operations use `RANGE` or `HASH` is transparent to the user. The information is provided by Fabric and Connector/Python uses the correct mechanism automatically.

To specify *shard tables* and *shard keys*, use the `tables` and `key` attributes of the `set_property()` method.

The format of each *shard table* is usually given as `'db_name.tbl_name'`. Because one or more tables can be specified, the `tables` argument to `set_property()` is specified as a tuple or list:

```
fcnx.set_property(tables=['employees.employees'], key=40)
cur = fcnx.cursor()
# do operations for employee with emp_no 40
```

```
fcnx.close()
```

By default, operations occur in local scope, or the `scope` property can be given to specify local or global scope explicitly. For local operations (as in the preceding example), the `key` argument must be specified to indicate which row to use. For global operations, do not specify the `key` attribute because the operation is performed on all rows in the table:

```
fcnx.set_property(tables=['employees.employees'], scope=fabric.SCOPE_GLOBAL)
cur = fcnx.cursor()
cur.execute("UPDATE employees SET last_name = UPPER(last_name)")
cnx.commit()
fcnx.close()
```

The default mode is read/write, so the driver connects to the master. The `mode` property can be given to specify read/write or read-only mode explicitly:

```
fcnx.set_property(group='myGroup', mode=fabric.MODE_READWRITE)
cur = fcnx.cursor()
cur.execute("UPDATE employees SET last_name = UPPER(last_name)")
cnx.commit()
fcnx.close()
```

Applications for which read-only mode is sufficient can specify a `mode` attribute of `fabric.MODE_READONLY`. In this case, a connection is established to a slave if one is available, or to the master otherwise.

Connector/Python 2.0.1 or later supports `RANGE_STRING` and `RANGE_DATETIME` as sharding types. These are similar to the regular `RANGE` sharding type, but instead of an integer key, require a value of a different type:

- For `RANGE_STRING`, a UTF-8 encoded string key is required. For example:

  ```
  cnx.set_property(tables=["employees.employees"],
                   key=u'employee_name', mode=fabric.MODE_READONLY)
  ```

  Only Unicode strings are supported. Any other type given when using a shard defined using `RANGE_STRING` causes a `ValueError` to be raised.

- For `RANGE_DATETIME`, a datetime or date object key is required. For example, to get the shard which holds employees hired after the year 2000, you could do the following, with lower bounds set as "group1/1980-01-01, group2/2000-01-01":

  ```
  cnx.set_property(tables=["employees.employees"],
                   key=datetime.date(2000, 1, 1), mode=fabric.MODE_READONLY)
  ```

  If the lower bounds included a time, it would have been like this:

  ```
  cnx.set_property(tables=["employees.employees"],
                   key=datetime.datetime(2000, 1, 1, 12, 0, 0),
                   mode=fabric.MODE_READONLY)
  ```

  Only `datetime.datetime` and `datetime.date` values are supported. Any other type given when using a shard defined using `RANGE_DATETIME` causes a `ValueError` to be raised.

8.9 Using Connector/J with MySQL Fabric

MySQL Fabric provides data distribution and high-availability features for a set of MySQL database servers.

Developers using Connector/J can take advantage of its features to work with a set of servers managed by MySQL Fabric. Connector/J supports the following MySQL Fabric capabilities:

- Automatic node selection based on application-provided *shard* information (table and key)
- Read/write splitting within a MySQL Fabric *server group*
- Reporting errors to the Fabric node as part of the distributed failure detector

The Fabric Client library for Java, which is included with Connector/J, is comprised of the following packages:

- `src/com/mysql/fabric/xmlrpc`: Classes for core implementation of the XML-RPC protocol
- `src/com/mysql/fabric`: Classes for interacting with the MySQL Fabric management system using the XML-RPC protocol
- `src/com/mysql/fabric/jdbc`: Classes for JDBC access to MySQL servers based on shard information
- `src/com/mysql/fabric/hibernate`: `FabricMultiTenantConnectionProvider.java` class enabling integration with Hibernate
- `testsuite/fabric`: JUnit tests
- `src/demo/fabric`: Usage samples

8.9.1 Installing Connector/J with MySQL Fabric Support

Fabric support is available in Connector/J 5.1.30 and later. Please refer to Connector/J documentation for installation instructions.

8.9.2 Loading the Driver and Requesting a Fabric Connection

When using Connector/J with MySQL Fabric, you must provide the host name and port of the MySQL Fabric server instead of the database server. The connection string must follow the same form it normally does, with the addition of the `fabric` keyword, as follows:

```
jdbc:mysql:fabric://fabrichost:32274/database
```

The user name and password provided to the connection are used for authentication with the individual database servers. Fabric authentication parameters can be given in the URL using the `fabricUsername` and `fabricPassword` properties. e.g.

```
jdbc:mysql:fabric://fabrichost:32274/database?fabricUsername=admin&fabricPassword=secret
```

Note

If the username and password to authenticate to the Fabric node are omitted, no authentication is used. This should only be done when authentication has been disabled on the Fabric node.

Note

If you are using Java 5, you must manually load the driver class before attempting to connect.

```
Class.forName("com.mysql.fabric.jdbc.Driver");
```

Connection now proceeds normally.

```
Connection conn = DriverManager.getConnection(
        "jdbc:mysql:fabric://fabrichost:32274/database",
        user,
        password);
```

To use the Connector/J APIs that support MySQL Fabric, you must cast the `Connection` object to the public interface that provides the necessary methods. The interfaces are:

- `com.mysql.fabric.jdbc.FabricMySQLConnection`: JDBC3 interface, compatible with Java 5 and later
- `com.mysql.fabric.jdbc.JDBC4FabricMySQLConnection`: JDBC4 interface, compatible with Java 6 and later. This interface must be used to access JDBC4 APIs on the connection.

8.9.3 Providing Information to Choose a MySQL Server

If you create a Fabric connection without providing any information about which data to access, the connection cannot function. To access a database, you must provide the driver with one of the following:

- The name of a *high-availability group* known by the MySQL Fabric instance to which you've connected. In such a group, one server is the master (the primary) and the others are slaves (secondaries).
- A *shard table*, and optionally a *shard key*, to guide Connector/J in selecting a high-availability group.
- One or more *query tables* to guide the connector in selecting a server group. Query tables can reference only a single shard mapping or the query is rejected. A shard mapping can include several tables but they must be sharded on the same index.

The following discussion describes both ways of providing information. In the examples, `conn` represents the Fabric connection object, created as shown in Section 8.9.2, “Loading the Driver and Requesting a Fabric Connection”.

Providing the name of a high-availability group specifies that we know exactly the set of database servers with which to interact. We can do this in two ways.

- The simplest method is to include the name of the server group in the connection string. This is useful if a connection needs to access data only in that server group. It is also possible to set the name of the server group in this way initially and to change it programatically later.

  ```
  // provide the server group as a connection property
  Connection conn = DriverManager.getConnection(
          "jdbc:mysql:fabric://fabrichost:32274/database?fabricServerGroup=myGroup");
  ```

- If we connect without specifying a server group, or want to change it later, we can use the `JDBC4FabricMySQLConnection` interface to set the **`server group name`**.

```
JDBC4FabricMySQLConnection conn;
// connection initialization here
conn.setServerGroupName("myGroup");
```

Providing *shard* information avoids the need to choose a high-availability group manually and permits Connector/J to do so based on information from the MySQL Fabric server.

- *Shard tables* and *shard keys* can also be given as connection properties if desirable. Here we say that we want to access the `employees` table. The driver chooses a server group based on this *shard table*.

  Note

  The format of the *shard table* is usually given as `db_name.tbl_name`.

  ```
  // provide the shard table as a connection property
  Connection conn = DriverManager.getConnection(
          "jdbc:mysql:fabric://fabrichost:32274/database?fabricShardTable=employees.employees");
  ```

- Alternatively, *query tables* can be provided to the connection before creating a statement. The following example sets up the connection to perform a join between the `employees` and `departments` tables. Details on how to provide the shard key are given in the next step.

  ```
  JDBC4FabricMySQLConnection conn;
  // provide the set of query tables to the connection
  conn.addQueryTable("departments");
  conn.addQueryTable("employees");
  ```

- In many cases, you want to work with different sets of data at different times. You can specify the *shard key* to change the set of data to be accessible.

  ```
  JDBC4FabricMySQLConnection conn;
  // connection initialization here
  conn.setShardKey("40"); // work with data related to shard key = 40
  ```

In summary, it is necessary to provide the name of a *server group* or a *shard table* and possibly *shard key* to access a database server.

8.9.4 MySQL Fabric Configuration for Running Samples

To run JUnit tests from `testsuite/fabric` or demonstration examples from `src/demo/fabric`, you must configure the MySQL Fabric test environment as follows.

1. Set up MySQL servers.

   - `mysql-fabric-config`: The backing store for Fabric configuration. Used internally by Fabric to store the server list, shard mappings, and so forth. You set up this server instance during the MySQL Fabric setup procedure.

   - `mysql-global`: The only server in the “global” group. Used to send DDL commands and update any data not in the shard data set.

     - Default location: 127.0.0.1:3401

     - Config properties: `com.mysql.fabric.testsuite.global.host`,

       `com.mysql.fabric.testsuite.global.port`

- `mysql-shard1`: First shard of sharded data set
  - Default location: 127.0.0.1:3402
  - Config properties: `com.mysql.fabric.testsuite.shard1.host`, `com.mysql.fabric.testsuite.shard1.port`
- `mysql-shard2`: Second shard of sharded data set
  - Default location: 127.0.0.1:3403
  - Config properties: `com.mysql.fabric.testsuite.shard2.host`, `com.mysql.fabric.testsuite.shard2.port`

All except `mysql-fabric-config` should have `server-id` set to a distinct value and the following entries added to `my.cnf`:

```
log-bin = mysql-bin
log-slave-updates = true
enforce-gtid-consistency = true
gtid-mode = on
```

2. Set up sharding. The user name and password of the account used to manage Fabric (Section 8.2.3.1, “Create the Associated MySQL Users”) must be specified in Fabric's configuration file (Section 8.2.3.2, “Configuration File”).

   - Create the global group:

   ```
   shell> mysqlfabric group create fabric_test1_global
   shell> mysqlfabric group add fabric_test1_global 127.0.0.1:3401
   shell> mysqlfabric group promote fabric_test1_global
   ```

   - Create shard groups:

   ```
   shell> mysqlfabric group create fabric_test1_shard1
   shell> mysqlfabric group add fabric_test1_shard1 127.0.0.1:3402
   shell> mysqlfabric group promote fabric_test1_shard1

   shell> mysqlfabric group create fabric_test1_shard2
   shell> mysqlfabric group add fabric_test1_shard2 127.0.0.1:3403
   shell> mysqlfabric group promote fabric_test1_shard2
   ```

   - Create the sharding definition:

   ```
   shell> mysqlfabric sharding create_definition RANGE fabric_test1_global
   ```

   Notice the return value in the command output; for example, return = 1. This is the *$MAPPING_ID* used in the following commands

   ```
   shell> mysqlfabric sharding add_table $MAPPING_ID employees.employees emp_no
   ```

   - Create the shard index:

```
shell> mysqlfabric sharding add_shard $MAPPING_ID \
  fabric_test1_shard1/0,fabric_test1_shard2/10000 --state=ENABLED
```

8.9.5 Running Tests

The `test-fabric` target in the `build.xml` file runs JUnit tests on these servers. It requires only the setup described in Section 8.9.4, "MySQL Fabric Configuration for Running Samples". All necessary tables and data are created during test run.

The parameters for the servers must be provided to Ant to verify that the correct information is received from the Fabric node. This includes server host names and ports. This data can be provided on the command line with -D arguments to Ant or in a `build.properties` file. This file should be placed in the root of the source directory, where `build.xml` is located. Based on the information given so far, this file would contain the following entries:

```
com.mysql.fabric.testsuite.hostname=localhost
com.mysql.fabric.testsuite.port=32274

com.mysql.fabric.testsuite.fabricUsername=admin
com.mysql.fabric.testsuite.fabricPassword=secret

com.mysql.fabric.testsuite.username=root
com.mysql.fabric.testsuite.password=
com.mysql.fabric.testsuite.database=employees
com.mysql.fabric.testsuite.global.host=127.0.0.1
com.mysql.fabric.testsuite.global.port=3401
com.mysql.fabric.testsuite.shard1.host=127.0.0.1
com.mysql.fabric.testsuite.shard1.port=3402
com.mysql.fabric.testsuite.shard2.host=127.0.0.1
com.mysql.fabric.testsuite.shard2.port=3403
```

Sample Ant calls are shown below. If the parameters are specified in your `build.properties` file, it is not necessary to include them on the command line.

```
shell> JAVA_HOME=/opt/jdk1.5/ ant \
  -Dcom.mysql.fabric.testsuite.password=pwd \
  -Dcom.mysql.fabric.testsuite.global.port=3401 \
  -Dcom.mysql.fabric.testsuite.shard1.port=3402 \
  -Dcom.mysql.fabric.testsuite.shard2.port=3403 \
  test-fabric
```

8.9.6 Running Demonstration Programs

To run the demo programs, you must set up the MySQL Fabric environment as described in Section 8.9.4, "MySQL Fabric Configuration for Running Samples". After that, you can use the `demo-fabric-*` Ant targets.

```
shell> JAVA_HOME=/opt/jdk1.5/ ant \
  -Dcom.mysql.fabric.testsuite.password=pwd \
  demo-fabric
```

These targets invoke all demo programs except Hibernate demos. You should use the `demo-fabric-hibernate` target instead:

```
shell> JAVA_HOME=/opt/jdk1.6/ ant \
  -Dcom.mysql.fabric.testsuite.password=pwd \
  demo-fabric-hibernate
```

Note

You need Java 6+ to use Hibernate Fabric integration. Multi-tenancy is a feature specific to Hibernate 4 and higher which requires Java 6+. That is why we do not provide the FabricMultiTenantConnectionProvider class or related demos compatible with Java 5.

8.9.7 A Complete Example: Working with Employee Data

This document demonstrates two possible ways of working with sharded data relating to employees. To run this program, you must set up a shard mapping for the employees table in MySQL Fabric as described in Section 8.9.4, “MySQL Fabric Configuration for Running Samples”.

This code can be found in the distribution package in `src/demo/fabric/EmployeesJdbc.java`.

```
/*
  Copyright (c) 2013, 2014, Oracle and/or its affiliates. All rights reserved.

  The MySQL Connector/J is licensed under the terms of the GPLv2
  <http://www.gnu.org/licenses/old-licenses/gpl-2.0.html>, like most MySQL Connectors.
  There are special exceptions to the terms and conditions of the GPLv2 as it is applied to
  this software, see the FLOSS License Exception
  <http://www.mysql.com/about/legal/licensing/foss-exception.html>.

  This program is free software; you can redistribute it and/or modify it under the terms
  of the GNU General Public License as published by the Free Software Foundation; version 2
  of the License.

  This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY;
  without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
  See the GNU General Public License for more details.

  You should have received a copy of the GNU General Public License along with this
  program; if not, write to the Free Software Foundation, Inc., 51 Franklin St, Fifth
  Floor, Boston, MA 02110-1301  USA

 */

package demo.fabric;

import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.PreparedStatement;
import java.sql.Statement;
import java.sql.ResultSet;

import com.mysql.fabric.jdbc.FabricMySQLConnection;

/**
 * Demonstrate working with employee data in MySQL Fabric with Connector/J and the JDBC APIs.
 */
public class EmployeesJdbc {
 public static void main(String args[]) throws Exception {

  String hostname = System.getProperty("com.mysql.fabric.testsuite.hostname");
  String port = System.getProperty("com.mysql.fabric.testsuite.port");
  String database = System.getProperty("com.mysql.fabric.testsuite.database");
  String user = System.getProperty("com.mysql.fabric.testsuite.username");
  String password = System.getProperty("com.mysql.fabric.testsuite.password");

  String baseUrl = "jdbc:mysql:fabric://" + hostname + ":" + Integer.valueOf(port) + "/";

  // Load the driver if running under Java 5
  if (!com.mysql.jdbc.Util.isJdbc4()) {
```

```
 Class.forName("com.mysql.fabric.jdbc.FabricMySQLDriver");
}

// 1. Create database and table for our demo
Connection rawConnection = DriverManager.getConnection(
  baseUrl + "mysql?fabricServerGroup=fabric_test1_global",
  user,
  password);
Statement statement = rawConnection.createStatement();
statement.executeUpdate("create database if not exists employees");
statement.close();
rawConnection.close();

// We should connect to the global group to run DDL statements,
// they will be replicated to the server groups for all shards.

// The 1-st way is to set its name explicitly via the
// "fabricServerGroup" connection property
rawConnection = DriverManager.getConnection(
  baseUrl + database + "?fabricServerGroup=fabric_test1_global",
  user,
  password);
statement = rawConnection.createStatement();
statement.executeUpdate("create database if not exists employees");
statement.close();
rawConnection.close();

// The 2-nd way is to get implicitly connected to global group
// when the shard key isn't provided, ie. set "fabricShardTable"
// connection property but don't set "fabricShardKey"
rawConnection = DriverManager.getConnection(
  baseUrl + "employees" + "?fabricShardTable=employees.employees",
  user,
  password);
// At this point, we have a connection to the global group for
// the 'employees.employees' shard mapping.
statement = rawConnection.createStatement();
statement.executeUpdate("drop table if exists employees");
statement.executeUpdate("create table employees (emp_no int not null," +
          "first_name varchar(50), last_name varchar(50)," +
    "primary key (emp_no))");

// 2. Insert data

// Cast to a Fabric connection to have access to specific methods
FabricMySQLConnection connection = (FabricMySQLConnection)rawConnection;

// example data used to create employee records
Integer ids[] = new Integer[] {1, 2, 10001, 10002};
String firstNames[] = new String[] {"John", "Jane", "Andy", "Alice"};
String lastNames[] = new String[] {"Doe", "Doe", "Wiley", "Wein"};

// insert employee data
PreparedStatement ps = connection.prepareStatement(
          "INSERT INTO employees.employees VALUES (?,?,?)");
for (int i = 0; i < 4; ++i) {
 // choose the shard that handles the data we interested in
 connection.setShardKey(ids[i].toString());

 // perform insert in standard fashion
 ps.setInt(1, ids[i]);
 ps.setString(2, firstNames[i]);
 ps.setString(3, lastNames[i]);
 ps.executeUpdate();
}

// 3. Query the data from employees
```

```
  System.out.println("Querying employees");
  System.out.format("%7s | %-30s | %-30s%n", "emp_no", "first_name", "last_name");
  System.out.println("--------+--------------------------------+--------------------------------");
  ps = connection.prepareStatement(
            "select emp_no, first_name, last_name from employees where emp_no = ?");
  for (int i = 0; i < 4; ++i) {

   // we need to specify the shard key before accessing the data
   connection.setShardKey(ids[i].toString());

   ps.setInt(1, ids[i]);
   ResultSet rs = ps.executeQuery();
   rs.next();
   System.out.format("%7d | %-30s | %-30s%n", rs.getInt(1), rs.getString(2), rs.getString(3));
   rs.close();
  }
  ps.close();

  // 4. Connect to the global group and clean up
  connection.setServerGroupName("fabric_test1_global");
  statement.executeUpdate("drop table if exists employees");
  statement.close();
  connection.close();
 }
}
```

Here is an alternative using the DataSource API:

```
/*
  Copyright (c) 2015, Oracle and/or its affiliates. All rights reserved.

  The MySQL Connector/J is licensed under the terms of the GPLv2
  <http://www.gnu.org/licenses/old-licenses/gpl-2.0.html>, like most MySQL Connectors.
  There are special exceptions to the terms and conditions of the GPLv2 as it is applied to
  this software, see the FOSS License Exception
  <http://www.mysql.com/about/legal/licensing/foss-exception.html>.

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  program; if not, write to the Free Software Foundation, Inc., 51 Franklin St, Fifth
  Floor, Boston, MA 02110-1301  USA

 */

package demo.fabric;

import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.PreparedStatement;
import java.sql.ResultSet;
import java.sql.Statement;

import com.mysql.fabric.jdbc.FabricMySQLConnection;
import com.mysql.fabric.jdbc.FabricMySQLDataSource;

/**
 * Demonstrate working with employee data in MySQL Fabric with Connector/J and the JDBC APIs via a DataSou
 */
```

```
public class EmployeesDataSource {
    public static void main(String args[]) throws Exception {

        String hostname = System.getProperty("com.mysql.fabric.testsuite.hostname");
        String port = System.getProperty("com.mysql.fabric.testsuite.port");
        String database = System.getProperty("com.mysql.fabric.testsuite.database");
        // credentials to authenticate with the SQL nodes
        String user = System.getProperty("com.mysql.fabric.testsuite.username");
        String password = System.getProperty("com.mysql.fabric.testsuite.password");
        // credentials to authenticate to the Fabric node
        String fabricUsername = System.getProperty("com.mysql.fabric.testsuite.fabricUsername");
        String fabricPassword = System.getProperty("com.mysql.fabric.testsuite.fabricPassword");

        // setup the Fabric datasource to create connections
        FabricMySQLDataSource ds = new FabricMySQLDataSource();
        ds.setServerName(hostname);
        ds.setPort(Integer.valueOf(port));
        ds.setDatabaseName(database);
        ds.setFabricUsername(fabricUsername);
        ds.setFabricPassword(fabricPassword);

        // Load the driver if running under Java 5
        if (!com.mysql.jdbc.Util.isJdbc4()) {
            Class.forName("com.mysql.fabric.jdbc.FabricMySQLDriver");
        }

        // 1. Create database and table for our demo
        ds.setDatabaseName("mysql"); // connect to the `mysql` database before creating our `employees` databa
        ds.setFabricServerGroup("fabric_test1_global"); // connect to the global group
        Connection rawConnection = ds.getConnection(user, password);
        Statement statement = rawConnection.createStatement();
        statement.executeUpdate("create database if not exists employees");
        statement.close();
        rawConnection.close();

        // We should connect to the global group to run DDL statements, they will be replicated to the server

        // The 1-st way is to set its name explicitly via the "fabricServerGroup" datasource property
        ds.setFabricServerGroup("fabric_test1_global");
        rawConnection = ds.getConnection(user, password);
        statement = rawConnection.createStatement();
        statement.executeUpdate("create database if not exists employees");
        statement.close();
        rawConnection.close();

        // The 2-nd way is to get implicitly connected to global group when the shard key isn't provided, ie.
        // don't set "fabricShardKey"
        ds.setFabricServerGroup(null); // clear the setting in the datasource for previous connections
        ds.setFabricShardTable("employee.employees");
        rawConnection = ds.getConnection(user, password);
        // At this point, we have a connection to the global group for  the 'employees.employees' shard mappin
        statement = rawConnection.createStatement();
        statement.executeUpdate("drop table if exists employees");
        statement.executeUpdate("create table employees (emp_no int not null, first_name varchar(50), last_nam

        // 2. Insert data

        // Cast to a Fabric connection to have access to Fabric-specific methods
        FabricMySQLConnection connection = (FabricMySQLConnection) rawConnection;

        // example data used to create employee records
        Integer ids[] = new Integer[] { 1, 2, 10001, 10002 };
        String firstNames[] = new String[] { "John", "Jane", "Andy", "Alice" };
        String lastNames[] = new String[] { "Doe", "Doe", "Wiley", "Wein" };

        // insert employee data
        PreparedStatement ps = connection.prepareStatement("INSERT INTO employees.employees VALUES (?,?,?)");
        for (int i = 0; i < 4; ++i) {
            // choose the shard that handles the data we interested in
            connection.setShardKey(ids[i].toString());

            // perform insert in standard fashion
            ps.setInt(1, ids[i]);
            ps.setString(2, firstNames[i]);
            ps.setString(3, lastNames[i]);
            ps.executeUpdate();
        }

        // 3. Query the data from employees
        System.out.println("Querying employees");
        System.out.format("%7s | %-30s | %-30s%n", "emp_no", "first_name", "last_name");
        System.out.println("--------+-------------------------------+------------------------------");
        ps = connection.prepareStatement("select emp_no, first_name, last_name from employees where emp_no
        for (int i = 0; i < 4; ++i) {

            // we need to specify the shard key before accessing the data
            connection.setShardKey(ids[i].toString());

            ps.setInt(1, ids[i]);
            ResultSet rs = ps.executeQuery();
            rs.next();
            System.out.format("%7d | %-30s | %-30s%n", rs.getInt(1), rs.getString(2), rs.getString(3));
            rs.close();
        }
        ps.close();

        // 4. Connect to the global group and clean up
        connection.setServerGroupName("fabric_test1_global");
        statement.executeUpdate("drop table if exists employees");
        statement.close();
        connection.close();
    }
}
```

8.9.8 How Connector/J Chooses a MySQL Server

Before a database server can be chosen, a server group must be chosen. The following values are taken into account:

- *server group* name: If a server group name is specified directly, it is used.
- *shard table*: If a shard table is given, the global group for the shard mapping governing the given shard table is used.
- *shard table* + *shard key*: If a shard key is given the shard mapping is used to determine which server group handles data for the shard key.
- *query tables*: If the query table set contains a sharded table, the shard mapping for that table is used.

The server group name can be accessed by `con.getCurrentServerGroup().getName()`.

Once a server group is chosen, an individual database server is chosen based on the read-only state of the connection. A read-only server is chosen if one is available. Otherwise a read-write server is chosen. The server *weight* is not currently taken into account.

None of these values can be changed while a transaction is in progress.

8.9.9 Using Hibernate with MySQL Fabric

It is possible to use Hibernate 4's multi-tenancy support to work with a set of database servers managed by MySQL Fabric.

APIs necessary to implement MultiTenantConnectionProvider

We can use internal APIs included with Connector/J with MySQL Fabric support to implement Hibernate's MultiTenantConnectionProvider.

The following implementation is included in the package as the `com.mysql.fabric.hibernate.FabricMultiTenantConnectionProvider` class. An example of how to use it is included as the class `demo.fabric.HibernateFabric`.

To implement `MultiTenantConnectionProvider`, we use the `com.mysql.fabric.FabricConnection` class. This class connects to the MySQL Fabric manager to obtain information about servers and data sharding. This is an internal API and subject to change. The following `FabricConnection` methods can be used:

- `FabricConnection(String url, String username, String password) throws FabricCommunicationException`

  Construct a new instance of a MySQL Fabric client and initiate the connection.

- `ServerGroup getServerGroup(String serverGroupName) throws FabricCommunicationException`

  Retrieve an object representing the named server group. This includes the list of servers in the group including their mode (read-only or read-write).

- `ShardMapping getShardMapping(String database, String table) throws FabricCommunicationException`

  Retrieve an object representing a shard mapping for the given database and table. The `ShardMapping` indicates the global group and the individual shards.

The following additional methods are used:

- `Set<Server> ServerGroup.getServers()`

  Return the servers in this group.

- `String Server.getHostname()`

  Return the server host name.

- `int Server.getPort()`

  Return the server port.

Implementing MultiTenantConnectionProvider

To begin, we declare the class with members to keep necessary information for the connection and the constructor:

```
public class FabricMultiTenantConnectionProvider implements MultiTenantConnectionProvider {
    // a connection to the MySQL Fabric manager
    private FabricConnection fabricConnection;
    // the database and table of the sharded data
    private String database;
    private String table;
    // user and password for Fabric manager and MySQL servers
    private String user;
    private String password;
    // shard mapping for `database.table'
    private ShardMapping shardMapping;
    // global group for the shard mapping
    private ServerGroup globalGroup;

    public FabricMultiTenantConnectionProvider(
              String fabricUrl, String database, String table,
              String user, String password) {
        try {
            this.fabricConnection = new FabricConnection(fabricUrl, user, password);
            this.database = database;
            this.table = table;
            this.user = user;
            this.password = password;
            // eagerly retrieve the shard mapping and server group from the Fabric manager
            this.shardMapping = this.fabricConnection.getShardMapping(this.database, this.table);
            this.globalGroup = this.fabricConnection.
                    getServerGroup(this.shardMapping.getGlobalGroupName());
        } catch(FabricCommunicationException ex) {
            throw new RuntimeException(ex);
        }
    }
```

Next, create a method to create connections:

```
/**
 * Find a server with mode READ_WRITE in the given server group and create a JDBC connection to it.
 *
 * @returns a {@link Connection} to an arbitrary MySQL server
 * @throws SQLException if connection fails or a READ_WRITE server is not contained in the group
 */
private Connection getReadWriteConnectionFromServerGroup(ServerGroup serverGroup)
            throws SQLException {
    // iterate the list of servers in the given group until we find a r/w server
    for (Server s : serverGroup.getServers()) {
        if (ServerMode.READ_WRITE.equals(s.getMode())) {
            // create a connection to the server using vanilla JDBC
            String jdbcUrl = String.format("jdbc:mysql://%s:%s/%s",
                      s.getHostname(), s.getPort(), this.database);
            return DriverManager.getConnection(jdbcUrl, this.user, this.password);
        }
    }
    // throw an exception if we are unable to make the connection
    throw new SQLException(
          "Unable to find r/w server for chosen shard mapping in group " + serverGroup.getName());
}
```

To implement the interface, the following methods must be implemented:

- `Connection getAnyConnection() throws SQLException`

  This method should obtain a connection to the global group. We can implement it like this:

  ```
  /**
   * Get a connection that be used to access data or metadata not specific to any shard/tenant.
   * The returned connection is a READ_WRITE connection to the global group of the shard mapping
   * for the database and table association with this connection provider.
  ```

```
 */
public Connection getAnyConnection() throws SQLException {
    return getReadWriteConnectionFromServerGroup(this.globalGroup);
}
```

- `Connection getConnection(String tenantIdentifier) throws SQLException`

  This method must use the **`tenantIdentifier`** to determine which server to access. We can look up the `ServerGroup` from the `ShardMapping` like this:

```
/**
 * Get a connection to access data association with the provided `tenantIdentifier' (or shard
 * key in Fabric-speak). The returned connection is a READ_WRITE connection.
 */
public Connection getConnection(String tenantIdentifier) throws SQLException {
    String serverGroupName = this.shardMapping.getGroupNameForKey(tenantIdentifier);
    try {
        ServerGroup serverGroup = this.fabricConnection.getServerGroup(serverGroupName);
        return getReadWriteConnectionFromServerGroup(serverGroup);
    } catch(FabricCommunicationException ex) {
        throw new RuntimeException(ex);
    }
}
```

Finally, our trivial implementation to release connections:

```
/**
 * Release a non-shard-specific connection.
 */
public void releaseAnyConnection(Connection connection) throws SQLException {
    connection.close();
}

/**
 * Release a connection specific to `tenantIdentifier'.
 */
public void releaseConnection(String tenantIdentifier, Connection connection)
          throws SQLException {
    releaseAnyConnection(connection);
}

/**
 * We don't track connections.
 * @returns false
 */
public boolean supportsAggressiveRelease() {
    return false;
}
```

And finally to implement the `Wrapped` role:

```
public boolean isUnwrappableAs(Class unwrapType) {
    return false;
}

public <T> T unwrap(Class<T> unwrapType) {
    return null;
}
```

Using a custom MultiTenantConnectionProvider

The `SessionFactory` can be created like this:

```
// create a new instance of our custom connection provider supporting MySQL Fabric
FabricMultiTenantConnectionProvider connProvider =
          new FabricMultiTenantConnectionProvider(
                  fabricUrl, "employees", "employees", username, password);
// create a service registry with the connection provider to construct the session factory
ServiceRegistryBuilder srb = new ServiceRegistryBuilder();
srb.addService(
          org.hibernate.service.jdbc.connections.spi.MultiTenantConnectionProvider.class,
          connProvider);
srb.applySetting("hibernate.dialect", "org.hibernate.dialect.MySQLInnoDBDialect");

// create the configuration and build the session factory
Configuration config = new Configuration();
config.setProperty("hibernate.multiTenancy", "DATABASE");
config.addResource("com/mysql/fabric/demo/employee.hbm.xml");
return config.buildSessionFactory(srb.buildServiceRegistry());
```

Using Hibernate multi-tenancy

Once you have created a `SessionFactory` with your custom `MultiTenantConnectionProvider`, it is simple to use. Provide the *shard key* to the `SessionFactory` when creating the session:

```
// access data related to shard key = 40
Session session = sessionFactory.withOptions().tenantIdentifier("40").openSession();
```

Each `Session` is given a *shard key* (tenant identifier in Hibernate-speak) and uses it to obtain a connection to an appropriate server. This cannot be changed for the duration of the `Session`.

8.9.10 Connector/J Fabric Support Reference

8.9.10.1 Connection Properties

The following connection properties are recognized by Connector/J for dealing with MySQL Fabric:

- `fabricShardKey`

  The initial shard key used to determine which server group to send queries to. The `fabricShardTable` property must also be specified.

- `fabricShardTable`

  The initial shard mapping used to determine a server group to send queries to.

- `fabricServerGroup`

  The initial server group to direct queries to.

- `fabricProtocol`

  Protocol used to communicate with the Fabric node. XML-RPC over HTTP is currently the only supported protocol and is specified with a value of "http".

- `fabricUsername`

  Username used to authenticate with the Fabric node.

- `fabricPassword`

  Password used to authenticate with the Fabric node.

- `fabricReportErrors` (default=false)

  Determines whether or not errors are reported to Fabric's distributed failure detector. Only connection errors, those with an SQL state beginning with "08", are reported.

8.9.10.2 FabricMySQLConnection API

The following methods are available in the `com.mysql.fabric.jdbc.FabricMySQLConnection` interface.

- `void clearServerSelectionCriteria()`

  Clear all the state that is used to determine which server to send queries to.

- `void setShardKey(String shardKey) throws SQLException`

  Set the shard key for the data being accessed.

- `String getShardKey()`

  Get the shard key for the data being accessed.

- `void setShardTable(String shardTable) throws SQLException`

  Set the table being accessed. Can be a table name or a database and table name pair in the form *`db_name.tbl_name`*. The table must be known by Fabric as a sharded table.

- `String getShardTable()`

  Get the name of the table being accessed.

- `void setServerGroupName(String serverGroupName) throws SQLException`

  Set the server group name to connect to. Direct server group selection is mutually exclusive of sharded data access.

- `String getServerGroupName()`

  Get the server group name when using direct server group selection.

- `ServerGroup getCurrentServerGroup()`

  Get the current server group if sufficient server group selection has been provided. Otherwise null.

- `void clearQueryTables() throws SQLException`

  Clear the list of tables for the last query. This also clears the shard mapping/table and must be given again for the next query via `setShardTable()` or `addQueryTable()`.

- `void addQueryTable(String tableName) throws SQLException`

  Specify that the given table is intended to be used in the next query.

- `Set<String> getQueryTables()`

  Get the list of tables intended to be used in the next query.

8.10 MySQL Fabric Frequently Asked Questions

FAQ Categories

- **General Questions**
- **High-Availability Questions**
- **Sharding Questions**
- **Consistency Questions**

General

8.10.1. What is MySQL Fabric?

MySQL Fabric is a framework for managing groups of MySQL Servers and using those servers to provide services. It is designed to be extensible so that over time many different services can be added. In the current version the services provided are High Availability (built on top of MySQL Replication) and scale-out (by sharding the data).

MySQL Fabric is implemented as a MySQL Fabric node/process (which performs management functions) and Fabric-aware connectors that are able to route queries and transactions directly to the most appropriate MySQL Server. The MySQL Fabric node stores state and routing information in its State Store (which is a MySQL database).

8.10.2. Is it necessary to use a MySQL Fabric-specific Storage Engine?

No. The MySQL Servers that are being managed by MySQL Fabric continue to use InnoDB (and in the future NDB/MySQL Cluster may also be supported).

8.10.3. What versions of MySQL are supported by MySQL Fabric?

Currently MySQL 5.6. New MySQL releases will be fully supported as they reach General Availability status.

8.10.4. What connectors support MySQL Fabric?

Java, PHP, Python, and .NET. In addition the Hibernate and Doctrine Object-Relational Mappings frameworks are also supported. Connector/C 6.2 also adds fabric support as a labs release.

8.10.5. Are transactions ACID?

Yes. Because each transaction is local to a single MySQL Server, all of the ACID behavior of the InnoDB storage engine is experienced.

8.10.6. How many machines are needed in order to use MySQL Fabric?

For development, the MySQL Fabric node and all of the managed MySQL Servers can be hosted on a single machine.

For deployment, the minimal HA configuration would need 3 or more machines:

- 2 to host MySQL Servers
- 1 to host the MySQL Fabric process (that machine could also be running application code).

8.10.7. Do I need to run an agent for each MySQL Server?

No. The MySQL Fabric node is the only additional process and does not need to be co-located with any of the MySQL Servers that are being managed.

8.10.8. What interface is available to manage MySQL Fabric and its server farm?

A Command Line Interface (CLI) is provided as well as an XML/RPC API that can be used by connectors and/or applications to make management changes or retrieve the routing information - in this way, an application could use MySQL Fabric without a Fabric-aware connector.

8.10.9. How does MySQL Fabric Compare with MySQL Cluster?

MySQL Cluster is a mature, well proven solution for providing very high levels of availability and scaling out of both reads and writes. Some of the main extra capabilities that MySQL Cluster has over MySQL Fabric are:

- Synchronous replication
- Faster (automated) fail-over (resulting in higher availability)
- Transparent sharding
- Cross-shard joins and Foreign Keys
- In-memory, real-time performance

MySQL Fabric on the other hand, allows the application to stick with the InnoDB storage engine which is better suited to many applications.

8.10.10. How is MySQL Fabric licensed?

MySQL Fabric is available for use under the GPL v2 Open Source license or it can be commercially licensed as part of MySQL Enterprise Edition or MySQL Cluster Carrier Grade Edition.

8.10.11. What if MySQL Fabric doesn't do what I need it to?

There are a number of options:

- Raise feature requests or bug reports
- Modify the code to customize the current services. MySQL Fabric is written in Python and is designed to be easy to extend.
- Implement new modules that bind into the MySQL Fabric framework to implement new services.

High-Availability

8.10.1. How is High Availability achieved with MySQL Fabric?

MySQL Fabric manages one or more HA-Groups where each HA-Group contains one or more MySQL Servers. For High Availability, a HA Group contains a Primary and one or more Secondary MySQL Servers. The Primary is currently a MySQL Replication master which replicates to each of the secondaries (MySQL Replication slaves) within the group.

By default, the Fabric-aware connectors route writes to the Primary and load balance reads across the available secondaries.

Should the Primary fail, MySQL Fabric will promote one of the Secondaries to be the new Primary (automatically promoting the MySQL Server to be the replication Master and updating the routing performed by the Fabric-aware connectors).

8.10.2. How are MySQL Server failures detected?

The MySQL Fabric node has a built-in monitoring function that checks on the status of the master. In addition, the Fabric-aware connectors report to MySQL Fabric when the Primary becomes unavailable to them. The administrator can configure how many problems need to be reported (and over what time period) before the failover is initiated.

8.10.3. What happens when the primary (master) MySQL Server fails?

The MySQL Fabric node will orchestrate the promotion of one of the Secondaries to be the new Primary. This involves two main actions:

- Promoting the Secondary to be the replication master (and any other surviving Secondaries will become slaves to the new master)
- Updating the routing information such that Fabric-aware connectors will no longer send any queries or transactions to the failed Primary and instead send all writes to the new Primary.

8.10.4. Does my application need to do anything as part of the failover?

No. The failover is transparent to the application as the Fabric-aware connectors will automatically start routing transactions and queries based on the new server topology. The application does need to handle the failure of a number of transactions when the Primary has failed but before the new Primary is in place but this should be considered part of normal MySQL error handling.

8.10.5. Is a recovered MySQL Server automatically put back into service?

No, the user must explicitly invoke MySQL Fabric to return a recovered MySQL Server to a HA Group. This is intentional so that the user can ensure that the server really is ready to take on an active role again.

8.10.6. Does MySQL Fabric work with semisynchronous replication?

In this version, MySQL Fabric sets up the HA Group to use asynchronous replication. If the user prefers to use semisynchronous replication then they can activate it manually after MySQL Fabric has created the replication relationships.

8.10.7. Do I have to use MySQL Replication for implementing HA?

At present, HA Groups are formed using MySQL Replication; future releases may offer further options such as MySQL Cluster or DRBD.

8.10.8. Is the MySQL Fabric node itself fault tolerant? What happens when the MySQL Fabric node is not available?

There is currently only a single instance of the MySQL Fabric node. If that process should fail then it can be restarted on that or another machine and the state and routing information read from the existing state store (a MySQL database) or a replicated copy of the state store.

While the MySQL Fabric node is unavailable, Fabric-aware connectors continue to route queries and transactions to the correct MySQL Servers based on their cached copies of the routing data. However, should a Primary fail, automated failover will not happen until the MySQL Fabric node is returned to service and so it's important to recover the process as quickly as possible.

Sharding

8.10.1. How is scaling achieved with MySQL Fabric?

Horizontal scaling is achieved by partitioning (sharding) the data from a table across multiple MySQL Servers or HA Groups. In that way, each server or group will contain a subset of the rows from a specific table.

The user specifies what column from the table(s) should be used as the shard key as well as indicating whether to use a HASH or RANGE partitioning scheme for that key; if using RANGE based sharding then the user should also specify which ranges map to which shards. Currently the sharding key must be numeric.

When accessing the database, the application specifies the sharding key which the Fabric-aware connector will then map to a shard ID (using the mapping data it has retrieved and cached from MySQL Fabric) and route the query or transaction to the correct MySQL Server instance.

Within a HA group, the Fabric-aware connector is able to direct writes to the Primary and then spread the read queries across all available Secondaries (and optionally the Primary).

8.10.2. Does scaling apply to both reads and writes?

Yes. Both reads and writes scale linearly as more HA groups are added. Reads can also be scaled independently by adding more Secondary servers to a HA Group.

8.10.3. What if I have table data that needs to be in every shard?

A special group can be created called the *Global Group* which holds the Global Tables. Any table whose data should appear in its entirety in all HA Groups should be handled as a Global Table. For a Global Table, all writes are sent to the Global Group and then replicated to all of the HA Groups. An example might be the department table from an employee database - the contents of the department table being small enough to be stored in every server and where that data could be referenced by any record from one of the sharded employee tables.

Similarly, any schema changes would be sent to the Global Group where they can be replicated to all of the HA Groups.

8.10.4. How many MySQL Servers can I scale to?

There is no limit—either to the number of HA Groups or the number of servers within a HA group.

8.10.5. Can MySQL Fabric introduce contention or deadlock?

No. A single transaction can only access data from a single shard (+ Global Table data) and all writes are sent to the Primary server within that shard's HA Group. In other words, all writes to a specific row will be handled by the same MySQL Server and so InnoDB's row-based locking will work as normal.

8.10.6. What happens when my data set or usage grows and a shard grows too big?

MySQL Fabric provides the ability to either:

- Move a shard to a new HA group containing larger or more powerful servers
- Split an existing shard into two shards where the new shard will be stored in a new HA Group. In the future, different levels of granularity may be supported for shard splitting.

8.10.7. Is there extra latency when using MySQL Fabric?

No. Because the routing is handled within the connector there is no need for any extra "hops" to route the request via a proxy process.

8.10.8. Why does MySQL Fabric route using connector logic rather than via a proxy?

One reason is to reduce complexity; rather than having a pool of proxy processes (a single proxy would represent a single point of failure) the logic is just part of each connector instance. The second reason is to avoid the latency involved in all operations being diverted via a proxy process (which is likely to be an a different machine).

8.10.9. What is the difference between a shard key and a shard identifier?

The shard key is simply the value of a column from one or more tables. The shard key does not change if a row is migrated from one shard or server to another. The shard key is mapped to a shard id (using either a HASH or RANGE based mapping scheme); the shard id represents the shard itself.

As an example, if an existing shard were split in two then some of the rows would map to one shard's shard id and the rest to the other's; any given row's shard key would *not* change as part of that split.

Very importantly, shard keys are known to the application while shard ids are not and so any changes to the topology of the collection of servers is completely transparent to the application.

8.10.10. Does my application need to change when a shard is moved to a different MySQL Server or split into multiple shards?

No. Because the application deals in shard keys and shard keys do not change during shard moves or splits.

8.10.11. Is it possible to perform cross-shard unions or joins?

Not at present; all queries are limited to the data within a single shard + the Global Table data. If data from multiple shards is required then it is currently the application's responsibility to collect and aggregate the data.

8.10.12. Is the routing of queries and transactions transparent to my application?

Partially.

For HA, the application simply needs to specify whether the operations are read-only or involve writes (or consistent reads).

For sharding, the application must specify the sharding key (a column from one or more tables) *but* this is independent of the topology of the MySQL Servers and where the data is held and it is unaffected when data is moved from one server to another.

Consistency

8.10.1. What do I do if I need immediately-consistent reads?

Because replication from the Primary (master) to the Secondaries (slaves) is not synchronous, you cannot guarantee that you will retrieve the most current data when reading from a secondary. To force a read to be sent to the Primary, the application may set the *mode* property for the connection to read/write rather than read.

Chapter 9 Appendix

Table of Contents

This chapter includes additional information about MySQL Utilities including a list of frequently asked questions.

9.1 MySQL Utilities Frequently Asked Questions

FAQ Categories

- **General Questions**
- **Storage Engine Questions**
- **The mysqlfrm Utility: .frm File Reader Questions**

General

9.1.1. Are these utilities present in the community version of MySQL?

Yes, see Chapter 1, *How to Install MySQL Utilities*.

Storage Engines

9.1.1. Can the utilities be used with MyISAM or CSV?

Yes. There are no storage engine specific limitations in using the utilities. There are some features written specifically for InnoDB so those may not apply but in general no utility is storage engine specific. For example, the `mysqldiskusage` utility shows exact sizes for MyISAM and InnoDB files but uses estimated sizes for any other storage engine based on number of rows and row size.

The mysqlfrm Utility: .frm File Reader

9.1.1. Can the .frm reader read a .frm file without the associated data files?

Yes! The .frm reader was designed to read the contents of an .frm file without requiring the data files.

9.1.2. Will the .frm reader modify my original .frm file?

No, it does not modify the original .frm file in either default or diagnostic mode.

9.1.3. What is diagnostic mode and why doesn't it produce the same output as the default mode?

The diagnostic mode does not use a spawned server to read the .frm file. Instead, it attempts to read the contents of the file byte-by-byte and forms a best-effort approximation of the CREATE statement. Due to the many complexities of the server code, the diagnostic mode does not currently process all features of a table. Future revisions will improve the accuracy of the diagnostic mode.

9.1.4. If the diagnostic mode is only a best-effort compilation, why use it?

The diagnostic mode is used to attempt to read corrupt or otherwise damaged .frm files. You would also use it if you had no access to a server installation on the local machine.

9.1.5. Why does the default mode require a server?

The default mode uses a server to create a temporary working copy of the server instance. It does *not* access the donor server in any way other than to execute the mysqld[.exe] process.

9.1.6. Can the .frm reader read any .frm file?

Although it can read most .frm files, there are known limits to which storage engines it can process correctly. Currently, tables with storage engines partition and performance_schema cannot be read. However, these .frm files can be read by the diagnostic mode,

9.1.7. My .frm files are tucked away in a restricted folder. How do I get access to them to run the .frm reader without copying or modifying file privileges?

You can use elevated privileges such as su or sudo to execute the .frm reader. You must use the --user option to specify a user to launch the spawned server, however. This will permit the .frm reader to read the original .frm file and copy it to the spawned server and access the copy without requiring additional privileges.

9.1.8. Will the default mode display a 100% accurate CREATE statement?

For most tables and all views, yes. However, there are at least two features that are not stored in the .frm file and therefore will not be included. These are autoincrement values and foreign keys. That being said, the CREATE statement produced will be syntactically correct.