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Percona XtraBackup 8.0 Documentation

Release 8.0.10

Percona LLC and/or its affiliates

Mar 16, 2020

CONTENTS

Percona XtraBackup is an open-source hot backup utility for *MySQL* - based servers that doesn't lock your database during the backup.

Whether it is a 24x7 highly loaded server or a low-transaction-volume environment, *Percona XtraBackup* is designed to make backups a seamless procedure without disrupting the performance of the server in a production environment. Commercial support contracts are available.

Percona XtraBackup can back up data from *InnoDB*, *XtraDB*, *MyISAM*, and MyRocks tables on *MySQL* 8.0 servers as well as *Percona Server for MySQL* with *XtraDB*, *Percona Server for MySQL* 8.0, and *Percona XtraDB Cluster* 8.0.

Important: The support of the MyRocks storage engine was added in version 8.0.6.

Percona XtraBackup 8.0 does not support the TokuDB storage engine.

See also:

Percona TokuBackup https://www.percona.com/doc/percona-server/LATEST/tokudb/toku_backup.html

Percona XtraBackup 8.0 does not support making backups of databases created in versions prior to 8.0 of *MySQL*, *Percona Server for MySQL* or *Percona XtraDB Cluster*. As the changes that *MySQL* 8.0 introduced in *data dictionaries*, *redo log* and *undo log* are incompatible with previous versions, it is currently impossible for *Percona XtraBackup* 8.0 to also support versions prior to 8.0.

For a high-level overview of many of its advanced features, including a feature comparison, please see *About Percona XtraBackup*.

Part I

Introduction

CHAPTER

ONE

ABOUT PERCONA XTRABACKUP

Percona XtraBackup is the world's only open-source, free *MySQL* hot backup software that performs non-blocking backups for *InnoDB* and *XtraDB* databases. With *Percona XtraBackup*, you can achieve the following benefits:

- Backups that complete quickly and reliably
- Uninterrupted transaction processing during backups
- Savings on disk space and network bandwidth
- Automatic backup verification
- Higher uptime due to faster restore time

Percona XtraBackup makes *MySQL* hot backups for all versions of *Percona Server for MySQL*, and *MySQL*. It performs streaming, compressed, and incremental *MySQL* backups.

Important: With the introduction of *Percona XtraBackup* 8.0, *Percona XtraBackup* 2.4 will continue to support MySQL and Percona Server 5.6 and 5.7 databases. Due to the new MySQL redo log and data dictionary formats the Percona XtraBackup 8.0.x versions will only be compatible with MySQL 8.0.x and the upcoming Percona Server for MySQL 8.0.x

Percona's enterprise-grade commercial MySQL Support contracts include support for *Percona XtraBackup*. We recommend support for critical production deployments.

Supported storage engines

Percona XtraBackup works with *MySQL* and *Percona Server for MySQL*. It supports completely non-blocking backups of *InnoDB*, *XtraDB*, and MyRocks storage engines. In addition, it can back up the following storage engines by briefly pausing writes at the end of the backup: *MyISAM*, *Merge*, and *Archive*, including partitioned tables, triggers, and database options.

Important: The support of the MyRocks storage engine was added in version 8.0.6.

Percona XtraBackup 8.0 does not support the TokuDB storage engine.

See also:

Percona TokuBackup https://www.percona.com/doc/percona-server/LATEST/tokudb/toku_backup.html

MySQL Backup Tool Feature Comparison

Features	Percona XtraBackup	MySQL Enterprise backup
License	GPL	Proprietary
Price	Free	Included in subscription at $5000 per Server
Streaming and encryption formats	Open source	Proprietary
Supported *MySQL* flavors	*MySQL*, *Percona Server for MySQL*, *Percona XtraDB Cluster*,	*MySQL*
Supported operating systems	Linux	Linux, Solaris, Windows, OSX, FreeBSD.
Non-blocking InnoDB backups[1]	Yes	Yes
Blocking MyISAM backups	Yes	Yes
Incremental backups	Yes	Yes
Full compressed backups	Yes	Yes
Incremental compressed backups	Yes	
Fast incremental backups[2]	Yes	
Incremental backups with archived logs feature in Percona Server	Yes	
Incremental backups with REDO log only		Yes
Backup locks[7]	Yes (`LOCK TABLE FOR BACKUP`)	Yes (`LOCK INSTANCE FOR BACKUP`)
Encrypted backups	Yes	Yes[3]
Streaming backups	Yes	Yes
Parallel local backups	Yes	Yes
Parallel compression	Yes	Yes
Parallel encryption	Yes	Yes
Parallel apply-log	Yes	
Parallel copy-back		Yes
Partial backups	Yes	Yes
Partial backups of individual partitions	Yes	
Throttling[4]	Yes	Yes
Backup image validation		Yes
Point-in-time recovery support	Yes	Yes
Safe slave backups	Yes	
Compact backups[5]	Yes	
Buffer pool state backups	Yes	
Individual tables export	Yes	Yes[6]
Individual partitions export	Yes	
Restoring tables to a different server	Yes	Yes
Data & index file statistics	Yes	
InnoDB secondary indexes defragmentation	Yes	
`rsync` support to minimize lock time	Yes	
Improved `FTWRL` handling	Yes	
Backup history table	Yes	Yes
Backup progress table		Yes
Offline backups		Yes
Backup to tape media managers		Yes

Continued on next page

Table 1.1 – continued from previous page

Features	Percona XtraBackup	MySQL Enterprise backup
Cloud backups support		Amazon S3
External graphical user interfaces to backup/recovery	Zmanda Recovery Manager for MySQL	MySQL Workbench, MySQL Enterprise Monitor

What are the features of Percona XtraBackup?

Here is a short list of *Percona XtraBackup* features. See the documentation for more.

- Create hot *InnoDB* backups without pausing your database
- Make incremental backups of *MySQL*
- Stream compressed *MySQL* backups to another server
- Move tables between *MySQL* servers on-line
- Create new *MySQL* replication slaves easily
- Backup *MySQL* without adding load to the server

[1] *InnoDB* tables are still locked while copying non-*InnoDB* data.

[2] Fast incremental backups are supported for *Percona Server for MySQL* with XtraDB changed page tracking enabled.

[7] Backup locks is a lightweight alternative to `FLUSH TABLES WITH READ LOCK` available in *Percona Server for MySQL*. *Percona XtraBackup* uses them automatically to copy non-InnoDB data to avoid blocking DML queries that modify *InnoDB* tables.

For more information see *How Percona XtraBackup Works*

[3] *Percona XtraBackup* supports encryption with any kinds of backups. *MySQL Enterprise Backup* only supports encryption for single-file backups.

[4] *Percona XtraBackup* performs throttling based on the number of IO operations per second. *MySQL Enterprise Backup* supports a configurable sleep time between operations.

[5] *Percona XtraBackup* skips secondary index pages and recreates them when a compact backup is prepared. *MySQL Enterprise Backup* skips unused pages and reinserts on the prepare stage.

[6] *Percona XtraBackup* can export individual tables even from a full backup, regardless of the InnoDB version. *MySQL Enterprise Backup* uses InnoDB 5.6 transportable tablespaces only when performing a partial backup.

CHAPTER

TWO

HOW *PERCONA XTRABACKUP* WORKS

Percona XtraBackup is based on *InnoDB*'s crash-recovery functionality. It copies your *InnoDB* data files, which results in data that is internally inconsistent; but then it performs crash recovery on the files to make them a consistent, usable database again.

This works because *InnoDB* maintains a redo log, also called the transaction log. This contains a record of every change to InnoDB data. When *InnoDB* starts, it inspects the data files and the transaction log, and performs two steps. It applies committed transaction log entries to the data files, and it performs an undo operation on any transactions that modified data but did not commit.

Percona XtraBackup works by remembering the log sequence number (*LSN*) when it starts, and then copying away the data files. It takes some time to do this, so if the files are changing, then they reflect the state of the database at different points in time. At the same time, *Percona XtraBackup* runs a background process that watches the transaction log files, and copies changes from it. *Percona XtraBackup* needs to do this continually because the transaction logs are written in a round-robin fashion, and can be reused after a while. *Percona XtraBackup* needs the transaction log records for every change to the data files since it began execution.

Percona XtraBackup uses Backup locks where available as a lightweight alternative to `FLUSH TABLES WITH READ LOCK`. This feature is available in *Percona Server for MySQL* 5.6+. *MySQL* 8.0 allows acquiring an instance level backup lock via the `LOCK INSTANCE FOR BACKUP` statement.

Locking is only done for *MyISAM* and other non-InnoDB tables **after** *Percona XtraBackup* finishes backing up all InnoDB/XtraDB data and logs. *Percona XtraBackup* uses this automatically to copy non-InnoDB data to avoid blocking DML queries that modify *InnoDB* tables.

Important: To use effectively either `LOCK INSTANCE FOR BACKUP` or `LOCK TABLES FOR BACKUP`, the `BACKUP_ADMIN` privilege is needed in order to query `performance_schema.log_status`.

`xtrabackup` tries to avoid backup locks and `FLUSH TABLES WITH READ LOCK` when the instance contains only InnoDB tables. In this case, **`xtrabackup`** obtains binary log coordinates from `performance_schema.log_status`. `FLUSH TABLES WITH READ LOCK` is still required in MySQL 8.0 when xtrabackup is started with the *`--slave-info`*. The `log_status` table in *Percona Server for MySQL* 8.0 is extended to include the relay log coordinates, so no locks are needed even with the *`--slave-info`* option.

See also:

***MySQL* Documentation: More information about `LOCK INSTANCE FOR BACKUP`** https://dev.mysql.com/doc/refman/8.0/en/lock-instance-for-backup.html

When backup locks are supported by the server, **`xtrabackup`** first copies *InnoDB* data, runs the `LOCK TABLES FOR BACKUP` and then copies the *MyISAM* tables. Once this is done, the backup of the files will begin. It will backup *.frm*, *.MRG*, *.MYD*, *.MYI*, *.ARM*, *.ARZ*, *.CSM*, *.CSV*, `.sdi` and `.par` files.

After that **`xtrabackup`** will use `LOCK BINLOG FOR BACKUP` to block all operations that might change either binary log position or `Exec_Master_Log_Pos` or `Exec_Gtid_Set` (i.e. master binary log coordinates corresponding to the current SQL thread state on a replication slave) as reported by `SHOW MASTER/SLAVE STATUS`. **xtrabackup** will then finish copying the REDO log files and fetch the binary log coordinates. After this is completed **xtrabackup** will unlock the binary log and tables.

Finally, the binary log position will be printed to `STDERR` and **xtrabackup** will exit returning 0 if all went OK.

Note that the `STDERR` of **xtrabackup** is not written in any file. You will have to redirect it to a file, e.g., `xtrabackup OPTIONS 2> backupout.log`.

It will also create the *following files* in the directory of the backup.

During the prepare phase, *Percona XtraBackup* performs crash recovery against the copied data files, using the copied transaction log file. After this is done, the database is ready to restore and use.

The backed-up *MyISAM* and *InnoDB* tables will be eventually consistent with each other, because after the prepare (recovery) process, *InnoDB*'s data is rolled forward to the point at which the backup completed, not rolled back to the point at which it started. This point in time matches where the `FLUSH TABLES WITH READ LOCK` was taken, so the *MyISAM* data and the prepared *InnoDB* data are in sync.

The **xtrabackup** offers many features not mentioned in the preceding explanation. The functionality of each tool is explained in more detail further in this manual. In brief, though, the tools enable you to do operations such as streaming and incremental backups with various combinations of copying the data files, copying the log files, and applying the logs to the data.

Restoring a backup

To restore a backup with **xtrabackup** you can use the *`--copy-back`* or *`--move-back`* options.

xtrabackup will read from the `my.cnf` the variables *datadir*, *innodb_data_home_dir*, *innodb_data_file_path*, *innodb_log_group_home_dir* and check that the directories exist.

It will copy the *MyISAM* tables, indexes, etc. (*.MRG*, *.MYD*, *.MYI*, *.ARM*, *.ARZ*, *.CSM*, *.CSV*, `.sdi`, and `par` files) first, *InnoDB* tables and indexes next and the log files at last. It will preserve file's attributes when copying them, you may have to change the files' ownership to `mysql` before starting the database server, as they will be owned by the user who created the backup.

Alternatively, the *`--move-back`* option may be used to restore a backup. This option is similar to *`--copy-back`* with the only difference that instead of copying files it moves them to their target locations. As this option removes backup files, it must be used with caution. It is useful in cases when there is not enough free disk space to hold both data files and their backup copies.

Part II

Installation

CHAPTER

THREE

INSTALLING *PERCONA XTRABACKUP* 8.0

This page provides the information on how to install *Percona XtraBackup*. Following options are available:

- *Installing Percona XtraBackup from Repositories* (recommended)
- Installing *Percona XtraBackup* from Downloaded *rpm* or *apt* packages
- *Compiling and Installing from Source Code*

Before installing, you might want to read the *Percona XtraBackup 8.0 Release Notes*.

Installing *Percona XtraBackup* from Repositories

Percona provides repositories for **yum** (`RPM` packages for *Red Hat*, *CentOS* and *Amazon Linux AMI*) and **apt** (`.deb` packages for *Ubuntu* and *Debian*) for software such as *Percona Server for MySQL*, *Percona XtraBackup*, and *Percona Toolkit*. This makes it easy to install and update your software and its dependencies through your operating system's package manager. This is the recommend way of installing where possible.

Following guides describe the installation process for using the official Percona repositories for `.deb` and `.rpm` packages.

Installing *Percona XtraBackup* on *Debian* and *Ubuntu*

Ready-to-use packages are available from the *Percona XtraBackup* software repositories and the download page.

Supported releases:

- Debian 8.0 (jessie)
- Debian 9.0 (stretch)
- Ubuntu 16.04 (xenial)
- Ubuntu 18.04 LTS (bionic)

Supported architectures:

- x86_64 (also known as `amd64`)

What's in each DEB package?

The `percona-xtrabackup-80` package contains the latest *Percona XtraBackup* GA binaries and associated files.

The `percona-xtrabackup-dbg-80` package contains the debug symbols for binaries in `percona-xtrabackup-80`.

The `percona-xtrabackup-test-80` package contains the test suite for *Percona XtraBackup*.

The `percona-xtrabackup` package contains the older version of the *Percona XtraBackup*.

Installing *Percona XtraBackup* from Percona `apt` repository

1. Fetch the repository packages from Percona web:

```
$ wget https://repo.percona.com/apt/percona-release_latest.$(lsb_release -sc)_all.
↪deb
```

2. Install the downloaded package with **dpkg**. To do that, run the following commands as root or with **sudo**: `dpkg -i percona-release_latest.$(lsb_release -sc)_all.deb`

   Once you install this package the Percona repositories should be added. You can check the repository setup in the `/etc/apt/sources.list.d/percona-release.list` file.

Enable the repository: `percona-release enable-only tools release`

If *Percona XtraBackup* is intented to be used in combination with the upstream MySQL Server, you only need to enable the `tools` repository: `percona-release enable-only tools`.

1. Remember to update the local cache: `apt-get update`
2. After that you can install the package: `apt-get install percona-xtrabackup-80`

Apt-Pinning the packages

In some cases you might need to "pin" the selected packages to avoid the upgrades from the distribution repositories. You'll need to make a new file `/etc/apt/preferences.d/00percona.pref` and add the following lines in it:

```
Package: *
Pin: release o=Percona Development Team
Pin-Priority: 1001
```

For more information about the pinning you can check the official debian wiki.

Installing *Percona XtraBackup* using downloaded deb packages

Download the packages of the desired series for your architecture from the download page. The following example will download *Percona XtraBackup* 8.0.4-1 release package for *Debian* 8.0:

```
$ wget https://www.percona.com/downloads/XtraBackup/Percona-XtraBackup-8.0.4/binary/
↪debian/stretch/x86_64/percona-xtrabackup-80_8.0.4-1.stretch_amd64.deb
```

Now you can install *Percona XtraBackup* by running:

```
$ sudo dpkg -i percona-xtrabackup-80_0.4-1.stretch_amd64.deb
```

Note: When installing packages manually like this, you'll need to make sure to resolve all the dependencies and install missing packages yourself.

Uninstalling *Percona XtraBackup*

To uninstall *Percona XtraBackup* you'll need to remove all the installed packages.

1. Remove the packages

```
$ sudo apt-get remove percona-xtrabackup-80
```

Installing *Percona XtraBackup* on *Red Hat Enterprise Linux* and *CentOS*

Ready-to-use packages are available from the *Percona XtraBackup* software repositories and the download page. The *Percona* **yum** repository supports popular *RPM*-based operating systems, including the *Amazon Linux AMI*.

The easiest way to install the *Percona Yum* repository is to install an *RPM* that configures **yum** and installs the Percona GPG key.

Supported Releases:

- *CentOS* 6 and *RHEL* 6 (Current Stable)
- *CentOS* 7 and *RHEL* 7
- *Amazon Linux AMI* (works the same as *CentOS* 6)
- *Amazon Linux 2*

Note: *Current Stable*: We support only the current stable RHEL6/CentOS6 release, because there is no official (i.e. RedHat provided) method to support or download the latest OpenSSL on RHEL/CentOS versions prior to 6.5. Similarly, and also as a result thereof, there is no official Percona way to support the latest Percona XtraBackup builds on RHEL/CentOS versions prior to 6.5. Additionally, many users will need to upgrade to OpenSSL 1.0.1g or later (due to the Heartbleed vulnerability), and this OpenSSL version is not available for download from any official RHEL/CentOS repository for versions 6.4 and prior. For any officially unsupported system, src.rpm packages may be used to rebuild *Percona XtraBackup* for any environment. Please contact our support service if you require further information on this.

The *CentOS* repositories should work well with *Red Hat Enterprise Linux* too, provided that **yum** is installed on the server.

Supported architectures:

- x86_64 (also known as `amd64`)

What's in each RPM package?

The `percona-xtrabackup-80` package contains the latest *Percona XtraBackup* GA binaries and associated files.

Package	Contains
`percona-xtrabackup-80-debuginfo`	The debug symbols for binaries in `percona-xtrabackup-80`
`percona-xtrabackup-test-80`	The test suite for *Percona XtraBackup*
`percona-xtrabackup`	The older version of the *Percona XtraBackup*

Installing *Percona XtraBackup* from Percona `yum` repository

1. Install the Percona yum repository by running the following command as the `root` user or with **sudo**: `yum install https://repo.percona.com/yum/percona-release-latest.noarch.rpm`

Enable the repository: `percona-release enable-only tools release`

If *Percona XtraBackup* is intented to be used in combination with the upstream MySQL Server, you only need to enable the `tools` repository: `percona-release enable-only tools`.

1. Install *Percona XtraBackup* by running: `yum install percona-xtrabackup-80`

Warning: Make sure that you have the `libev` package installed before installing *Percona XtraBackup* on CentOS 6. For this operating system, the `libev` package is available from the EPEL repositories.

Installing *Percona XtraBackup* using downloaded rpm packages

Download the packages of the desired series for your architecture from the download page. The following example downloads *Percona XtraBackup* 8.0.4 release package for *CentOS* 7:

```
$ wget https://www.percona.com/downloads/XtraBackup/Percona-XtraBackup-8.0.4/binary/
↪redhat/7/x86_64/percona-xtrabackup-80-8.0.4-1.el7.x86_64.rpm
```

Now you can install *Percona XtraBackup* by running `yum localinstall`:

```
$ yum localinstall percona-xtrabackup-80-8.0.4-1.el7.x86_64.rpm
```

Note: When installing packages manually like this, you'll need to make sure to resolve all the dependencies and install missing packages yourself.

Uninstalling *Percona XtraBackup*

To completely uninstall *Percona XtraBackup* you'll need to remove all the installed packages: `yum remove percona-xtrabackup`

Note: For experimental migrations from earlier database server versions, you will need to backup and restore using XtraBackup 2.4 and then use `mysql_upgrade` from MySQL 8.0.x

See also:

About the support of MySQL and Percona Server versions in *Percona XtraBackup* 2.4 and 8.0 *About Percona XtraBackup*

Compiling and Installing from Source Code

Percona XtraBackup is open source and the code is available on Github. Following guide describes the compiling and installation process from source code.

Compiling and Installing from Source Code

The source code is available from the *Percona XtraBackup Github* project. The easiest way to get the code is with **`git clone`** and switch to the desired release branch, such as the following:

```
$ git clone https://github.com/percona/percona-xtrabackup.git
$ cd percona-xtrabackup
$ git checkout 8.0
```

You should then have a directory named after the release you branched, such as `percona-xtrabackup`.

Compiling on Linux

Prerequisites

The following packages and tools must be installed to compile *Percona XtraBackup* from source. These might vary from system to system.

In Debian-based distributions, you need to:

```
$ apt install build-essential flex bison automake autoconf \
libtool cmake libaio-dev mysql-client libncurses-dev zlib1g-dev \
libgcrypt11-dev libev-dev libcurl4-gnutls-dev vim-common
```

Percona XtraBackup requires GCC version 5.3 or higher. If the version of GCC installed on your system is lower then you may need to install and enable the Developer Toolset 7 on `RPM`-based distributions to make sure that you use the latest GCC compiler and development tools. Then, install `cmake` and other dependencies:

```
$ yum install cmake openssl-devel libaio libaio-devel automake autoconf \
bison libtool ncurses-devel libgcrypt-devel libev-devel libcurl-devel zlib-devel \
vim-common
```

Important: In order to build *Percona XtraBackup* v8.0 from source, you need to use *cmake* version 3. In your distribution it may be available either as a separate package `cmake3` or as `cmake`. To check, run `cmake --version` and if it does report a version 3, install `cmake3` for your system.

Compiling with CMake

At the base directory of the source code tree, run *cmake* or *cmake3*. In both cases the options you need to use are the same. The following example demonstrates the usage of `cmake`. If you have `cmake3`, replace `cmake` with `cmake3` accordingly.

```
$ cmake -DWITH_BOOST=PATH-TO-BOOST-LIBRARY -DDOWNLOAD_BOOST=ON \
-DBUILD_CONFIG=xtrabackup_release -DWITH_MAN_PAGES=OFF -B TARGETDIR
```

For the `-DWITH_BOOST` parameter, specify a directory in your file system to download the boost library to. The `-B` parameter refers to an existing empty directory in which the source code should be built.

Before running the `make` command, change the working directory to the directory that you used as the value of the `-B` parameter `cmake3`.

```
$ cd TARGETDIR
$ make
```

After the `make` completes, *Percona XtraBackup* 8.0 will be ready for further installation with `make install`.

Note: You can build *Percona XtraBackup* with man pages but this requires `python-sphinx` package which isn't available from that main repositories for every distribution. If you installed the `python-sphinx` package you need to remove the `-DWITH_MAN_PAGES=OFF` from previous command.

Installation

The following command will install all *Percona XtraBackup* binaries, **`xtrabackup`** and tests to `/usr/local/xtrabackup`.

```
  $ make install

You can override this default by using the `DESTDIR` parameter.
```

```
$ make DESTDIR=... install
```

Alternatively, you can change the installation layout:

```
$ cmake -DINSTALL_LAYOUT=...
```

Part III

Prerequisites

CHAPTER

FOUR

CONNECTION AND PRIVILEGES NEEDED

Percona XtraBackup needs to be able to connect to the database server and perform operations on the server and the *datadir* when creating a backup, when preparing in some scenarios and when restoring it. In order to do so, there are privileges and permission requirements on its execution that must be fulfilled.

Privileges refers to the operations that a system user is permitted to do in the database server. **They are set at the database server and only apply to users in the database server**.

Permissions are those which permits a user to perform operations on the system, like reading, writing or executing on a certain directory or start/stop a system service. **They are set at a system level and only apply to system users**.

When **`xtrabackup`** is used, there are two actors involved: the user invoking the program - *a system user* - and the user performing action in the database server - *a database user*. Note that these are different users in different places, even though they may have the same username.

All the invocations of **`xtrabackup`** in this documentation assume that the system user has the appropriate permissions and you are providing the relevant options for connecting the database server - besides the options for the action to be performed - and the database user has adequate privileges.

Connecting to the server

The database user used to connect to the server and its password are specified by the *`--user`* and *`--password`* option:

```
$ xtrabackup --user=DVADER --password=14MY0URF4TH3R --backup \
--target-dir=/data/bkps/
```

If you don't use the *`--user`* option, *Percona XtraBackup* will assume the database user whose name is the system user executing it.

Other Connection Options

According to your system, you may need to specify one or more of the following options to connect to the server:

Option	Description
–port	The port to use when connecting to the database server with TCP/IP.
–socket	The socket to use when connecting to the local database.
–host	The host to use when connecting to the database server with TCP/IP.

These options are passed to the **`mysql`** child process without alteration, see `mysql --help` for details.

Note: In case of multiple server instances, the correct connection parameters (port, socket, host) must be specified in order for **xtrabackup** to talk to the correct server.

Permissions and Privileges Needed

Once connected to the server, in order to perform a backup you will need `READ` and `EXECUTE` permissions at a filesystem level in the server's *datadir*.

The database user needs the following privileges on the tables/databases to be backed up:

- `RELOAD` and `LOCK TABLES` (unless the *--no-lock* option is specified) in order to run `FLUSH TABLES WITH READ LOCK` and `FLUSH ENGINE LOGS` prior to start copying the files, and requires this privilege when Backup Locks are used
- `BACKUP_ADMIN` privilege is needed to query the performance_schema.log_status table, and run `LOCK INSTANCE FOR BACKUP`, `LOCK BINLOG FOR BACKUP`, or `LOCK TABLES FOR BACKUP`.
- `REPLICATION CLIENT` in order to obtain the binary log position,
- `CREATE TABLESPACE` in order to import tables (see *Restoring Individual Tables*),
- `PROCESS` in order to run `SHOW ENGINE INNODB STATUS` (which is mandatory), and optionally to see all threads which are running on the server (see *Handling FLUSH TABLES WITH READ LOCK*),
- `SUPER` in order to start/stop the slave threads in a replication environment, use XtraDB Changed Page Tracking for *Incremental Backups* and for *handling FLUSH TABLES WITH READ LOCK*,
- `CREATE` privilege in order to create the *PERCONA_SCHEMA.xtrabackup_history* database and table,
- `INSERT` privilege in order to add history records to the *PERCONA_SCHEMA.xtrabackup_history* table,
- `SELECT` privilege in order to use *--incremental-history-name* or *--incremental-history-uuid* in order for the feature to look up the `innodb_to_lsn` values in the *PERCONA_SCHEMA.xtrabackup_history* table.

The explanation of when these are used can be found in *How Percona XtraBackup Works*.

An SQL example of creating a database user with the minimum privileges required to full backups would be:

```
mysql> CREATE USER 'bkpuser'@'localhost' IDENTIFIED BY 's3cr%T';
mysql> GRANT BACKUP_ADMIN, PROCESS, RELOAD, LOCK TABLES, REPLICATION CLIENT ON *.* TO
↪'bkpuser'@'localhost';
mysql> GRANT SELECT ON performance_schema.log_status TO 'bkpuser'@'localhost';
mysql> FLUSH PRIVILEGES;
```

CHAPTER

FIVE

CONFIGURING XTRABACKUP

All of the **xtrabackup** configuration is done through options, which behave exactly like standard *MySQL* program options: they can be specified either at the command-line, or through a file such as `/etc/my.cnf`.

The **xtrabackup** binary reads the `[mysqld]` and `[xtrabackup]` sections from any configuration files, in that order. That is so that it can read its options from your existing *MySQL* installation, such as the *datadir* or some of the *InnoDB* options. If you want to override these, just specify them in the `[xtrabackup]` section, and because it is read later, it will take precedence.

You don't need to put any configuration in your `my.cnf` if you don't want to. You can simply specify the options on the command-line. Normally, the only thing you might find convenient to place in the `[xtrabackup]` section of your `my.cnf` file is the `target_dir` option to default the directory in which the backups will be placed, for example:

```
[xtrabackup]
target_dir = /data/backups/mysql/
```

This manual will assume that you do not have any file-based configuration for **xtrabackup**, so it will always show command-line options being used explicitly. Please see the *option and variable reference* for details on all of the configuration options.

The **xtrabackup** binary does not accept exactly the same syntax in the `my.cnf` file as the **mysqld** server binary does. For historical reasons, the **mysqld** server binary accepts parameters with a `--set-variable=<variable>=<value>` syntax, which **xtrabackup** does not understand. If your `my.cnf` file has such configuration directives, you should rewrite them in the `--variable=value` syntax.

System Configuration and NFS Volumes

The **xtrabackup** tool requires no special configuration on most systems. However, the storage where the *`--target-dir`* is located must behave properly when `fsync()` is called. In particular, we have noticed that NFS volumes not mounted with the `sync` option might not really sync the data. As a result, if you back up to an NFS volume mounted with the async option, and then try to prepare the backup from a different server that also mounts that volume, the data might appear to be corrupt. You can use the `sync` mount option to avoid this problem.

Part IV

Backup Scenarios

CHAPTER

SIX

THE BACKUP CYCLE - FULL BACKUPS

Creating a backup

To create a backup, run **xtrabackup** with the *--backup* option. You also need to specify the *--target-dir* option, which is where the backup will be stored, if the *InnoDB* data or log files are not stored in the same directory, you might need to specify the location of those, too. If the target directory does not exist, **xtrabackup** creates it. If the directory does exist and is empty, **xtrabackup** will succeed.

xtrabackup will not overwrite existing files, it will fail with operating system error 17, `file exists`.

To start the backup process run:

```
$ xtrabackup --backup --target-dir=/data/backups/
```

This will store the backup at `/data/backups/`. If you specify a relative path, the target directory will be relative to the current directory.

During the backup process, you should see a lot of output showing the data files being copied, as well as the log file thread repeatedly scanning the log files and copying from it. Here is an example that shows the log thread scanning the log in the background, and a file copying thread working on the `ibdata1` file:

```
160906 10:19:17 Finished backing up non-InnoDB tables and files
160906 10:19:17 Executing FLUSH NO_WRITE_TO_BINLOG ENGINE LOGS...
xtrabackup: The latest check point (for incremental): '62988944'
xtrabackup: Stopping log copying thread.
.160906 10:19:18 >> log scanned up to (137343534)
160906 10:19:18 Executing UNLOCK TABLES
160906 10:19:18 All tables unlocked
160906 10:19:18 Backup created in directory '/data/backups/'
160906 10:19:18 [00] Writing backup-my.cnf
160906 10:19:18 [00]        ...done
160906 10:19:18 [00] Writing xtrabackup_info
160906 10:19:18 [00]        ...done
xtrabackup: Transaction log of lsn (26970807) to (137343534) was copied.
160906 10:19:18 completed OK!
```

The last thing you should see is something like the following, where the value of the `<LSN>` will be a number that depends on your system:

```
$ xtrabackup: Transaction log of lsn (<SLN>) to (<LSN>) was copied.
```

Note: Log copying thread checks the transactional log every second to see if there were any new log records written that need to be copied, but there is a chance that the log copying thread might not be able to keep up with the amount of writes that go to the transactional logs, and will hit an error when the log records are overwritten before they could be read.

After the backup is finished, the target directory will contain files such as the following, assuming you have a single InnoDB table `test.tbl1` and you are using MySQL's *innodb_file_per_table* option:

```
$ ls -lh /data/backups/
total 182M
drwx------  7 root root 4.0K Sep  6 10:19 .
drwxrwxrwt 11 root root 4.0K Sep  6 11:05 ..
-rw-r-----  1 root root  387 Sep  6 10:19 backup-my.cnf
-rw-r-----  1 root root  76M Sep  6 10:19 ibdata1
drwx------  2 root root 4.0K Sep  6 10:19 mysql
drwx------  2 root root 4.0K Sep  6 10:19 performance_schema
drwx------  2 root root 4.0K Sep  6 10:19 sbtest
drwx------  2 root root 4.0K Sep  6 10:19 test
drwx------  2 root root 4.0K Sep  6 10:19 world2
-rw-r-----  1 root root  116 Sep  6 10:19 xtrabackup_checkpoints
-rw-r-----  1 root root  433 Sep  6 10:19 xtrabackup_info
-rw-r-----  1 root root 106M Sep  6 10:19 xtrabackup_logfile
```

The backup can take a long time, depending on how large the database is. It is safe to cancel at any time, because **`xtrabackup`** does not modify the database.

The next step is getting your backup ready to be restored.

Preparing a backup

After making a backup with the `--backup` option, you need need to prepare it in order to restore it. Data files are not point-in-time consistent until they are *prepared*, because they were copied at different times as the program ran, and they might have been changed while this was happening.

If you try to start InnoDB with these data files, it will detect corruption and stop working to avoid running on damaged data. The `--prepare` step makes the files perfectly consistent at a single instant in time, so you can run *InnoDB* on them.

You can run the *prepare* operation on any machine; it does not need to be on the originating server or the server to which you intend to restore. You can copy the backup to a utility server and prepare it there.

Note that *Percona XtraBackup* 8.0 can only prepare backups of *MySQL* 8.0, *Percona Server for MySQL* 8.0, and *Percona XtraDB Cluster* 8.0 databases. Releases prior to 8.0 are not supported.

During the *prepare* operation, **`xtrabackup`** boots up a kind of modified embedded InnoDB (the libraries **`xtrabackup`** was linked against). The modifications are necessary to disable InnoDB standard safety checks, such as complaining about the log file not being the right size. This warning is not appropriate for working with backups. These modifications are only for the xtrabackup binary; you do not need a modified *InnoDB* to use **`xtrabackup`** for your backups.

The *prepare* step uses this "embedded InnoDB" to perform crash recovery on the copied data files, using the copied log file. The `prepare` step is very simple to use: you simply run **`xtrabackup`** with the `--prepare` option and tell it which directory to prepare, for example, to prepare the previously taken backup run:

```
$ xtrabackup --prepare --target-dir=/data/backups/
```

When this finishes, you should see an `InnoDB shutdown` with a message such as the following, where again the value of *LSN* will depend on your system:

```
InnoDB: Shutdown completed; log sequence number 137345046
160906 11:21:01 completed OK!
```

All following prepares will not change the already prepared data files, you'll see that output says:

```
xtrabackup: This target seems to be already prepared.
xtrabackup: notice: xtrabackup_logfile was already used to '--prepare'.
```

It is not recommended to interrupt xtrabackup process while preparing backup because it may cause data files corruption and backup will become unusable. Backup validity is not guaranteed if prepare process was interrupted.

Note: If you intend the backup to be the basis for further incremental backups, you should use the *--apply-log-only* option when preparing the backup, or you will not be able to apply incremental backups to it. See the documentation on preparing *incremental backups* for more details.

Restoring a Backup

Warning: Backup needs to be *prepared* before it can be restored.

For convenience, **xtrabackup** binary has the *--copy-back* option to copy the backup to the *datadir* of the server:

```
$ xtrabackup --copy-back --target-dir=/data/backups/
```

If you don't want to save your backup, you can use the *--move-back* option which will move the backed up data to the *datadir*.

If you don't want to use any of the above options, you can additionally use **rsync** or **cp** to restore the files.

Note: The *datadir* must be empty before restoring the backup. Also it's important to note that MySQL server needs to be shut down before restore is performed. You cannot restore to a *datadir* of a running mysqld instance (except when importing a partial backup).

Example of the **rsync** command that can be used to restore the backup can look like this:

```
$ rsync -avrP /data/backup/ /var/lib/mysql/
```

You should check that the restored files have the correct ownership and permissions.

As files' attributes will be preserved, in most cases you will need to change the files' ownership to `mysql` before starting the database server, as they will be owned by the user who created the backup:

```
$ chown -R mysql:mysql /var/lib/mysql
```

Data is now restored and you can start the server.

CHAPTER

SEVEN

INCREMENTAL BACKUP

xtrabackup supports incremental backups, which means that they can copy only the data that has changed since the last backup.

You can perform many incremental backups between each full backup, so you can set up a backup process such as a full backup once a week and an incremental backup every day, or full backups every day and incremental backups every hour.

Incremental backups work because each *InnoDB* page contains a log sequence number, or *LSN*. The *LSN* is the system version number for the entire database. Each page's *LSN* shows how recently it was changed.

An incremental backup copies each page whose *LSN* is newer than the previous incremental or full backup's *LSN*. There are two algorithms in use to find the set of such pages to be copied. The first one, available with all the server types and versions, is to check the page *LSN* directly by reading all the data pages. The second one, available with *Percona Server for MySQL*, is to enable the changed page tracking feature on the server, which will note the pages as they are being changed. This information will be then written out in a compact separate so-called bitmap file. The **xtrabackup** binary will use that file to read only the data pages it needs for the incremental backup, potentially saving many read requests. The latter algorithm is enabled by default if the **xtrabackup** binary finds the bitmap file. It is possible to specify `--incremental-force-scan` to read all the pages even if the bitmap data is available.

Incremental backups do not actually compare the data files to the previous backup's data files. In fact, you can use `--incremental-lsn` to perform an incremental backup without even having the previous backup, if you know its *LSN*. Incremental backups simply read the pages and compare their *LSN* to the last backup's *LSN*. You still need a full backup to recover the incremental changes, however; without a full backup to act as a base, the incremental backups are useless.

Creating an Incremental Backup

To make an incremental backup, begin with a full backup as usual. The **xtrabackup** binary writes a file called `xtrabackup_checkpoints` into the backup's target directory. This file contains a line showing the `to_lsn`, which is the database's *LSN* at the end of the backup. *Create the full backup* with a following command:

```
$ xtrabackup --backup --target-dir=/data/backups/base
```

If you look at the `xtrabackup_checkpoints` file, you should see similar content depending on your LSN nuber:

```
backup_type = full-backuped
from_lsn = 0
to_lsn = 1626007
last_lsn = 1626007
compact = 0
recover_binlog_info = 1
```

Now that you have a full backup, you can make an incremental backup based on it. Use the following command:

```
$ xtrabackup --backup --target-dir=/data/backups/inc1 \
--incremental-basedir=/data/backups/base
```

The `/data/backups/inc1/` directory should now contain delta files, such as `ibdata1.delta` and `test/table1.ibd.delta`. These represent the changes since the `LSN 1626007`. If you examine the `xtrabackup_checkpoints` file in this directory, you should see similar content to the following:

```
backup_type = incremental
from_lsn = 1626007
to_lsn = 4124244
last_lsn = 4124244
compact = 0
recover_binlog_info = 1
```

`from_lsn` is the starting LSN of the backup and for incremental it has to be the same as `to_lsn` (if it is the last checkpoint) of the previous/base backup.

It's now possible to use this directory as the base for yet another incremental backup:

```
$ xtrabackup --backup --target-dir=/data/backups/inc2 \
--incremental-basedir=/data/backups/inc1
```

This folder also contains the `xtrabackup_checkpoints`:

```
backup_type = incremental
from_lsn = 4124244
to_lsn = 6938371
last_lsn = 7110572
compact = 0
recover_binlog_info = 1
```

Note: In this case you can see that there is a difference between the `to_lsn` (last checkpoint LSN) and `last_lsn` (last copied LSN), this means that there was some traffic on the server during the backup process.

Preparing the Incremental Backups

The *`--prepare`* step for incremental backups is not the same as for full backups. In full backups, two types of operations are performed to make the database consistent: committed transactions are replayed from the log file against the data files, and uncommitted transactions are rolled back. You must skip the rollback of uncommitted transactions when preparing an incremental backup, because transactions that were uncommitted at the time of your backup may be in progress, and it's likely that they will be committed in the next incremental backup. You should use the *`--apply-log-only`* option to prevent the rollback phase.

Warning: If you do not use the *`--apply-log-only`* option to prevent the rollback phase, then your incremental backups will be useless. After transactions have been rolled back, further incremental backups cannot be applied.

Beginning with the full backup you created, you can prepare it, and then apply the incremental differences to it. Recall that you have the following backups:

```
/data/backups/base
/data/backups/inc1
/data/backups/inc2
```

To prepare the base backup, you need to run `--prepare` as usual, but prevent the rollback phase:

```
$ xtrabackup --prepare --apply-log-only --target-dir=/data/backups/base
```

The output should end with text similar to the following:

```
InnoDB: Shutdown completed; log sequence number 1626007
161011 12:41:04 completed OK!
```

The log sequence number should match the `to_lsn` of the base backup, which you saw previously.

Note: This backup is actually safe to *restore* as-is now, even though the rollback phase has been skipped. If you restore it and start *MySQL*, *InnoDB* will detect that the rollback phase was not performed, and it will do that in the background, as it usually does for a crash recovery upon start. It will notify you that the database was not shut down normally.

To apply the first incremental backup to the full backup, run the following command:

```
$ xtrabackup --prepare --apply-log-only --target-dir=/data/backups/base \
--incremental-dir=/data/backups/inc1
```

This applies the delta files to the files in `/data/backups/base`, which rolls them forward in time to the time of the incremental backup. It then applies the redo log as usual to the result. The final data is in `/data/backups/base`, not in the incremental directory. You should see an output similar to:

```
incremental backup from 1626007 is enabled.
xtrabackup: cd to /data/backups/base
xtrabackup: This target seems to be already prepared with --apply-log-only.
xtrabackup: xtrabackup_logfile detected: size=2097152, start_lsn=(4124244)
...
xtrabackup: page size for /tmp/backups/inc1/ibdata1.delta is 16384 bytes
Applying /tmp/backups/inc1/ibdata1.delta to ./ibdata1...
...
161011 12:45:56 completed OK!
```

Again, the *LSN* should match what you saw from your earlier inspection of the first incremental backup. If you restore the files from `/data/backups/base`, you should see the state of the database as of the first incremental backup.

Warning: *Percona XtraBackup* does not support using the same incremental backup directory to prepare two copies of backup. Do not run `--prepare` with the same incremental backup directory (the value of *–incremental-dir*) more than once.

Preparing the second incremental backup is a similar process: apply the deltas to the (modified) base backup, and you will roll its data forward in time to the point of the second incremental backup:

```
$ xtrabackup --prepare --target-dir=/data/backups/base \
--incremental-dir=/data/backups/inc2
```

Note: `--apply-log-only` should be used when merging all incrementals except the last one. That's why the previous line doesn't contain the `--apply-log-only` option. Even if the `--apply-log-only` was used on the last step, backup would still be consistent but in that case server would perform the rollback phase.

Once prepared incremental backups are the same as the *full backups* and they can be *restored* in the same way.

CHAPTER

EIGHT

COMPRESSED BACKUP

Percona XtraBackup has implemented support for compressed backups. It can be used to compress/decompress local or streaming backup with *xbstream*.

Creating Compressed Backups

In order to make a compressed backup you'll need to use `--compress` option:

```
$ xtrabackup --backup --compress --target-dir=/data/compressed/
```

If you want to speed up the compression you can use the parallel compression, which can be enabled with `--compress-threads` option. Following example will use four threads for compression:

```
$ xtrabackup --backup --compress --compress-threads=4 \
--target-dir=/data/compressed/
```

Output should look like this

```
...
170223 13:00:38 [01] Compressing ./test/sbtest1.frm to /tmp/compressed/test/sbtest1.
↪frm.qp
170223 13:00:38 [01]        ...done
170223 13:00:38 [01] Compressing ./test/sbtest2.frm to /tmp/compressed/test/sbtest2.
↪frm.qp
170223 13:00:38 [01]        ...done
...
170223 13:00:39 [00] Compressing xtrabackup_info
170223 13:00:39 [00]        ...done
xtrabackup: Transaction log of lsn (9291934) to (9291934) was copied.
170223 13:00:39 completed OK!
```

Preparing the backup

Before you can prepare the backup you'll need to uncompress all the files. *Percona XtraBackup* has implemented `--decompress` option that can be used to decompress the backup.

Note: Before proceeding make sure that qpress is installed. It's available from *Percona Software repositories*

```
$ xtrabackup --decompress --target-dir=/data/compressed/
```

Note: *--parallel* can be used with *--decompress* option to decompress multiple files simultaneously.

Percona XtraBackup doesn't automatically remove the compressed files. In order to clean up the backup directory you should use *--remove-original* option. Even if they're not removed these files will not be copied/moved over to the datadir if *--copy-back* or *--move-back* are used.

When the files are uncompressed you can prepare the backup with the *--prepare* option:

```
$ xtrabackup --prepare --target-dir=/data/compressed/
```

You should check for a confirmation message:

```
InnoDB: Starting shutdown...
InnoDB: Shutdown completed; log sequence number 9293846
170223 13:39:31 completed OK!
```

Now the files in `/data/compressed/` are ready to be used by the server.

Restoring the backup

xtrabackup has a *--copy-back* option, which performs the restoration of a backup to the server's *datadir*:

```
$ xtrabackup --copy-back --target-dir=/data/backups/
```

It will copy all the data-related files back to the server's *datadir*, determined by the server's `my.cnf` configuration file. You should check the last line of the output for a success message:

```
170223 13:49:13 completed OK!
```

You should check the file permissions after copying the data back. You may need to adjust them with something like:

```
$ chown -R mysql:mysql /var/lib/mysql
```

Now that the *datadir* contains the restored data. You are ready to start the server.

Part V

User's Manual

CHAPTER

NINE

PERCONA XTRABACKUP USER MANUAL

The xtrabackup Binary

The **xtrabackup** binary is a compiled C program that is linked with the *InnoDB* libraries and the standard *MySQL* client libraries.

xtrabackup enables point-in-time backups of *InnoDB* / *XtraDB* tables together with the schema definitions, *MyISAM* tables, and other portions of the server.

The *InnoDB* libraries provide the functionality to apply a log to data files. The *MySQL* client libraries are used to parse command-line options and configuration file.

The tool runs in either `--backup` or `--prepare` mode, corresponding to the two main functions it performs. There are several variations on these functions to accomplish different tasks, and there are two less commonly used modes, `--stats` and `--print-param`.

Other Types of Backups

Incremental Backups

xtrabackup supports incremental backups. It copies only the data that has changed since the last full backup. You can perform many incremental backups between each full backup, so you can set up a backup process such as a full backup once a week and an incremental backup every day, or full backups every day and incremental backups every hour.

Incremental backups work because each InnoDB page (usually 16kb in size) contains a log sequence number, or *LSN*. The *LSN* is the system version number for the entire database. Each page's *LSN* shows how recently it was changed. An incremental backup copies each page whose *LSN* is newer than the previous incremental or full backup's *LSN*. There are two algorithms in use to find the set of such pages to be copied. The first one, available with all the server types and versions, is to check the page *LSN* directly by reading all the data pages. The second one, available with *Percona Server for MySQL*, is to enable the changed page tracking feature on the server, which will note the pages as they are being changed. This information will be then written out in a compact separate so-called bitmap file. The **xtrabackup** binary will use that file to read only the data pages it needs for the incremental backup, potentially saving many read requests. The latter algorithm is enabled by default if the **xtrabackup** binary finds the bitmap file. It is possible to specify `--incremental-force-scan` to read all the pages even if the bitmap data is available.

Incremental backups do not actually compare the data files to the previous backup's data files. In fact, you can use `--incremental-lsn` to perform an incremental backup without even having the previous backup, if you know its *LSN*. Incremental backups simply read the pages and compare their *LSN* to the last backup's *LSN*. You still need a full backup to recover the incremental changes, however; without a full backup to act as a base, the incremental backups are useless.

Creating an Incremental Backup

To make an incremental backup, begin with a full backup as usual. The **xtrabackup** binary writes a file called `xtrabackup_checkpoints` into the backup's target directory. This file contains a line showing the `to_lsn`, which is the database's *LSN* at the end of the backup. *Create the full backup* with a command such as the following:

```
$ xtrabackup --backup --target-dir=/data/backups/base --datadir=/var/lib/mysql/
```

If you look at the `xtrabackup_checkpoints` file, you should see contents similar to the following:

```
backup_type = full-backuped
from_lsn = 0
to_lsn = 1291135
```

Now that you have a full backup, you can make an incremental backup based on it. Use a command such as the following:

```
$ xtrabackup --backup --target-dir=/data/backups/inc1 \
--incremental-basedir=/data/backups/base --datadir=/var/lib/mysql/
```

The `/data/backups/inc1/` directory should now contain delta files, such as `ibdata1.delta` and `test/table1.ibd.delta`. These represent the changes since the `LSN 1291135`. If you examine the `xtrabackup_checkpoints` file in this directory, you should see something similar to the following:

```
backup_type = incremental
from_lsn = 1291135
to_lsn = 1291340
```

The meaning should be self-evident. It's now possible to use this directory as the base for yet another incremental backup:

```
$ xtrabackup --backup --target-dir=/data/backups/inc2 \
--incremental-basedir=/data/backups/inc1 --datadir=/var/lib/mysql/
```

Preparing the Incremental Backups

The *`--prepare`* step for incremental backups is not the same as for normal backups. In normal backups, two types of operations are performed to make the database consistent: committed transactions are replayed from the log file against the data files, and uncommitted transactions are rolled back. You must skip the rollback of uncommitted transactions when preparing a backup, because transactions that were uncommitted at the time of your backup may be in progress, and it is likely that they will be committed in the next incremental backup. You should use the *`--apply-log-only`* option to prevent the rollback phase.

Note: If you do not use the *`--apply-log-only`* option to prevent the rollback phase, then your incremental backups will be useless. After transactions have been rolled back, further incremental backups cannot be applied.

Beginning with the full backup you created, you can prepare it, and then apply the incremental differences to it. Recall that you have the following backups:

```
/data/backups/base
/data/backups/inc1
/data/backups/inc2
```

To prepare the base backup, you need to run *--prepare* as usual, but prevent the rollback phase:

```
xtrabackup --prepare --apply-log-only --target-dir=/data/backups/base
```

The output should end with some text such as the following:

```
101107 20:49:43  InnoDB: Shutdown completed; log sequence number 1291135
```

The log sequence number should match the `to_lsn` of the base backup, which you saw previously.

This backup is actually safe to *restore* as-is now, even though the rollback phase has been skipped. If you restore it and start *MySQL*, *InnoDB* will detect that the rollback phase was not performed, and it will do that in the background, as it usually does for a crash recovery upon start. It will notify you that the database was not shut down normally.

To apply the first incremental backup to the full backup, you should use the following command:

```
xtrabackup --prepare --apply-log-only --target-dir=/data/backups/base \
--incremental-dir=/data/backups/inc1
```

This applies the delta files to the files in `/data/backups/base`, which rolls them forward in time to the time of the incremental backup. It then applies the redo log as usual to the result. The final data is in `/data/backups/base`, not in the incremental directory. You should see some output such as the following:

```
incremental backup from 1291135 is enabled.
xtrabackup: cd to /data/backups/base/
xtrabackup: This target seems to be already prepared.
xtrabackup: xtrabackup_logfile detected: size=2097152, start_lsn=(1291340)
Applying /data/backups/inc1/ibdata1.delta ...
Applying /data/backups/inc1/test/table1.ibd.delta ...
.... snip
101107 20:56:30  InnoDB: Shutdown completed; log sequence number 1291340
```

Again, the *LSN* should match what you saw from your earlier inspection of the first incremental backup. If you restore the files from `/data/backups/base`, you should see the state of the database as of the first incremental backup.

Preparing the second incremental backup is a similar process: apply the deltas to the (modified) base backup, and you will roll its data forward in time to the point of the second incremental backup:

```
xtrabackup --prepare --target-dir=/data/backups/base \
--incremental-dir=/data/backups/inc2
```

Note: *--apply-log-only* should be used when merging all incrementals except the last one. That's why the previous line doesn't contain the *--apply-log-only* option. Even if the *--apply-log-only* was used on the last step, backup would still be consistent but in that case server would perform the rollback phase.

If you wish to avoid the notice that *InnoDB* was not shut down normally, when you applied the desired deltas to the base backup, you can run *--prepare* again without disabling the rollback phase.

Restoring Incremental Backups

After preparing the incremental backups, the base directory contains the same data as the full backup. To restoring this backup, you can use this command: `xtrabackup --copy-back --target-dir=BASE-DIR`

You may have to change the ownership as detailed on *Restoring a Backup*.

Incremental Streaming Backups Using xbstream

Incremental streaming backups can be performed with the *xbstream* streaming option. Currently backups are packed in custom **xbstream** format. With this feature, you need to take a BASE backup as well.

Making a base backup

```
$ xtrabackup --backup --target-dir=/data/backups
```

Taking a local backup

```
$ xtrabackup --backup --incremental-lsn=LSN-number --stream=xbstream --target-dir=./ >
↪ incremental.xbstream
```

Unpacking the backup

```
$ xbstream -x < incremental.xbstream
```

Taking a local backup and streaming it to the remote server and unpacking it

```
$ xtrabackup --backup --incremental-lsn=LSN-number --stream=xbstream --target-dir=./
$ ssh user@hostname " cat - | xbstream -x -C > /backup-dir/"
```

Partial Backups

xtrabackup supports taking partial backups when the *innodb_file_per_table* option is enabled. There are three ways to create partial backups:

1. matching the tables names with a regular expression
2. providing a list of table names in a file
3. providing a list of databases

Important: There is only one caveat about partial backups: do not copy back the prepared backup. Restoring partial backups should be done by importing the tables, not by using the *--copy-back* option. Although there are some scenarios where restoring can be done by copying back the files, this may be lead to database inconsistencies in many cases and it is not the recommended way to do it.

For the purposes of this manual page, we will assume that there is a database named `test` which contains tables named `t1` and `t2`.

Warning: If any of the matched or listed tables is deleted during the backup, **xtrabackup** will fail.

Creating Partial Backups

There are two ways of specifying which part of the whole data will be backed up: enumerating the tables in a file (*--tables-file*) or providing a list of databases (*--databases*).

The --tables Option

The first method involves the xtrabackup --tables option. The option's value is a regular expression that is matched against the fully qualified tablename, including the database name, in the form databasename.tablename.

To back up only tables in the test database, you can use the following command:

```
$ xtrabackup --backup --datadir=/var/lib/mysql --target-dir=/data/backups/ \
--tables="^test[.].*"
```

To back up only the table test.t1, you can use the following command:

```
$ xtrabackup --backup --datadir=/var/lib/mysql --target-dir=/data/backups/ \
--tables="^test[.]t1"
```

The --tables-file Option

The --tables-file option specifies a file that can contain multiple table names, one table name per line in the file. Only the tables named in the file will be backed up. Names are matched exactly, case-sensitive, with no pattern or regular expression matching. The table names must be fully qualified, in databasename.tablename format.

```
$ echo "mydatabase.mytable" > /tmp/tables.txt
$ xtrabackup --backup --tables-file=/tmp/tables.txt
```

The --databases and --databases-file options

xtrabackup --databases accepts a space-separated list of the databases and tables to backup in the format databasename[.tablename]. In addition to this list make sure to specify the mysql, sys, and performance_schema databases. These databases are required when restoring the databases using xtrabackup --copy-back.

```
$ xtrabackup --databases='mysql sys performance_schema ...'
```

xtrabackup --databases-file specifies a file that can contain multiple databases and tables in the databasename[.tablename] form, one element name per line in the file. Only named databases and tables will be backed up. Names are matched exactly, case-sensitive, with no pattern or regular expression matching.

Preparing Partial Backups

The procedure is analogous to *restoring individual tables* : apply the logs and use the *--export* option:

```
$ xtrabackup --prepare --export --target-dir=/path/to/partial/backup
```

When you use the `xtrabackup --prepare` option on a partial backup, you will see warnings about tables that don't exist. This is because these tables exist in the data dictionary inside InnoDB, but the corresponding *.ibd* files don't exist. They were not copied into the backup directory. These tables will be removed from the data dictionary, and when you restore the backup and start InnoDB, they will no longer exist and will not cause any errors or warnings to be printed to the log file.

An example of the error message you will see during the prepare phase follows.

```
InnoDB: Reading tablespace information from the .ibd files...
101107 22:31:30  InnoDB: Error: table 'test1/t'
InnoDB: in InnoDB data dictionary has tablespace id 6,
InnoDB: but tablespace with that id or name does not exist. It will be removed from␣
↪data dictionary.
```

Restoring Partial Backups

Restoring should be done by *restoring individual tables* in the partial backup to the server.

It can also be done by copying back the prepared backup to a "clean" *datadir* (in that case, make sure to include the `mysql` database). System database can be created with:

```
$ sudo mysql_install_db --user=mysql
```

Advanced Features

Analyzing Table Statistics

The **`xtrabackup`** binary can analyze InnoDB data files in read-only mode to give statistics about them. To do this, you should use the *`--stats`* option. You can combine this with the *`--tables`* option to limit the files to examine. It also uses the *`--use-memory`* option.

You can perform the analysis on a running server, with some chance of errors due to the data being changed during analysis. Or, you can analyze a backup copy of the database. Either way, to use the statistics feature, you need a clean copy of the database including correctly sized log files, so you need to execute with *`--prepare`* twice to use this functionality on a backup.

The result of running on a backup might look like the following:

```
<INDEX STATISTICS>
  table: test/table1, index: PRIMARY, space id: 12, root page 3
  estimated statistics in dictionary:
    key vals: 25265338, leaf pages 497839, size pages 498304
  real statistics:
     level 2 pages: pages=1, data=5395 bytes, data/pages=32%
     level 1 pages: pages=415, data=6471907 bytes, data/pages=95%
        leaf pages: recs=25958413, pages=497839, data=7492026403 bytes, data/pages=91%
```

This can be interpreted as follows:

- The first line simply shows the table and index name and its internal identifiers. If you see an index named `GEN_CLUST_INDEX`, that is the table's clustered index, automatically created because you did not explicitly create a `PRIMARY KEY`.
- The estimated statistics in dictionary information is similar to the data that's gathered through `ANALYZE TABLE` inside of *InnoDB* to be stored as estimated cardinality statistics and passed to the query optimizer.

- The real statistics information is the result of scanning the data pages and computing exact information about the index.
- The `level <X> pages`: output means that the line shows information about pages at that level in the index tree. The larger `<X>` is, the farther it is from the leaf pages, which are level 0. The first line is the root page.
- The `leaf pages` output shows the leaf pages, of course. This is where the table's data is stored.
- The `external pages`: output (not shown) shows large external pages that hold values too long to fit in the row itself, such as long `BLOB` and `TEXT` values.
- The `recs` is the real number of records (rows) in leaf pages.
- The `pages` is the page count.
- The `data` is the total size of the data in the pages, in bytes.
- The `data/pages` is calculated as (`data` / (`pages` * `PAGE_SIZE`)) * 100%. It will never reach 100% because of space reserved for page headers and footers.

A more detailed example is posted as a MySQL Performance Blog post.

Script to Format Output

The following script can be used to summarize and tabulate the output of the statistics information:

```
tabulate-xtrabackup-stats.pl

#!/usr/bin/env perl
use strict;
use warnings FATAL => 'all';
my $script_version = "0.1";

my $PG_SIZE = 16_384; # InnoDB defaults to 16k pages, change if needed.
my ($cur_idx, $cur_tbl);
my (%idx_stats, %tbl_stats);
my ($max_tbl_len, $max_idx_len) = (0, 0);
while ( my $line = <> ) {
   if ( my ($t, $i) = $line =~ m/table: (.*), index: (.*), space id:/ ) {
      $t =~ s!/!.!;
      $cur_tbl = $t;
      $cur_idx = $i;
      if ( length($i) > $max_idx_len ) {
         $max_idx_len = length($i);
      }
      if ( length($t) > $max_tbl_len ) {
         $max_tbl_len = length($t);
      }
   }
   elsif ( my ($kv, $lp, $sp) = $line =~ m/key vals: (\d+), \D*(\d+), \D*(\d+)/ ) {
      @{$idx_stats{$cur_tbl}->{$cur_idx}}{qw(est_kv est_lp est_sp)} = ($kv, $lp, $sp);
      $tbl_stats{$cur_tbl}->{est_kv} += $kv;
      $tbl_stats{$cur_tbl}->{est_lp} += $lp;
      $tbl_stats{$cur_tbl}->{est_sp} += $sp;
   }
   elsif ( my ($l, $pages, $bytes) = $line =~ m/(?:level (\d+)|leaf) pages:.
↪*pages=(\d+), data=(\d+) bytes/ ) {
      $l ||= 0;
      $idx_stats{$cur_tbl}->{$cur_idx}->{real_pages} += $pages;
      $idx_stats{$cur_tbl}->{$cur_idx}->{real_bytes} += $bytes;
      $tbl_stats{$cur_tbl}->{real_pages} += $pages;
      $tbl_stats{$cur_tbl}->{real_bytes} += $bytes;
   }
}

my $hdr_fmt = "%${max_tbl_len}s %${max_idx_len}s %9s %10s %10s\n";
my @headers = qw(TABLE INDEX TOT_PAGES FREE_PAGES PCT_FULL);
printf $hdr_fmt, @headers;

my $row_fmt = "%${max_tbl_len}s %${max_idx_len}s %9d %10d %9.1f%%\n";
foreach my $t ( sort keys %tbl_stats ) {
   my $tbl = $tbl_stats{$t};
   printf $row_fmt, $t, "", $tbl->{est_sp}, $tbl->{est_sp} - $tbl->{real_pages},
      $tbl->{real_bytes} / ($tbl->{real_pages} * $PG_SIZE) * 100;
   foreach my $i ( sort keys %{$idx_stats{$t}} ) {
      my $idx = $idx_stats{$t}->{$i};
      printf $row_fmt, $t, $i, $idx->{est_sp}, $idx->{est_sp} - $idx->{real_pages},
         $idx->{real_bytes} / ($idx->{real_pages} * $PG_SIZE) * 100;
   }
}
```

Sample Script Output

The output of the above Perl script, when run against the sample shown in the previously mentioned blog post, will appear as follows:

```
          TABLE           INDEX TOT_PAGES FREE_PAGES   PCT_FULL
art.link_out104                    832383      38561      86.8%
art.link_out104         PRIMARY    498304         49      91.9%
art.link_out104       domain_id     49600       6230      76.9%
art.link_out104     domain_id_2     26495       3339      89.1%
art.link_out104 from_message_id     28160        142      96.3%
art.link_out104    from_site_id     38848       4874      79.4%
art.link_out104   revert_domain    153984      19276      71.4%
art.link_out104    site_message     36992       4651      83.4%
```

The columns are the table and index, followed by the total number of pages in that index, the number of pages not actually occupied by data, and the number of bytes of real data as a percentage of the total size of the pages of real data. The first line in the above output, in which the `INDEX` column is empty, is a summary of the entire table.

Working with Binary Logs

The `xtrabackup` binary integrates with information that *InnoDB* stores in its transaction log about the corresponding binary log position for committed transactions. This enables it to print out the binary log position to which a backup corresponds, so you can use it to set up new replication slaves or perform point-in-time recovery.

Finding the Binary Log Position

You can find the binary log position corresponding to a backup once the backup has been prepared. This can be done by either running the **xtrabackup** with the *--prepare* or *--apply-log-only* option. If your backup is from a server with binary logging enabled, **xtrabackup** will create a file named `xtrabackup_binlog_info` in the target directory. This file contains the binary log file name and position of the exact point in the binary log to which the prepared backup corresponds.

You will also see output similar to the following during the prepare stage:

```
InnoDB: Last MySQL binlog file position 0 3252710, file name ./mysql-bin.000001
... snip ...
[notice (again)]
  If you use binary log and don't use any hack of group commit,
  the binary log position seems to be:
InnoDB: Last MySQL binlog file position 0 3252710, file name ./mysql-bin.000001
```

This output can also be found in the `xtrabackup_binlog_pos_innodb` file, but **it is only correct** when no other than *XtraDB* or *InnoDB* are used as storage engines.

If other storage engines are used (i.e. *MyISAM*), you should use the `xtrabackup_binlog_info` file to retrieve the position.

The message about hacking group commit refers to an early implementation of emulated group commit in *Percona Server for MySQL*.

Point-In-Time Recovery

To perform a point-in-time recovery from an `xtrabackup` backup, you should prepare and restore the backup, and then replay binary logs from the point shown in the `xtrabackup_binlog_info` file.

A more detailed procedure is found *here*.

Setting Up a New Replication Slave

To set up a new replica, you should prepare the backup, and restore it to the data directory of your new replication slave. Then in your `CHANGE MASTER TO` command, use the binary log filename and position shown in the `xtrabackup_binlog_info` file to start replication.

A more detailed procedure is found in *How to setup a slave for replication in 6 simple steps with Percona XtraBackup*.

Restoring Individual Tables

With *Percona XtraBackup*, you can export individual tables from any *InnoDB* database, and import them into *Percona Server for MySQL* with *XtraDB* or *MySQL* 8.0. (The source doesn't have to be *XtraDB* or *MySQL* 8.0, but the destination does.) This only works on individual *.ibd* files, and cannot export a table that is not contained in its own *.ibd* file.

Let's see how to export and import the following table:

```
CREATE TABLE export_test (
a int(11) DEFAULT NULL
) ENGINE=InnoDB DEFAULT CHARSET=latin1;
```

Exporting the Table

This table should be created in *innodb_file_per_table* mode, so after taking a backup as usual with `--backup`, the *.ibd* file should exist in the target directory:

```
$ find /data/backups/mysql/ -name export_test.*
/data/backups/mysql/test/export_test.ibd
```

when you prepare the backup, add the extra parameter *--export* to the command. Here is an example:

```
$ xtrabackup --prepare --export --target-dir=/data/backups/mysql/
```

Note: If you're trying to restore *encrypted InnoDB tablespace* table you'll need to specify the keyring file as well:

```
$ xtrabackup --prepare --export --target-dir=/tmp/table \
--keyring-file-data=/var/lib/mysql-keyring/keyring
```

Now you should see a *.exp* file in the target directory:

```
$ find /data/backups/mysql/ -name export_test.*
/data/backups/mysql/test/export_test.exp
/data/backups/mysql/test/export_test.ibd
/data/backups/mysql/test/export_test.cfg
```

These three files are all you need to import the table into a server running *Percona Server for MySQL* with *XtraDB* or *MySQL* 8.0. In case server is using InnoDB Tablespace Encryption additional `.cfp` file be listed for encrypted tables.

Note: *MySQL* uses `.cfg` file which contains *InnoDB* dictionary dump in special format. This format is different from the `.exp`` one which is used in *XtraDB* for the same purpose. Strictly speaking, a `.cfg`` file is not required to import a tablespace to *MySQL* 8.0 or *Percona Server for MySQL* 8.0. A tablespace will be imported successfully even if it is from another server, but *InnoDB* will do schema validation if the corresponding `.cfg` file is present in the same directory.

Importing the Table

On the destination server running *Percona Server for MySQL* with *XtraDB* and innodb_import_table_from_xtrabackup option enabled, or *MySQL* 8.0, create a table with the same structure, and then perform the following steps:

1. Run the `ALTER TABLE test.export_test DISCARD TABLESPACE;` command. If you see this error then you must enable *innodb_file_per_table* and create the table again.

   Error

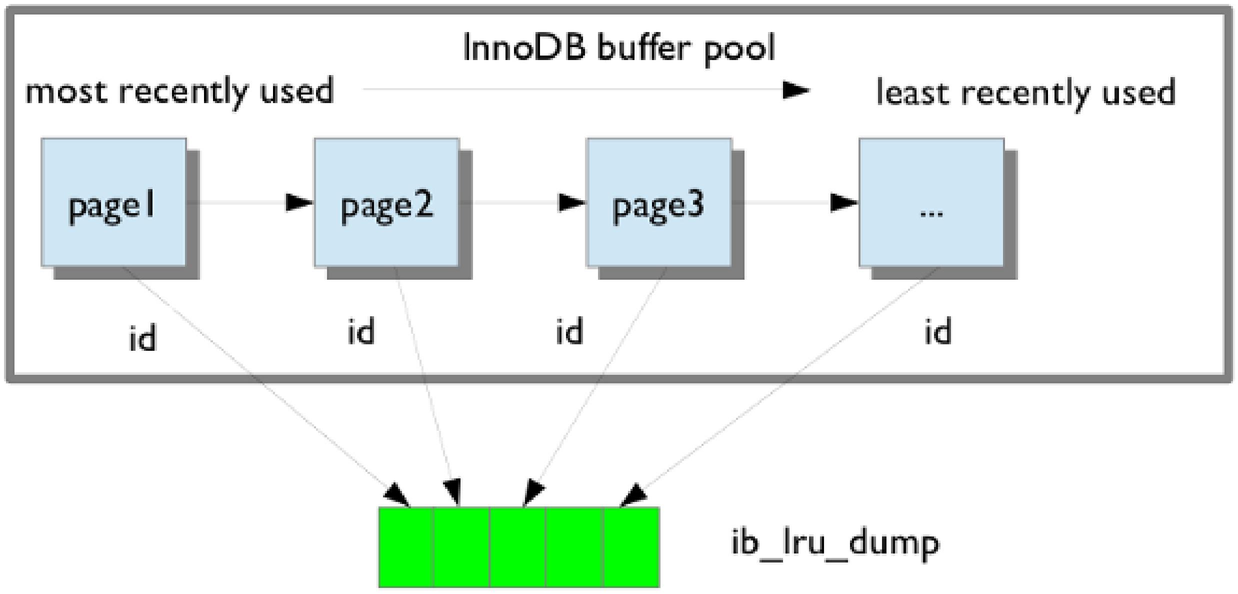
   ERROR 1030 (HY000): Got error -1 from storage engine

2. Copy the exported files to the `test/` subdirectory of the destination server's data directory
3. Run `ALTER TABLE test.export_test IMPORT TABLESPACE;`

The table should now be imported, and you should be able to `SELECT` from it and see the imported data.

LRU dump backup

Percona XtraBackup includes a saved buffer pool dump into a backup to enable reducing the warm up time. It restores the buffer pool state from `ib_buffer_pool` file after restart. *Percona XtraBackup* discovers `ib_buffer_pool` and backs it up automatically.



If the buffer restore option is enabled in `my.cnf` buffer pool will be in the warm state after backup is restored.

See also:

***MySQL* Documentation: Saving and Restoring the Buffer Pool State** https://dev.mysql.com/doc/refman/8.0/en/innodb-preload-buffer-pool.html

Streaming Backups

Streaming mode, supported by *Percona XtraBackup*, sends backup to `STDOUT` in the *xbstream* format instead of copying files to the backup directory.

This allows you to use other programs to filter the output of the backup, providing greater flexibility for storage of the backup. For example, compression is achieved by piping the output to a compression utility. One of the benefits of streaming backups and using Unix pipes is that the backups can be automatically encrypted.

To use the streaming feature, you must use the *`--stream`*, providing the format of the stream (`xbstream`) and where to store the temporary files:

```
$ xtrabackup --stream=xbstream --target-dir=/tmp
```

`xtrabackup` uses *xbstream* to stream all of the data files to `STDOUT`, in a special `xbstream` format. After it finishes streaming all of the data files to `STDOUT`, it stops xtrabackup and streams the saved log file too.

See also:

More information about *xbstream* *The xbstream binary*

When compression is enabled, **`xtrabackup`** compresses all output data, except the meta and non-InnoDB files which are not compressed, using the specified compression algorithm. The only currently supported algorithm is `quicklz`. The resulting files have the `qpress` archive format, i.e. every *.qp file produced by xtrabackup is essentially a one-file qpress archive and can be extracted and uncompressed by the qpress file archiver which is available from *Percona Software repositories*.

Using *xbstream* as a stream option, backups can be copied and compressed in parallel which can significantly speed up the backup process. In case backups were both compressed and encrypted, they'll need to decrypted first in order to be uncompressed.

Task	Command
Stream the backup into an archive named `backup.xbstream`	`xtrabackup --backup --stream=xbstream --target-dir=./ > backup.xbstream`
Stream the backup into a *compressed* archive named `backup.xbstream`	`xtrabackup --backup --stream=xbstream --compress --target-dir=./ > backup.xbstream`
Encrypt the backup	$ xtrabackup –backup –stream=xbstream ./ > backup.xbstream gzip - | openssl des3 -salt -k “password” > backup.xbstream.gz.des3
Unpack the backup to the current directory	`xbstream -x < backup.xbstream`
Send the backup compressed directly to another host and unpack it	`xtrabackup --backup --compress --stream=xbstream --target-dir=./ | ssh user@otherhost "xbstream -x"`

Send the backup to another server using `netcat`.	On the destination host:
	`$ nc -l 9999 | cat - > /data/backups/backup.xbstream`
	On the source host:
	`$ xtrabackup --backup --stream=xbstream ./ | nc desthost 9999`

Send the backup to another server using a one-liner:	$ ssh user@desthost “(nc -l 9999 > /data/backups/backup.xbstream &)” && xtrabackup –backup –stream=xbstream ./ | nc desthost 9999
Throttle the throughput to 10MB/sec using the `pipe viewer` tool[1]	$ xtrabackup –backup –stream=xbstream ./ | pv -q -L10m ssh user@desthost “cat - > /data/backups/backup.xbstream”

Checksumming the backup during the streaming:	On the destination host:
	`$ nc -l 9999 | tee >(sha1sum > destination_checksum) > /data/backups/backup.xbstream`
	On the source host:
	`$ xtrabackup --backup --stream=xbstream ./ | tee >(sha1sum > source_checksum) | nc desthost 9999`
	Compare the checksums on the source host:
	`$ cat source_checksum`
	`65e4f916a49c1f216e0887ce54cf59bf3934dbad -`
	Compare the checksums on the destination host:
	`$ cat destination_checksum`
	`65e4f916a49c1f216e0887ce54cf59bf3934dbad -`

Parallel compression with parallel copying backup	`xtrabackup --backup --compress --compress-threads=8 --stream=xbstream --parallel=4 --target-dir=./ > backup.xbstream`

Note that the streamed backup will need to be prepared before restoration. Streaming mode does not prepare the backup.

[1] Install from the official site or from the distribution package (`apt install pv`)

Encrypting Backups

Percona XtraBackup supports encrypting and decrypting local and streaming backups with *xbstream* option adding another layer of protection. The encryption is implemented using the `libgcrypt` library from GnuPG.

Creating Encrypted Backups

To make an encrypted backup the following options need to be specified (options `--encrypt-key` and `--encrypt-key-file` are mutually exclusive, i.e. just one of them needs to be provided):

- `--encrypt`
- :option:' –encrypt-key'
- :option:' –encrypt-key-file'

Both the `--encrypt-key` option and `--encrypt-key-file` option can be used to specify the encryption key. An encryption key can be generated with a command like `openssl rand -base64 24`

Example output of that command should look like this:

```
GCHFLrDFVx6UAsRb88uLVbAVWbK+Yzfs
```

This value then can be used as the encryption key

The `--encrypt-key` Option

Example of the **xtrabackup** command using the `--encrypt-key` should look like this:

```
$  xtrabackup --backup --encrypt=AES256 --encrypt-key=
↪"GCHFLrDFVx6UAsRb88uLVbAVWbK+Yzfs" --target-dir=/data/backup
```

The `--encrypt-key-file` Option

Use the `--encrypt-key-file` option as follows:

```
$ xtrabackup --backup --encrypt=AES256 --encrypt-key-file=/data/backups/keyfile --
↪target-dir=/data/backup
```

Note: Depending on the text editor that you use to make the `KEYFILE`, the editor can automatically insert the CRLF (end of line) character. This will cause the key size to grow and thus making it invalid. The suggested way to create the file is by using the command line: `echo -n "GCHFLrDFVx6UAsRb88uLVbAVWbK+Yzfs" > /data/backups/keyfile`.

Optimizing the encryption process

Two new options are available for encrypted backups that can be used to speed up the encryption process. These are `--encrypt-threads` and `--encrypt-chunk-size`. By using the `--encrypt-threads` option multiple threads can be specified to be used for encryption in parallel. Option `--encrypt-chunk-size` can be used to specify the size (in bytes) of the working encryption buffer for each encryption thread (default is 64K).

Decrypting Encrypted Backups

Backups can be decrypted with *The xbcrypt binary*. The following one-liner can be used to encrypt the whole folder:

```
$ for i in `find . -iname "*\.xbcrypt"`; do xbcrypt -d --encrypt-key-file=/root/
↪secret_key --encrypt-algo=AES256 < $i > $(dirname $i)/$(basename $i .xbcrypt) && rm
↪$i; done
```

Percona XtraBackup `--decrypt` option has been implemented that can be used to decrypt the backups:

```
$ xtrabackup --decrypt=AES256 --encrypt-key="GCHFLrDFVx6UAsRb88uLVbAVWbK+Yzfs" --
↪target-dir=/data/backup/
```

Percona XtraBackup doesn't automatically remove the encrypted files. In order to clean up the backup directory users should remove the `*.xbcrypt` files.

Note: `--parallel` can be used with `--decrypt` option to decrypt multiple files simultaneously.

When the files are decrypted, the backup can be prepared.

Preparing Encrypted Backups

After the backups have been decrypted, they can be prepared in the same way as the standard full backups with the `--prepare` option:

```
$ xtrabackup --prepare --target-dir=/data/backup/
```

Restoring Encrypted Backups

`xtrabackup` offers the `--copy-back` option to restore a backup to the server's *datadir*:

```
$ xtrabackup --copy-back --target-dir=/data/backup/
```

It will copy all the data-related files back to the server's *datadir*, determined by the server's `my.cnf` configuration file. You should check the last line of the output for a success message:

```
150318 11:08:13  xtrabackup: completed OK!
```

See also:

GnuPG Documentation: `libgcrypt` library http://www.gnupg.org/documentation/manuals/gcrypt/

Handling `FLUSH TABLES WITH READ LOCK`

When making backups, `FLUSH TABLES WITH READ LOCK` is used before the non-InnoDB files are backed up to ensure that the backup is consistent. `FLUSH TABLES WITH READ LOCK` can be run even though there may be a running query that has been executing for hours.

In this case, everything is locked in the `Waiting for table flush` or `Waiting for master to send event` state. Killing the `FLUSH TABLES WITH READ LOCK` does not correct this problem. The only way to get the server operating normally again is to kill off the long running queries that blocked it to begin with. This means that if there are long running queries `FLUSH TABLES WITH READ LOCK` can get stuck, leaving server in read-only mode until waiting for these queries to complete.

Note: All described in this section has no effect when backup locks are used. *Percona XtraBackup* will use Backup locks where available as a lightweight alternative to `FLUSH TABLES WITH READ LOCK`. This feature is available in *Percona Server for MySQL* 5.6+. *Percona XtraBackup* uses this automatically to copy non-InnoDB data to avoid blocking DML queries that modify InnoDB tables.

In order to prevent this from happening two things have been implemented:

- **`xtrabackup`** can wait for a good moment to issue the global lock.
- **`xtrabackup`** can kill all or only SELECT queries which are preventing the global lock from being acquired

Waiting for queries to finish

Good moment to issue a global lock is the moment when there are no long queries running. But waiting for a good moment to issue the global lock for extended period of time isn't always good approach, as it can extend the time needed for backup to take place. To prevent **`xtrabackup`** from waiting to issue `FLUSH TABLES WITH READ LOCK` for too long, new option has been implemented: *`--ftwrl-wait-timeout`* option can be used to limit the waiting time. If the good moment to issue the lock did not happen during this time, **`xtrabackup`** will give up and exit with an error message and backup will not be taken. Zero value for this option turns off the feature (which is default).

Another possibility is to specify the type of query to wait on. In this case *`--ftwrl-wait-query-type`*. Possible values are `all` and `update`. When `all` is used **`xtrabackup`** will wait for all long running queries (execution time longer than allowed by *`--ftwrl-wait-threshold`*) to finish before running the `FLUSH TABLES WITH READ LOCK`. When `update` is used **`xtrabackup`** will wait on `UPDATE/ALTER/REPLACE/INSERT` queries to finish.

Although the time needed for a specific query to complete is hard to predict, we can assume that the queries that have been running for a long time are not likely to finish soon. The queries which are running for a short time are likely to finish shortly. **`xtrabackup`** can use the value of *`--ftwrl-wait-threshold`* option to specify which query is long running and will likely block global lock for a while. In order to use this option xtrabackup user should have `PROCESS` and `SUPER` privileges.

Killing the blocking queries

The second option is to kill all the queries which prevent from acquiring the global lock. In this case, all queries which run longer than `FLUSH TABLES WITH READ LOCK` are potential blockers. Although all queries can be killed, additional time can be specified for the short running queries to finish using the *`--kill-long-queries-timeout`* option. This option specifies the time for queries to complete, after the value is reached, all the running queries will be killed. The default value is zero, which turns this feature off.

The *`--kill-long-query-type`* option can be used to specify all or only `SELECT` queries that are preventing global lock from being acquired. In order to use this option xtrabackup user should have `PROCESS` and `SUPER` privileges.

Options summary

- *`--ftwrl-wait-timeout`* (seconds) - how long to wait for a good moment. Default is 0, not to wait.

- *--ftwrl-wait-query-type* - which long queries should be finished before `FLUSH TABLES WITH READ LOCK` is run. Default is all.
- *--ftwrl-wait-threshold* (seconds) - how long query should be running before we consider it long running and potential blocker of global lock.
- *--kill-long-queries-timeout* (seconds) - how many time we give for queries to complete after `FLUSH TABLES WITH READ LOCK` is issued before start to kill. Default if `0`, not to kill.
- *--kill-long-query-type* - which queries should be killed once `kill-long-queries-timeout` has expired.

Example

Running the **xtrabackup** with the following options will cause **xtrabackup** to spend no longer than 3 minutes waiting for all queries older than 40 seconds to complete.

```
$  xtrabackup --backup --ftwrl-wait-threshold=40 \
--ftwrl-wait-query-type=all --ftwrl-wait-timeout=180 \
--kill-long-queries-timeout=20 --kill-long-query-type=all \
--target-dir=/data/backups/
```

After `FLUSH TABLES WITH READ LOCK` is issued, **xtrabackup** will wait for 20 seconds for lock to be acquired. If lock is still not acquired after 20 seconds, it will kill all queries which are running longer that the `FLUSH TABLES WITH READ LOCK`.

Accelerating the backup process

Copying with the `--parallel` and *–compress-threads* Options

When making a local or streaming backup with *xbstream* option, multiple files can be copied at the same time when using the *--parallel* option. This option specifies the number of threads created by **xtrabackup** to copy data files.

To take advantage of this option either the multiple tablespaces option must be enabled (*innodb_file_per_table*) or the shared tablespace must be stored in multiple *ibdata* files with the *innodb_data_file_path* option. Having multiple files for the database (or splitting one into many) doesn't have a measurable impact on performance.

As this feature is implemented **at the file level**, concurrent file transfer can sometimes increase I/O throughput when doing a backup on highly fragmented data files, due to the overlap of a greater number of random read requests. You should consider tuning the filesystem also to obtain the maximum performance (e.g. checking fragmentation).

If the data is stored on a single file, this option will have no effect.

To use this feature, simply add the option to a local backup, for example:

```
$ xtrabackup --backup --parallel=4 --target-dir=/path/to/backup
```

By using the *xbstream* in streaming backups, you can additionally speed up the compression process with the *--compress-threads* option. This option specifies the number of threads created by **xtrabackup** for for parallel data compression. The default value for this option is 1.

To use this feature, simply add the option to a local backup, for example:

```
$ xtrabackup --backup --stream=xbstream --compress --compress-threads=4 --target-dir=.
↪/ > backup.xbstream
```

Before applying logs, compressed files will need to be uncompressed.

The `--rsync` Option

In order to speed up the backup process and to minimize the time `FLUSH TABLES WITH READ LOCK` is blocking the writes, the option *`--rsync`* should be used. When this option is specified, **`xtrabackup`** uses `rsync` to copy all non-InnoDB files instead of spawning a separate `cp` for each file, which can be much faster for servers with a large number of databases or tables. **`xtrabackup`** will call the `rsync` twice, once before the `FLUSH TABLES WITH READ LOCK` and once during to minimize the time the read lock is being held. During the second `rsync` call, it will only synchronize the changes to non-transactional data (if any) since the first call performed before the `FLUSH TABLES WITH READ LOCK`. Note that *Percona XtraBackup* will use Backup locks where available as a lightweight alternative to `FLUSH TABLES WITH READ LOCK`. This feature is available in *Percona Server for MySQL* 5.6+. *Percona XtraBackup* uses this automatically to copy non-InnoDB data to avoid blocking DML queries that modify InnoDB tables.

Note: This option cannot be used together with the *`--stream`* option.

Point-In-Time recovery

Recovering up to particular moment in database's history can be done with **`xtrabackup`** and the binary logs of the server.

Note that the binary log contains the operations that modified the database from a point in the past. You need a full *datadir* as a base, and then you can apply a series of operations from the binary log to make the data match what it was at the point in time you want.

```
$ xtrabackup --backup --target-dir=/path/to/backup
$ xtrabackup --prepare --target-dir=/path/to/backup
```

For more details on these procedures, see *Creating a backup* and *Preparing a backup*.

Now, suppose that some time has passed, and you want to restore the database to a certain point in the past, having in mind that there is the constraint of the point where the snapshot was taken.

To find out what is the situation of binary logging in the server, execute the following queries:

```
mysql> SHOW BINARY LOGS;
+------------------+-----------+
| Log_name         | File_size |
+------------------+-----------+
| mysql-bin.000001 |       126 |
| mysql-bin.000002 |      1306 |
| mysql-bin.000003 |       126 |
| mysql-bin.000004 |       497 |
+------------------+-----------+
```

and

```
mysql> SHOW MASTER STATUS;
+------------------+----------+--------------+------------------+
| File             | Position | Binlog_Do_DB | Binlog_Ignore_DB |
+------------------+----------+--------------+------------------+
| mysql-bin.000004 |      497 |              |                  |
+------------------+----------+--------------+------------------+
```

The first query will tell you which files contain the binary log and the second one which file is currently being used to record changes, and the current position within it. Those files are stored usually in the *datadir* (unless other location is specified when the server is started with the `--log-bin=` option).

To find out the position of the snapshot taken, see the `xtrabackup_binlog_info` at the backup's directory:

```
$ cat /path/to/backup/xtrabackup_binlog_info
mysql-bin.000003      57
```

This will tell you which file was used at moment of the backup for the binary log and its position. That position will be the effective one when you restore the backup:

```
$ xtrabackup --copy-back --target-dir=/path/to/backup
```

As the restoration will not affect the binary log files (you may need to adjust file permissions, see *Restoring a Backup*), the next step is extracting the queries from the binary log with **mysqlbinlog** starting from the position of the snapshot and redirecting it to a file

```
$ mysqlbinlog /path/to/datadir/mysql-bin.000003 /path/to/datadir/mysql-bin.000004 \
    --start-position=57 > mybinlog.sql
```

Note that if you have multiple files for the binary log, as in the example, you have to extract the queries with one process, as shown above.

Inspect the file with the queries to determine which position or date corresponds to the point-in-time wanted. Once determined, pipe it to the server. Assuming the point is `11-12-25 01:00:00`:

```
$ mysqlbinlog /path/to/datadir/mysql-bin.000003 /path/to/datadir/mysql-bin.000004 \
    --start-position=57 --stop-datetime="11-12-25 01:00:00" | mysql -u root -p
```

and the database will be rolled forward up to that Point-In-Time.

Making Backups in Replication Environments

There are options specific to back up from a replication slave.

The `--slave-info` Option

This option is useful when backing up a replication slave server. It prints the binary log position and name of the master server. It also writes this information to the `xtrabackup_slave_info` file as a `CHANGE MASTER` statement.

This is useful for setting up a new slave for this master can be set up by starting a slave server on this backup and issuing the statement saved in the `xtrabackup_slave_info` file. More details of this procedure can be found in *How to setup a slave for replication in 6 simple steps with Percona XtraBackup*.

The `--safe-slave-backup` Option

In order to assure a consistent replication state, this option stops the slave SQL thread and wait to start backing up until `Slave_open_temp_tables` in `SHOW STATUS` is zero. If there are no open temporary tables, the backup will take place, otherwise the SQL thread will be started and stopped until there are no open temporary tables. The backup will fail if `Slave_open_temp_tables` does not become zero after *`--safe-slave-backup-timeout`* seconds (defaults to 300 seconds). The slave SQL thread will be restarted when the backup finishes.

Using this option is always recommended when taking backups from a slave server.

Warning: Make sure your slave is a true replica of the master before using it as a source for backup. A good tool to validate a slave is pt-table-checksum.

Store backup history on the server

Percona XtraBackup supports storing the backups history on the server. This feature was implemented in *Percona XtraBackup* 2.2. Storing backup history on the server was implemented to provide users with additional information about backups that are being taken. Backup history information will be stored in the *PERCONA_SCHEMA.XTRABACKUP_HISTORY* table.

To use this feature the following options are available:

- `--history` =<name> : This option enables the history feature and allows the user to specify a backup series name that will be placed within the history record.
- `--incremental-history-name` =<name> : This option allows an incremental backup to be made based on a specific history series by name. **xtrabackup** will search the history table looking for the most recent (highest `to_lsn`) backup in the series and take the `to_lsn` value to use as it's starting lsn. This is mutually exclusive with `--incremental-history-uuid`, `--incremental-basedir` and `--incremental-lsn` options. If no valid LSN can be found (no series by that name) **xtrabackup** will return with an error.
- `--incremental-history-uuid` =<uuid> : Allows an incremental backup to be made based on a specific history record identified by UUID. **xtrabackup** will search the history table looking for the record matching UUID and take the `to_lsn` value to use as it's starting LSN. This options is mutually exclusive with `--incremental-basedir`, `--incremental-lsn` and `--incremental-history-name` options. If no valid LSN can be found (no record by that UUID or missing `to_lsn`), **xtrabackup** will return with an error.

Note: Backup that's currently being performed will **NOT** exist in the xtrabackup_history table within the resulting backup set as the record will not be added to that table until after the backup has been taken.

If you want access to backup history outside of your backup set in the case of some catastrophic event, you will need to either perform a `mysqldump`, partial backup or `SELECT` * on the history table after **xtrabackup** completes and store the results with you backup set.

Privileges

User performing the backup will need following privileges:

- `CREATE` privilege in order to create the *PERCONA_SCHEMA.xtrabackup_history* database and table.
- `INSERT` privilege in order to add history records to the *PERCONA_SCHEMA.xtrabackup_history* table.
- `SELECT` privilege in order to use `--incremental-history-name` or `--incremental-history-uuid` in order for the feature to look up the `innodb_to_lsn` values in the *PERCONA_SCHEMA.xtrabackup_history* table.

PERCONA_SCHEMA.XTRABACKUP_HISTORY table

This table contains the information about the previous server backups. Information about the backups will only be written if the backup was taken with `--history` option.

Column Name	Description
uuid	Unique backup id
name	User provided name of backup series. There may be multiple entries with the same name used to identify related backups in a series.
tool_name	Name of tool used to take backup
tool_command	Exact command line given to the tool with –password and –encryption_key obfuscated
tool_version	Version of tool used to take backup
ib-backup_version	Version of the xtrabackup binary used to take backup
server_version	Server version on which backup was taken
start_time	Time at the start of the backup
end_time	Time at the end of the backup
lock_time	Amount of time, in seconds, spent calling and holding locks for `FLUSH TABLES WITH READ LOCK`
binlog_pos	Binlog file and position at end of `FLUSH TABLES WITH READ LOCK`
inn-odb_from_lsn	LSN at beginning of backup which can be used to determine prior backups
inn-odb_to_lsn	LSN at end of backup which can be used as the starting lsn for the next incremental
partial	Is this a partial backup, if `N` that means that it's the full backup
incremental	Is this an incremental backup
format	Description of result format (`file`, `tar`, `xbstream`)
compact	Is this a compact backup
compressed	Is this a compressed backup
encrypted	Is this an encrypted backup

Limitations

- *`--history`* option must be specified only on the command line and not within a configuration file in order to be effective.
- *`--incremental-history-name`* and *`--incremental-history-uuid`* options must be specified only on the command line and not within a configuration file in order to be effective.

Implementation

Implementation Details

This page contains notes on various internal aspects of the **`xtrabackup`** tool's operation.

File Permissions

`xtrabackup` opens the source data files in read-write mode, although it does not modify the files. This means that you must run **`xtrabackup`** as a user who has permission to write the data files. The reason for opening the files in read-write mode is that **`xtrabackup`** uses the embedded *InnoDB* libraries to open and read the files, and *InnoDB* opens them in read-write mode because it normally assumes it is going to write to them.

Tuning the OS Buffers

Because **xtrabackup** reads large amounts of data from the filesystem, it uses `posix_fadvise()` where possible, to instruct the operating system not to try to cache the blocks it reads from disk. Without this hint, the operating system would prefer to cache the blocks, assuming that `xtrabackup` is likely to need them again, which is not the case. Caching such large files can place pressure on the operating system's virtual memory and cause other processes, such as the database server, to be swapped out. The `xtrabackup` tool avoids this with the following hint on both the source and destination files:

```
posix_fadvise(file, 0, 0, POSIX_FADV_DONTNEED)
```

In addition, xtrabackup asks the operating system to perform more aggressive read-ahead optimizations on the source files:

```
posix_fadvise(file, 0, 0, POSIX_FADV_SEQUENTIAL)
```

Copying Data Files

When copying the data files to the target directory, **xtrabackup** reads and writes 1 MB of data at a time. This is not configurable. When copying the log file, **xtrabackup** reads and writes 512 bytes at a time. This is also not possible to configure, and matches InnoDB's behavior (workaround exists in *Percona Server for MySQL* because it has an option to tune `innodb_log_block_size` for *XtraDB*, and in that case *Percona XtraBackup* will match the tuning).

After reading from the files, `xtrabackup` iterates over the 1MB buffer a page at a time, and checks for page corruption on each page with InnoDB's `buf_page_is_corrupted()` function. If the page is corrupt, it re-reads and retries up to 10 times for each page. It skips this check on the doublewrite buffer.

`xtrabackup` Exit Codes

The **xtrabackup** binary exits with the traditional success value of 0 after a backup when no error occurs. If an error occurs during the backup, the exit value is 1.

In certain cases, the exit value can be something other than 0 or 1, due to the command-line option code included from the *MySQL* libraries. An unknown command-line option, for example, will cause an exit code of 255.

References

The `xtrabackup` Option Reference

This page documents all of the command-line options for the **xtrabackup** binary.

Modes of operation

You invoke **xtrabackup** in one of the following modes:

- *`--backup`* mode to make a backup in a target directory
- *`--prepare`* mode to restore data from a backup (created in *`--backup`* mode)
- *`--copy-back`* to copy data from a backup to the location that contained the original data; to move data instead of copying use the alternate *`--move-back`* mode.

- `--stats` mode to scan the specified data files and print out index statistics.

When you intend to run **xtrabackup** in any of these modes, use the following syntax:

```
$ xtrabackup [--defaults-file=#] --backup|--prepare|--copy-back|--stats [OPTIONS]
```

For example, the `--prepare` mode is applied as follows:

```
$ xtrabackup --prepare --target-dir=/data/backup/mysql/
```

For all modes, the default options are read from the **xtrabackup** and **mysqld** configuration groups from the following files in the given order:

1. `/etc/my.cnf`
2. `/etc/mysql/my.cnf`
3. `/usr/etc/my.cnf`
4. `~/.my.cnf`.

As the first parameter to **xtrabackup** (in place of the `--defaults-file`, you may supply one of the following:

- `--print-defaults` to have **xtrabackup** print the argument list and exit.
- `--no-defaults` to forbid reading options from any file but the login file.
- `--defaults-file` to read the default options from the given file.
- `--defaults-extra-file` to read the specified additional file after the global files have been read.
- `--defaults-group-suffix` to read the configuration groups with the given suffix. The effective group name is constructed by concatenating the default configuration groups (**xtrabackup** and **mysqld**) with the given suffix.
- `--login-path` to read the given path from the login file.

InnoDB Options

There is a large group of InnoDB options that are normally read from the `my.cnf` configuration file, so that **xtrabackup** boots up its embedded InnoDB in the same configuration as your current server. You normally do not need to specify them explicitly. These options have the same behavior in InnoDB and XtraDB. See `--innodb-miscellaneous` for more information.

Options

--apply-log-only
This option causes only the redo stage to be performed when preparing a backup. It is very important for incremental backups.

--backup
Make a backup and place it in `--target-dir`. See *Creating a backup*.

--backup-lock-timeout
The timeout in seconds for attempts to acquire metadata locks.

--backup-lock-retry-count
The number of attempts to acquire metadata locks.

--backup-locks
This option controls if backup locks should be used instead of `FLUSH TABLES WITH READ LOCK` on the backup stage. The option has no effect when backup locks are not supported by the server. This option is enabled by default, disable with *`--no-backup-locks`*.

--check-privileges
This option checks if *Percona XtraBackup* has all required privileges. If a missing privilege is required for the current operation, it will terminate and print out an error message. If a missing privilege is not required for the current operation, but may be necessary for some other XtraBackup operation, the process is not aborted and a warning is printed.

```
xtrabackup: Error: missing required privilege LOCK TABLES on *.*
xtrabackup: Warning: missing required privilege REPLICATION CLIENT on *.*
```

--close-files
Do not keep files opened. When **xtrabackup** opens tablespace it normally doesn't close its file handle in order to handle the DDL operations correctly. However, if the number of tablespaces is really huge and can not fit into any limit, there is an option to close file handles once they are no longer accessed. *Percona XtraBackup* can produce inconsistent backups with this option enabled. Use at your own risk.

--compress
This option tells **xtrabackup** to compress all output data, including the transaction log file and meta data files, using either the `quicklz` or `lz4` compression algorithm. `quicklz` is chosen by default.

When using `--compress=quicklz` or `--compress`, the resulting files have the qpress archive format, i.e. every `*.qp` file produced by **xtrabackup** is essentially a one-file qpress archive and can be extracted and uncompressed by the qpress file archiver.

`--compress=lz4` produces `*.lz4` files. You can extract the contents of these files by using a program such as `lz4`.

See also:

QuickLZ http://www.quicklz.com

LZ4 https://lz4.github.io/lz4/

--compress-chunk-size=#
Size of working buffer(s) for compression threads in bytes. The default value is 64K.

--compress-threads=#
This option specifies the number of worker threads used by **xtrabackup** for parallel data compression. This option defaults to `1`. Parallel compression (*`--compress-threads`*) can be used together with parallel file copying (*`--parallel`*). For example, `--parallel=4 --compress --compress-threads=2` will create 4 I/O threads that will read the data and pipe it to 2 compression threads.

--copy-back
Copy all the files in a previously made backup from the backup directory to their original locations. This option will not copy over existing files unless *`--force-non-empty-directories`* option is specified.

--core-file
Write core on fatal signals.

--databases=#
This option specifies a list of databases and tables that should be backed up. The option accepts the list of the form `"databasename1[.table_name1] databasename2[.table_name2] . . ."`.

--databases-exclude=name
Excluding databases based on name, Operates the same way as *`--databases`*, but matched names are excluded from backup. Note that this option has a higher priority than *`--databases`*.

--databases-file=#
This option specifies the path to the file containing the list of databases and tables that should be backed up. The file can contain the list elements of the form `databasename1[.table_name1]`, one element per line.

--datadir=DIRECTORY
The source directory for the backup. This should be the same as the datadir for your *MySQL* server, so it should be read from `my.cnf` if that exists; otherwise you must specify it on the command line.

When combined with the *--copy-back* or *--move-back* option, *--datadir* refers to the destination directory.

Once connected to the server, in order to perform a backup you will need `READ` and `EXECUTE` permissions at a filesystem level in the server's *datadir*.

--debug-sleep-before-unlock=#
This is a debug-only option used by the **xtrabackup** test suite.

--debug-sync=name
The debug sync point. This option is only used by the **xtrabackup** test suite.

--decompress
Decompresses all files with the `.qp` extension in a backup previously made with the *--compress* option. The *--parallel* option will allow multiple files to be decrypted simultaneously. In order to decompress, the qpress utility MUST be installed and accessible within the path. *Percona XtraBackup* does not automatically remove the compressed files. In order to clean up the backup directory users should use *--remove-original* option.

The *--decompress* option may be used with *xbstream* to decompress individual qpress files.

If you used the `lz4` compression algorithm to compress the files (`--compress=lz4`), change the *--decompress* parameter accordingly: `--decompress=lz4`.

--decompress-threads=#
Force *xbstream* to use the specified number of threads for decompressing.

--decrypt=ENCRYPTION-ALGORITHM
Decrypts all files with the `.xbcrypt` extension in a backup previously made with *--encrypt* option. The *--parallel* option will allow multiple files to be decrypted simultaneously. *Percona XtraBackup* doesn't automatically remove the encrypted files. In order to clean up the backup directory users should use *--remove-original* option.

--defaults-extra-file=[MY.CNF]
Read this file after the global files are read. Must be given as the first option on the command-line.

--defaults-file=[MY.CNF]
Only read default options from the given file. Must be given as the first option on the command-line. Must be a real file; it cannot be a symbolic link.

--defaults-group=GROUP-NAME
This option is to set the group which should be read from the configuration file. This is used by **xtrabackup** if you use the *--defaults-group* option. It is needed for `mysqld_multi` deployments.

--defaults-group-suffix=#
Also reads groups with concat(group, suffix).

--dump-innodb-buffer-pool
This option controls whether or not a new dump of buffer pool content should be done.

With `--dump-innodb-buffer-pool`, **xtrabackup** makes a request to the server to start the buffer pool dump (it takes some time to complete and is done in background) at the beginning of a backup provided the status variable `innodb_buffer_pool_dump_status` reports that the dump has been completed.

```
$ xtrabackup --backup --dump-innodb-buffer-pool --target-dir=/home/user/backup
```

By default, this option is set to *OFF*.

If `innodb_buffer_pool_dump_status` reports that there is running dump of buffer pool, **xtrabackup** waits for the dump to complete using the value of *--dump-innodb-buffer-pool-timeout*

The file `ib_buffer_pool` stores tablespace ID and page ID data used to warm up the buffer pool sooner.

See also:

***MySQL* Documentation: Saving and Restoring the Buffer Pool State** https://dev.mysql.com/doc/refman/5.7/en/innodb-preload-buffer-pool.html

--dump-innodb-buffer-pool-timeout

This option contains the number of seconds that **xtrabackup** should monitor the value of `innodb_buffer_pool_dump_status` to determine if buffer pool dump has completed.

This option is used in combination with *--dump-innodb-buffer-pool*. By default, it is set to *10* seconds.

--dump-innodb-buffer-pool-pct

This option contains the percentage of the most recently used buffer pool pages to dump.

This option is effective if *--dump-innodb-buffer-pool* option is set to *ON*. If this option contains a value, **xtrabackup** sets the *MySQL* system variable `innodb_buffer_pool_dump_pct`. As soon as the buffer pool dump completes or it is stopped (see *--dump-innodb-buffer-pool-timeout*), the value of the *MySQL* system variable is restored.

See also:

Changing the timeout for buffer pool dump *--dump-innodb-buffer-pool-timeout*

***MySQL* Documentation: innodb_buffer_pool_dump_pct system variable** https://dev.mysql.com/doc/refman/8.0/en/innodb-parameters.html#sysvar_innodb_buffer_pool_dump_pct

--encrypt=ENCRYPTION_ALGORITHM

This option instructs xtrabackup to encrypt backup copies of InnoDB data files using the algorithm specified in the ENCRYPTION_ALGORITHM. Currently supported algorithms are: `AES128`, `AES192` and `AES256`

--encrypt-key=ENCRYPTION_KEY

A proper length encryption key to use. It is not recommended to use this option where there is uncontrolled access to the machine as the command line and thus the key can be viewed as part of the process info.

--encrypt-key-file=ENCRYPTION_KEY_FILE

The name of a file where the raw key of the appropriate length can be read from. The file must be a simple binary (or text) file that contains exactly the key to be used.

It is passed directly to the xtrabackup child process. See the **xtrabackup** *documentation* for more details.

--encrypt-threads=#

This option specifies the number of worker threads that will be used for parallel encryption/decryption. See the **xtrabackup** *documentation* for more details.

--encrypt-chunk-size=#

This option specifies the size of the internal working buffer for each encryption thread, measured in bytes. It is passed directly to the xtrabackup child process. See the **xtrabackup** *documentation* for more details.

--export

Create files necessary for exporting tables. See *Restoring Individual Tables*.

--extra-lsndir=DIRECTORY
(for –backup): save an extra copy of the `xtrabackup_checkpoints` and `xtrabackup_info` files in this directory.

--force-non-empty-directories
When specified, it makes *--copy-back* and *--move-back* option transfer files to non-empty directories. No existing files will be overwritten. If files that need to be copied/moved from the backup directory already exist in the destination directory, it will still fail with an error.

--ftwrl-wait-timeout=SECONDS
This option specifies time in seconds that xtrabackup should wait for queries that would block `FLUSH TABLES WITH READ LOCK` before running it. If there are still such queries when the timeout expires, xtrabackup terminates with an error. Default is `0`, in which case it does not wait for queries to complete and starts `FLUSH TABLES WITH READ LOCK` immediately. Where supported **xtrabackup** will automatically use Backup Locks as a lightweight alternative to `FLUSH TABLES WITH READ LOCK` to copy non-InnoDB data to avoid blocking DML queries that modify InnoDB tables.

--ftwrl-wait-threshold=SECONDS
This option specifies the query run time threshold which is used by xtrabackup to detect long-running queries with a non-zero value of *--ftwrl-wait-timeout*. `FLUSH TABLES WITH READ LOCK` is not started until such long-running queries exist. This option has no effect if *--ftwrl-wait-timeout* is `0`. Default value is `60` seconds. Where supported xtrabackup will automatically use Backup Locks as a lightweight alternative to `FLUSH TABLES WITH READ LOCK` to copy non-InnoDB data to avoid blocking DML queries that modify InnoDB tables.

--ftwrl-wait-query-type=all|update
This option specifies which types of queries are allowed to complete before xtrabackup will issue the global lock. Default is `all`.

--galera-info
This option creates the `xtrabackup_galera_info` file which contains the local node state at the time of the backup. Option should be used when performing the backup of *Percona XtraDB Cluster*. It has no effect when backup locks are used to create the backup.

--generate-new-master-key
Generate a new master key when doing a copy-back.

--generate-transition-key
xtrabackup needs to access the same keyring file or vault server during *prepare* and *copy-back* but it should not depend on whether the server keys have been purged.

--generate-transition-key creates and adds to the keyring a transition key for **xtrabackup** to use if the master key used for encryption is not found because it has been rotated and purged.

--get-server-public-key
Get the server public key

See also:

MySQL Documentation: The –get-server-public-key Option

https://dev.mysql.com/doc/refman/5.7/en/connection-options.html#option_general_get-server-public-key

--help
When run with this option or without any options **xtrabackup** displays information about how to run the program on the command line along with all supported options and variables with default values where appropriate.

--history=NAME
This option enables the tracking of backup history in the `PERCONA_SCHEMA.xtrabackup_history` table.

An optional history series name may be specified that will be placed with the history record for the current backup being taken.

--host=HOST
This option accepts a string argument that specifies the host to use when connecting to the database server with TCP/IP. It is passed to the mysql child process without alteration. See **mysql --help** for details.

--incremental
This option tells **xtrabackup** to create an incremental backup. It is passed to the **xtrabackup** child process. When this option is specified, either *--incremental-lsn* or *--incremental-basedir* can also be given. If neither option is given, option *--incremental-basedir* is passed to **xtrabackup** by default, set to the first timestamped backup directory in the backup base directory.

See also:

More information about incremental backups See section *Incremental Backups*

--incremental-basedir=DIRECTORY
When creating an incremental backup, this is the directory containing the full backup that is the base dataset for the incremental backups.

--incremental-dir=DIRECTORY
When preparing an incremental backup, this is the directory where the incremental backup is combined with the full backup to make a new full backup.

--incremental-force-scan
When creating an incremental backup, force a full scan of the data pages in the instance being backuped even if the complete changed page bitmap data is available.

--incremental-history-name=name
This option specifies the name of the backup series stored in the `PERCONA_SCHEMA.xtrabackup_history` history record to base an incremental backup on. **xtrabackup** will search the history table looking for the most recent (highest `innodb_to_lsn`), successful backup in the series and take the to_lsn value to use as the starting `lsn` for the incremental backup. This will be mutually exclusive with *--incremental-history-uuid*, *--incremental-basedir* and *--incremental-lsn*. If no valid lsn can be found (no series by that name, no successful backups by that name) **xtrabackup** will return with an error. It is used with the *--incremental* option.

--incremental-history-uuid=name
This option specifies the *UUID* of the specific history record stored in the `PERCONA_SCHEMA.xtrabackup_history` to base an incremental backup on. *--incremental-history-name*, *--incremental-basedir* and *--incremental-lsn*. If no valid lsn can be found (no success record with that *UUID*) **xtrabackup** will return with an error. It is used with the –incremental option.

--incremental-lsn=LSN
When creating an incremental backup, you can specify the log sequence number (*LSN*) instead of specifying *--incremental-basedir*. For databases created in 5.1 and later, specify the *LSN* as a single 64-bit integer. **ATTENTION**: If a wrong LSN value is specified (a user error which *Percona XtraBackup* is unable to detect), the backup will be unusable. Be careful!

--innodb[=name]
This option is ignored for MySQL option compatibility.

--innodb-miscellaneous
There is a large group of InnoDB options that are normally read from the `my.cnf` configuration file, so that **xtrabackup** boots up its embedded InnoDB in the same configuration as your current server. You normally do not need to specify these explicitly. These options have the same behavior in InnoDB and XtraDB:

- –innodb-adaptive-hash-index

- –innodb-additional-mem-pool-size
- –innodb-autoextend-increment
- –innodb-buffer-pool-size
- –innodb-buffer-pool-filename
- –innodb-checksum-algorithm
- –innodb-checksums
- –innodb-data-file-path
- –innodb-data-home-dir
- –innodb-directories
- –innodb-doublewrite-file
- –innodb-doublewrite
- –innodb-extra-undoslots
- –innodb-fast-checksum
- –innodb-file-io-threads
- –innodb-file-per-table
- –innodb-flush-log-at-trx-commit
- –innodb-flush-method
- –innodb-io-capacity
- –innodb-lock-wait-timeout
- –innodb-log-block-size
- –innodb-log-buffer-size
- –innodb-log-checksums
- –innodb-log-files-in-group
- –innodb-log-file-size
- –innodb-log-group-home-dir
- –innodb-max-dirty-pages-pct
- –innodb-open-files
- –innodb-page-size
- –innodb-read-io-threads
- –innodb-redo-log-encrypt
- –innodb-undo-directory
- –innodb-undo-log-encrypt
- –innodb-undo-tablespaces‘
- –innodb-use-native-aio
- –innodb-write-io-threads

--keyring-file-data=FILENAME
The path to the keyring file. Combine this option with *--xtrabackup-plugin-dir*.

--kill-long-queries-timeout=SECONDS
This option specifies the number of seconds **xtrabackup** waits between starting `FLUSH TABLES WITH READ LOCK` and killing those queries that block it. Default is 0 seconds, which means **xtrabackup** will not attempt to kill any queries. In order to use this option xtrabackup user should have the `PROCESS` and `SUPER` privileges. Where supported, **xtrabackup** automatically uses Backup Locks as a lightweight alternative to `FLUSH TABLES WITH READ LOCK` to copy non-InnoDB data to avoid blocking DML queries that modify InnoDB tables.

--kill-long-query-type=all|select
This option specifies which types of queries should be killed to unblock the global lock. Default is "all".

--lock-ddl
Issue `LOCK TABLES FOR BACKUP` if it is supported by server (otherwise use `LOCK INSTANCE FOR BACKUP`) at the beginning of the backup to block all DDL operations.

--lock-ddl-per-table
Lock DDL for each table before xtrabackup starts to copy it and until the backup is completed.

--lock-ddl-timeout
If `LOCK TABLES FOR BACKUP` or `LOCK INSTANCE FOR BACKUP` does not return within given timeout, abort the backup.

--log
This option is ignored for *MySQL*

--log-bin
The base name for the log sequence.

--log-bin-index=name
File that holds the names for binary log files.

--log-copy-interval=#
This option specifies the time interval between checks done by the log copying thread in milliseconds (default is 1 second).

--login-path
Read the given path from the login file.

--move-back
Move all the files in a previously made backup from the backup directory to their original locations. As this option removes backup files, it must be used with caution.

--no-backup-locks
Explicity disables the *--backup-locks* option which is enabled by default.

--no-defaults
The default options are only read from the login file.

--no-lock
Use this option to disable table lock with `FLUSH TABLES WITH READ LOCK`. Use it only if ALL your tables are InnoDB and you **DO NOT CARE** about the binary log position of the backup. This option shouldn't be used if there are any `DDL` statements being executed or if any updates are happening on non-InnoDB tables (this includes the system MyISAM tables in the *mysql* database), otherwise it could lead to an inconsistent backup. Where supported **xtrabackup** will automatically use Backup Locks as a lightweight alternative to `FLUSH TABLES WITH READ LOCK` to copy non-InnoDB data to avoid blocking DML queries that modify InnoDB tables. If you are considering to use this because your backups are failing to acquire the lock, this could be because of incoming replication events are preventing the lock from succeeding. Please try using *--safe-slave-backup* to momentarily stop the replication slave thread, this may help the backup to succeed and you do not need to use this option.

`xtrabackup_binlog_info` is not created when –no-lock option is used (because `SHOW MASTER STATUS` may be inconsistent), but under certain conditions `xtrabackup_binlog_pos_innodb` can be used instead to get consistent binlog coordinates as described in *Working with Binary Logs*.

--no-version-check
This option disables the version check. If you do not pass this option, the automatic version check is enabled implicitly when **xtrabackup** runs in the `--backup` mode. To disable the version check, you should pass explicitly the `--no-version-check` option when envoking **xtrabackup**.

When the automatic version check is enabled, **xtrabackup** performs a version check against the server on the backup stage after creating a server connection. **xtrabackup** sends the following information to the server:

- MySQL flavour and version
- Operating system name
- Percona Toolkit version
- Perl version

Each piece of information has a unique identifier. This is a MD5 hash value that Percona Toolkit uses to obtain statistics about how it is used. This is a random UUID; no client information is either collected or stored.

`--open-files-limit``=#`
The maximum number of file descriptors to reserve with setrlimit().

`--parallel``=#`
This option specifies the number of threads to use to copy multiple data files concurrently when creating a backup. The default value is 1 (i.e., no concurrent transfer). In *Percona XtraBackup* 2.3.10 and newer, this option can be used with the *`--copy-back`* option to copy the user data files in parallel (redo logs and system tablespaces are copied in the main thread).

`--password``=PASSWORD`
This option specifies the password to use when connecting to the database. It accepts a string argument. See **`mysql --help`** for details.

`--plugin-load`
List of plugins to load.

`--port``=PORT`
This option accepts a string argument that specifies the port to use when connecting to the database server with TCP/IP. It is passed to the **`mysql`** child process without alteration. See **`mysql --help`** for details.

`--prepare`
Makes **`xtrabackup`** perform a recovery on a backup created with *`--backup`*, so that it is ready to use. See *preparing a backup*.

`--print-defaults`
Print the program argument list and exit. Must be given as the first option on the command-line.

`--print-param`
Makes **`xtrabackup`** print out parameters that can be used for copying the data files back to their original locations to restore them.

`--read-buffer-size`
Set the datafile read buffer size, given value is scaled up to page size. Default is 10Mb.

`--rebuild-indexes`
Rebuilds indexes in a compact backup. This option only has effect when the *`--prepare`* and *`--rebuild-threads`* options are provided.

`--rebuild-threads``=#`
Uses the given number of threads to rebuild indexes in a compact backup. This option only has effect with the *`--prepare`* and *`--rebuild-indexes`* options.

`--remove-original`
Implemented in *Percona XtraBackup* 2.4.6, this option when specified will remove `.qp`, `.xbcrypt` and `.qp.xbcrypt` files after decryption and decompression.

`--rocksdb-datadir`
RocksDB data directory

`--rocksdb-wal-dir`
RocksDB WAL directory.

`--rocksdb-checkpoint-max-age`
The checkpoint cannot be older than this number of seconds when the backup completes.

`--rocksdb-checkpoint-max-count`
Complete the backup even if the checkpoint age requirement has not been met after this number of checkpoints.

`--rollback-prepared-trx`
Force rollback prepared InnoDB transactions.

`--rsync`
Uses the **`rsync`** utility to optimize local file transfers. When this option is specified, **`xtrabackup`** uses **`rsync`** to copy all non-InnoDB files instead of spawning a separate **`cp`** for each file, which can be much faster for servers with a large number of databases or tables. This option cannot be used together with *`--stream`*.

`--safe-slave-backup`
When specified, xtrabackup will stop the slave SQL thread just before running `FLUSH TABLES WITH READ LOCK` and wait to start backup until `Slave_open_temp_tables` in `SHOW STATUS` is zero. If there are no open temporary tables, the backup will take place, otherwise the SQL thread will be started and stopped until there are no open temporary tables. The backup will fail if `Slave_open_temp_tables` does not become zero after *`--safe-slave-backup-timeout`* seconds. The slave SQL thread will be restarted when the backup finishes. This option is implemented in order to deal with replicating temporary tables and isn't neccessary with Row-Based-Replication.

`--safe-slave-backup-timeout``=SECONDS`
How many seconds *`--safe-slave-backup`* should wait for `Slave_open_temp_tables` to become zero. Defaults to 300 seconds.

`--secure-auth`
Refuse client connecting to server if it uses old (pre-4.1.1) protocol. (Enabled by default; use –skip-secure-auth to disable.)

`--server-id``=#`
The server instance being backed up.

`--server-public-key-path`
The file path to the server public RSA key in the PEM format.

See also:

***MySQL* Documentation: The –server-public-key-path Option** https://dev.mysql.com/doc/refman/8.0/en/connection-options.html#option_general_server-public-key-path

`--skip-tables-compatibility-check`
See *`--tables-compatibility-check`*.

`--slave-info`
This option is useful when backing up a replication slave server. It prints the binary log position of the master server. It also writes the binary log coordinates to the `xtrabackup_slave_info` file as a `CHANGE MASTER` command. A new slave for this master can be set up by starting a slave server on this backup and issuing a `CHANGE MASTER` command with the binary log position saved in the `xtrabackup_slave_info` file.

`--socket`
This option accepts a string argument that specifies the socket to use when connecting to the local database server with a UNIX domain socket. It is passed to the mysql child process without alteration. See **`mysql --help`** for details.

`--ssl`
Enable secure connection. More information can be found in –ssl MySQL server documentation.

`--ssl-ca`
Path of the file which contains list of trusted SSL CAs. More information can be found in –ssl-ca MySQL server documentation.

--ssl-capath
Directory path that contains trusted SSL CA certificates in PEM format. More information can be found in –ssl-capath MySQL server documentation.

--ssl-cert
Path of the file which contains X509 certificate in PEM format. More information can be found in –ssl-cert MySQL server documentation.

--ssl-cipher
List of permitted ciphers to use for connection encryption. More information can be found in –ssl-cipher MySQL server documentation.

--ssl-crl
Path of the file that contains certificate revocation lists. More information can be found in –ssl-crl MySQL server documentation.

--ssl-crlpath
Path of directory that contains certificate revocation list files. More information can be found in –ssl-crlpath MySQL server documentation.

--ssl-fips-mode
SSL FIPS mode (applies only for OpenSSL); permitted values are: *OFF*, *ON*, *STRICT*.

--ssl-key
Path of file that contains X509 key in PEM format. More information can be found in –ssl-key MySQL server documentation.

--ssl-mode
Security state of connection to server. More information can be found in –ssl-mode MySQL server documentation.

--ssl-verify-server-cert
Verify server certificate Common Name value against host name used when connecting to server. More information can be found in –ssl-verify-server-cert MySQL server documentation.

--stats
Causes **xtrabackup** to scan the specified data files and print out index statistics.

--stream=FORMAT
Stream all backup files to the standard output in the specified format. Currently, this option only supports the *xbstream* format.

--strict
If this option is specified, **xtrabackup** fails with an error when invalid parameters are passed.

--tables=name
A regular expression against which the full tablename, in `databasename.tablename` format, is matched. If the name matches, the table is backed up. See *partial backups*.

--tables-compatibility-check
Enables the engine compatibility warning. The default value is ON. To disable the engine compatibility warning use *--skip-tables-compatibility-check*.

--tables-exclude=name
Filtering by regexp for table names. Operates the same way as *--tables*, but matched names are excluded from backup. Note that this option has a higher priority than *--tables*.

--tables-file=name
A file containing one table name per line, in databasename.tablename format. The backup will be limited to the specified tables.

--target-dir=DIRECTORY
This option specifies the destination directory for the backup. If the directory does not exist, **xtrabackup** creates it. If the directory does exist and is empty, **xtrabackup** will succeed. **xtrabackup** will not overwrite existing files, however; it will fail with operating system error 17, `file exists`.

If this option is a relative path, it is interpreted as being relative to the current working directory from which **xtrabackup** is executed.

In order to perform a backup, you need `READ`, `WRITE`, and `EXECUTE` permissions at a filesystem level for the directory that you supply as the value of *--target-dir*.

--innodb-temp-tablespaces-dir=DIRECTORY
Directory where temp tablespace files live, this path can be absolute.

--throttle=#
This option limits the number of chunks copied per second. The chunk size is *10 MB*. To limit the bandwidth to *10 MB/s*, set the option to *1*: *–throttle=1*.

See also:

More information about how to throttle a backup *Throttling Backups*

--tls-ciphersuites
TLS v1.3 cipher to use.

--tls-version
TLS version to use, permitted values are: *TLSv1*, *TLSv1.1*, *TLSv1.2*, *TLSv1.3*.

--tmpdir=name
Specify the directory that will be used to store temporary files during the backup

--transition-key=name
This option is used to enable processing the backup without accessing the keyring vault server. In this case, **xtrabackup** derives the AES encryption key from the specified passphrase and uses it to encrypt tablespace keys of tablespaces being backed up.

If *--transition-key* does not have any value, **xtrabackup** will ask for it. The same passphrase should be specified for the *--prepare* command.

--use-memory
This option affects how much memory is allocated for preparing a backup with *--prepare*, or analyzing statistics with *--stats*. Its purpose is similar to *innodb_buffer_pool_size*. It does not do the same thing as the similarly named option in Oracle's InnoDB Hot Backup tool. The default value is 100MB, and if you have enough available memory, 1GB to 2GB is a good recommended value. Multiples are supported providing the unit (e.g. 1MB, 1M, 1GB, 1G).

--user=USERNAME
This option specifies the MySQL username used when connecting to the server, if that's not the current user. The option accepts a string argument. See mysql –help for details.

-v
See *--version*

--version
This option prints **xtrabackup** version and exits.

--xtrabackup-plugin-dir=DIRNAME
The absolute path to the directory that contains the `keyring` plugin.

See also:

***Percona Server for MySQL* Documentation: keyring_vault plugin with Data at Rest Encryption** https://www.percona.com/doc/percona-server/LATEST/management/data_at_rest_encryption.html#keyring-vault-plugin

***MySQL* Documentation: Using the keyring_file File-Based Plugin** https://dev.mysql.com/doc/refman/5.7/en/keyring-file-plugin.html

The xbstream binary

To support simultaneous compression and streaming, a new custom streaming format called xbstream was introduced to *Percona XtraBackup* in addition to the TAR format. That was required to overcome some limitations of traditional archive formats such as tar, cpio and others which did not allow streaming dynamically generated files, for example dynamically compressed files. Other advantages of xbstream over traditional streaming/archive format include ability to stream multiple files concurrently (so it is possible to use streaming in the xbstream format together with the –parallel option) and more compact data storage.

This utility has a tar-like interface:

- with the `-x` option it extracts files from the stream read from its standard input to the current directory unless specified otherwise with the `-c` option. Support for parallel extraction with the `--parallel` option has been implemented in *Percona XtraBackup* 2.4.7.
- with the `-c` option it streams files specified on the command line to its standard output.
- with the `--decrypt=ALGO` option specified xbstream will automatically decrypt encrypted files when extracting input stream. Supported values for this option are: `AES128`, `AES192`, and `AES256`. Either `--encrypt-key` or `--encrypt-key-file` options must be specified to provide encryption key, but not both. This option has been implemented in *Percona XtraBackup* 2.4.7.
- with the `--encrypt-threads` option you can specify the number of threads for parallel data encryption. The default value is `1`. This option has been implemented in *Percona XtraBackup* 2.4.7.
- the `--encrypt-key` option is used to specify the encryption key that will be used. It can't be used with `--encrypt-key-file` option because they are mutually exclusive. This option has been implemented in *Percona XtraBackup* 2.4.7.
- the `--encrypt-key-file` option is used to specify the file that contains the encryption key. It can't be used with `--encrypt-key` option. because they are mutually exclusive. This option has been implemented in *Percona XtraBackup* 2.4.7.

The utility also tries to minimize its impact on the OS page cache by using the appropriate `posix_fadvise()` calls when available.

When compression is enabled with **`xtrabackup`** all data is being compressed, including the transaction log file and meta data files, using the specified compression algorithm. The only currently supported algorithm is `quicklz`.

The resulting files have the qpress archive format, i.e., every `*.qp` file produced by **`xtrabackup`** is essentially a one-file qpress archive and can be extracted and uncompressed by the qpress file archiver. This means that there is no need to decompress entire backup to restore a single table as with `tar.gz`.

To decompress individual files, run *xbstream* with the *`--decompress`* option. You may control the number of threads used for decompressing by passing the *`--decompress-threads`* option.

Also, files can be decompressed using the **qpress** tool that can be downloaded from here. Qpress supports multi-threaded decompression.

The xbcrypt binary

To support encryption and decryption of the backups, a new tool `xbcrypt` was introduced to *Percona XtraBackup*.

This utility has been modeled after *The xbstream binary* to perform encryption and decryption outside of *Percona XtraBackup*. `xbcrypt` has following command line options:

-d, --decrypt
Decrypt data input to output.

-i, --input=name
Optional input file. If not specified, input will be read from standard input.

-o, --output=name
Optional output file. If not specified, output will be written to standard output.

-a, --encrypt-algo=name
Encryption algorithm.

-k, --encrypt-key=name
Encryption key.

-f, --encrypt-key-file=name
File which contains encryption key.

-s, --encrypt-chunk-size=#
Size of working buffer for encryption in bytes. The default value is 64K.

--encrypt-threads=#
This option specifies the number of worker threads that will be used for parallel encryption/decryption.

-v, --verbose
Display verbose status output.

The xbcloud Binary

The purpose of *xbcloud* is to download and upload full or part of *xbstream* archive from/to cloud. *xbcloud* will not overwrite the backup with the same name. *xbcloud* accepts input via a pipe from *xbstream* so that it can be invoked as a pipeline with **`xtrabackup`** to stream directly to the cloud without needing a local storage.

xbcloud stores each chunk as a separate object with a name `backup_name/database/table.ibd.NNNNNNNNNNNNNNNNNNNN`, where `NNN...` is a 0-padded serial number of chunk within file. Size of chunk produced by **`xtrabackup`** and *xbstream* changed to 10M.

xbcloud has three essential operations: *put*, *get*, and *delete*. With these operations, backups are created, stored, retrieved, restored, and deleted. *xbcloud* operations clearly map to similar operations within the AWS S3 API.

Supported Cloud Storage Types

In addition to Swift, which has been the only option for storing backups in a cloud storage until *Percona XtraBackup* 2.4.14, *xbcloud* supports Amazon S3, MinIO, and Google Cloud Storage. Other Amazon S3 compatible storages, such as Wasabi or Digital Ocean Spaces, are also supported.

See also:

OpenStack Object Storage ("Swift") https://wiki.openstack.org/wiki/Swift

Amazon Simple Storage Service https://aws.amazon.com/s3/

MinIO https://min.io/

Google Cloud Storage https://cloud.google.com/storage/

Wasabi https://wasabi.com/

Digital Ocean Spaces https://www.digitalocean.com/products/spaces/

Usage

```
$ xtrabackup --backup --stream=xbstream --target-dir=/tmp | xbcloud \
put [options] <name>
```

Creating a full backup with Swift

The following example shows how to make a full backup and upload it to Swift.

```
$ xtrabackup --backup --stream=xbstream --extra-lsndir=/tmp --target-dir=/tmp | \
xbcloud put --storage=swift \
--swift-container=test \
--swift-user=test:tester \
--swift-auth-url=http://192.168.8.80:8080/ \
--swift-key=testing \
--parallel=10 \
full_backup
```

Creating a full backup with Amazon S3

```
$ xtrabackup --backup --stream=xbstream --extra-lsndir=/tmp --target-dir=/tmp | \
xbcloud put --storage=s3 \
--s3-endpoint='s3.amazonaws.com' \
--s3-access-key='YOUR-ACCESSKEYID' \
--s3-secret-key='YOUR-SECRETACCESSKEY' \
--s3-bucket='mysql_backups'
--parallel=10 \
${date -I}-full_backup
```

The following options are available when using Amazon S3:

Option	Details
–s3-access-key	Use to supply the AWS access key ID
–s3-secret-key	Use to supply the AWS secret access key
–s3-bucket	Use supply the AWS bucket name
–s3-region	Use to specify the AWS region. The default value is **us-east-1**
–s3-api-version = <AUTO|2|4>	Select the signing algorithm. The default value is AUTO. In this case, *xbcloud* will probe.
–s3-bucket-lookup = <AUTO|PATH|DNS>	Specify whether to use **bucket.endpoint.com** or *endpoint.com/bucket** style requests. The default value is AUTO. In this case, *xbcloud* will probe.

Creating a full backup with MinIO

```
$ xtrabackup --backup --stream=xbstream --extra-lsndir=/tmp --target-dir=/tmp | \
xbcloud put --storage=s3 \
--s3-endpoint='play.minio.io:9000' \
--s3-access-key='YOUR-ACCESSKEYID' \
--s3-secret-key='YOUR-SECRETACCESSKEY' \
--s3-bucket='mysql_backups'
--parallel=10 \
${date -I}-full_backup
```

Creating a full backup with Google Cloud Storage

The support for Google Cloud Storage is implemented using the interoperability mode. This mode was especially designed to interact with cloud services compatible with Amazon S3.

See also:

Cloud Storage Interoperability https://cloud.google.com/storage/docs/interoperability

```
$ xtrabackup --backup --stream=xbstream --extra-lsndir=/tmp --target-dir=/tmp | \
xbcloud put --storage=google \
--google-endpoint=`storage.googleapis.com` \
--google-access-key='YOUR-ACCESSKEYID' \
--google-secret-key='YOUR-SECRETACCESSKEY' \
--google-bucket='mysql_backups'
--parallel=10 \
${date -I}-full_backup
```

The following options are available when using Google Cloud Storage:

- –google-access-key = <ACCESS KEY ID>
- –google-secret-key = <SECRET ACCESS KEY>
- –google-bucket = <BUCKET NAME>

Supplying parameters

Each storage type has mandatory parameters that you can supply on the command line, in a configuration file, and via environment variables.

Configuration files

The parameters the values of which do not change frequently can be stored in `my.cnf` or in a custom configuration file. The following example is a template of configuration options under the `[xbcloud]` group:

```
[xbcloud]
storage=s3
s3-endpoint=http://localhost:9000/
s3-access-key=minio
s3-secret-key=minio123
s3-bucket=backupsx
s3-bucket-lookup=path
s3-api-version=4
```

Note: If you explicitly use a parameter on the command line and in a configuration file, *xbcloud* uses the the value provided on the command line.

Environment variables

The following environment variables are recognized. *xbcloud* maps them automatically to corresponding parameters applicable to the selected storage.

- AWS_ACCESS_KEY_ID (or ACCESS_KEY_ID)
- AWS_SECRET_ACCESS_KEY (or SECRET_ACCESS_KEY)
- AWS_DEFAULT_REGION (or DEFAULT_REGION)
- AWS_ENDPOINT (or ENDPOINT)
- AWS_CA_BUNDLE

Note: If you explicitly use a parameter on the command line, in a configuration file, and the corresponding environment variable contains a value, *xbcloud* uses the the value provided on the command line or in the configuration file.

OpenStack environment variables are also recognized and mapped automatically to corresponding **swift** parameters (`--storage=swift`).

- OS_AUTH_URL
- OS_TENANT_NAME
- OS_TENANT_ID
- OS_USERNAME
- OS_PASSWORD
- OS_USER_DOMAIN
- OS_USER_DOMAIN_ID
- OS_PROJECT_DOMAIN
- OS_PROJECT_DOMAIN_ID
- OS_REGION_NAME
- OS_STORAGE_URL
- OS_CACERT

Shortcuts

For all operations (put, get, and delete), you can use a shortcut to specify the storage type, bucket name, and backup name as one parameter instead of using three distinct parameters (–storage, –s3-bucket, and backup name per se).

Using a shortcut syntax to provide a storage type, bucket, and backup name

Use the following format: `storage-type://bucket-name/backup-name`

```
$ xbcloud get s3://operator-testing/bak22 ...
```

In this example, **s3** refers to a storage type, **operator-testing** is a bucket name, and **bak22** is the backup name. This shortcut expands as follows:

```
$ xbcloud get --storage=s3 --s3-bucket=operator-testing bak22 ...
```

You can supply the mandatory parameters not only on the command line. You may use configuration files and environment variables.

Additional parameters

xbcloud accepts additional parameters that you can use with any storage type. The --md5 parameter computes the MD5 hash value of the backup chunks. The result is stored in files that following the backup_name.md5 pattern.

```
$ xtrabackup --backup --stream=xbstream \
--parallel=8 2>backup.log | xbcloud put s3://operator-testing/bak22 \
--parallel=8 --md5 2>upload.log
```

You may use the --header parameter to pass an additional HTTP header with the server side encryption while specifying a customer key.

Example of using –header for AES256 encryption

```
$ xtrabackup --backup --stream=xbstream --parallel=4 | \
xbcloud put s3://operator-testing/bak-enc/ \
--header="X-Amz-Server-Side-Encryption-Customer-Algorithm: AES256" \
--header="X-Amz-Server-Side-Encryption-Customer-Key: CuStoMerKey=" \
--header="X-Amz-Server-Side-Encryption-Customer-Key-MD5: CuStoMerKeyMd5==" \
--parallel=8
```

The --header parameter is also useful to set the access control list (ACL) permissions: --header="x-amz-acl: bucket-owner-full-control

Restoring with Swift

```
$ xbcloud get [options] <name> [<list-of-files>] | xbstream -x
```

The following example shows how to fetch and restore the backup from Swift:

```
$ xbcloud get --storage=swift \
--swift-container=test \
--swift-user=test:tester \
--swift-auth-url=http://192.168.8.80:8080/ \
--swift-key=testing \
full_backup | xbstream -xv -C /tmp/downloaded_full

$ xbcloud delete --storage=swift --swift-user=xtrabackup \
--swift-password=xtrabackup123! --swift-auth-version=3 \
--swift-auth-url=http://openstack.ci.percona.com:5000/ \
--swift-container=mybackup1 --swift-domain=Default
```

Restoring with Amazon S3

```
$ xbcloud get s3://operator-testing/bak22 \
--s3-endpoint=https://storage.googleapis.com/ \
--parallel=10 2>download.log | xbstream -x -C restore --parallel=8
```

Incremental backups

First, you need to make the full backup on which the incremental one is going to be based:

```
xtrabackup --backup --stream=xbstream --extra-lsndir=/storage/backups/ \
--target-dir=/storage/backups/ | xbcloud put \
--storage=swift --swift-container=test_backup \
--swift-auth-version=2.0 --swift-user=admin \
--swift-tenant=admin --swift-password=xoxoxoxo \
--swift-auth-url=http://127.0.0.1:35357/ --parallel=10 \
full_backup
```

Then you can make the incremental backup:

```
$ xtrabackup --backup --incremental-basedir=/storage/backups \
--stream=xbstream --target-dir=/storage/inc_backup | xbcloud put \
--storage=swift --swift-container=test_backup \
--swift-auth-version=2.0 --swift-user=admin \
--swift-tenant=admin --swift-password=xoxoxoxo \
--swift-auth-url=http://127.0.0.1:35357/ --parallel=10 \
inc_backup
```

Preparing incremental backups

To prepare a backup you first need to download the full backup:

```
$ xbcloud get --swift-container=test_backup \
--swift-auth-version=2.0 --swift-user=admin \
--swift-tenant=admin --swift-password=xoxoxoxo \
--swift-auth-url=http://127.0.0.1:35357/ --parallel=10 \
full_backup | xbstream -xv -C /storage/downloaded_full
```

Once you download the full backup it should be prepared:

```
$ xtrabackup --prepare --apply-log-only --target-dir=/storage/downloaded_full
```

After the full backup has been prepared you can download the incremental backup:

```
$ xbcloud get --swift-container=test_backup \
--swift-auth-version=2.0 --swift-user=admin \
--swift-tenant=admin --swift-password=xoxoxoxo \
--swift-auth-url=http://127.0.0.1:35357/ --parallel=10 \
inc_backup | xbstream -xv -C /storage/downloaded_inc
```

Once the incremental backup has been downloaded you can prepare it by running:

```
$ xtrabackup --prepare --apply-log-only \
--target-dir=/storage/downloaded_full \
--incremental-dir=/storage/downloaded_inc

$ xtrabackup --prepare --target-dir=/storage/downloaded_full
```

Partial download of the cloud backup

If you do not want to download the entire backup to restore the specific database you can specify only the tables you want to restore:

```
$ xbcloud get --swift-container=test_backup
--swift-auth-version=2.0 --swift-user=admin \
--swift-tenant=admin --swift-password=xoxoxoxo \
--swift-auth-url=http://127.0.0.1:35357/ full_backup \
ibdata1 sakila/payment.ibd \
> /storage/partial/partial.xbs

$ xbstream -xv -C /storage/partial < /storage/partial/partial.xbs
```

This command will download just `ibdata1` and `sakila/payment.ibd` table from the full backup.

Command-line options

xbcloud has the following command line options:

--storage=[swift|s3|google]
Cloud storage option. *xbcloud* supports Swift, MinIO, and AWS S3. The default value is `swift`.

--swift-auth-url
URL of Swift cluster.

--swift-storage-url
xbcloud will try to get object-store URL for given region (if any specified) from the keystone response. One can override that URL by passing –swift-storage-url=URL argument.

--swift-user
Swift username (X-Auth-User, specific to Swift)

--swift-key
Swift key/password (X-Auth-Key, specific to Swift)

--swift-container
Container to backup into (specific to Swift)

--parallel=N
Maximum number of concurrent upload/download threads. Default is `1`.

--cacert
Path to the file with CA certificates

--insecure
Do not verify servers certificate

Swift authentication options

Swift specification describes several authentication options. *xbcloud* can authenticate against keystone with API version 2 and 3.

--swift-auth-version
Specifies the swift authentication version. Possible values are: `1.0` - TempAuth, `2.0` - Keystone v2.0, and `3` - Keystone v3. Default value is `1.0`.

For v2 additional options are:

--swift-tenant
Swift tenant name.

--swift-tenant-id
Swift tenant ID.

`--swift-region`
Swift endpoint region.

`--swift-password`
Swift password for the user.

For v3 additional options are:

`--swift-user-id`
Swift user ID.

`--swift-project`
Swift project name.

`--swift-project-id`
Swift project ID.

`--swift-domain`
Swift domain name.

`--swift-domain-id`
Swift domain ID.

Percona XtraBackup is a set of the following tools:

xtrabackup a compiled *C* binary that provides functionality to backup a whole *MySQL* database instance with *MyISAM*, *InnoDB*, and *XtraDB* tables.

xbcrypt utility used for encrypting and decrypting backup files.

xbstream utility that allows streaming and extracting files to/from the *xbstream* format.

xbcloud utility used for downloading and uploading full or part of *xbstream* archive from/to cloud.

After *Percona XtraBackup* 2.3 release, the recommend way to take the backup is by using the **`xtrabackup`** script. More information on script options can be found in *how to use xtrabackup*.

Part VI

Advanced Features

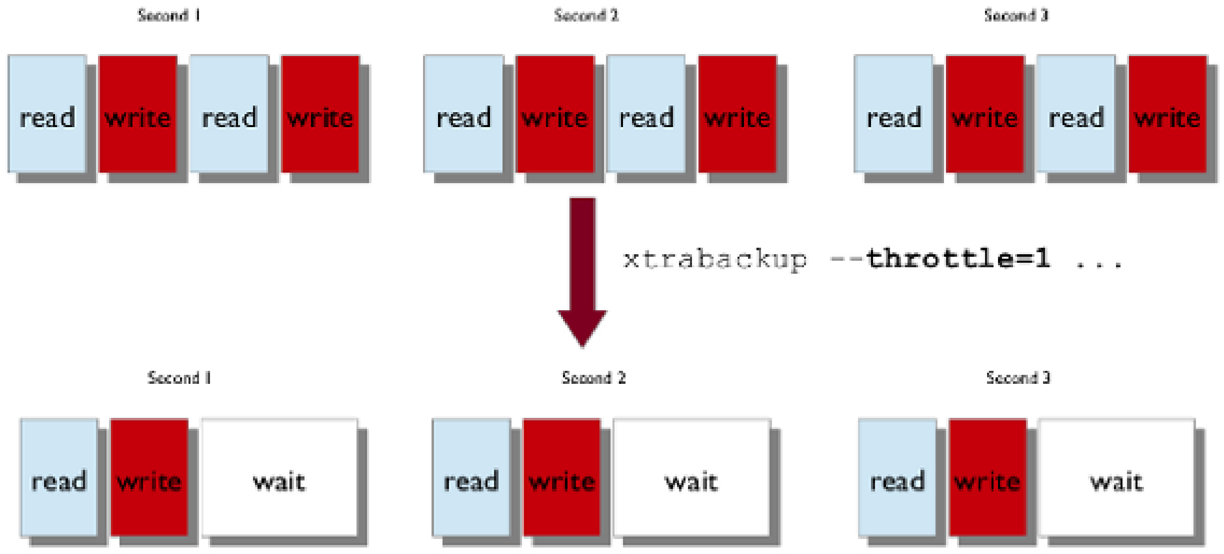
CHAPTER

TEN

THROTTLING BACKUPS

Although **xtrabackup** does not block your database's operation, any backup can add load to the system being backed up. On systems that do not have much spare I/O capacity, it might be helpful to throttle the rate at which **xtrabackup** reads and writes data. You can do this with the *--throttle* option. This option limits the number of chunks copied per second. The chunk +size is *10 MB*.

The image below shows how throttling works when *--throttle* is set to 1.



When specified with the *--backup* option, this option limits the number of pairs of read-and-write operations per second that **xtrabackup** will perform. If you are creating an incremental backup, then the limit is the number of read I/O operations per second.

By default, there is no throttling, and **xtrabackup** reads and writes data as quickly as it can. If you set too strict of a limit on the IOPS, the backup might be so slow that it will never catch up with the transaction logs that InnoDB is writing, so the backup might never complete.

CHAPTER

ELEVEN

ENCRYPTED INNODB TABLESPACE BACKUPS

Starting from *MySQL* 5.7, InnoDB supports data encryption for InnoDB tables stored in file-per-table tablespaces. This feature provides at-rest encryption for physical tablespace data files.

For an authenticated user or application to access an encrypted tablespace, InnoDB will use the master encryption key to decrypt the tablespace key. The master encryption key is stored in a keyring. **xtrabackup** supports two keyring plugins: `keyring_file`, and `keyring_vault`. These plugins are installed into the `plugin` directory.

Making a backup

Using `keyring_file` plugin

In order to backup and prepare a database containing encrypted InnoDB tablespaces, specify the path to a keyring file as the value of the `--keyring-file-data` option.

```
$ xtrabackup --backup --target-dir=/data/backup/ --user=root \
--keyring-file-data=/var/lib/mysql-keyring/keyring
```

Note: for use with *MySQL* prior to 5.7.13, the `--server-id` option is added to the backup creation command, making the previous example look like the following:

```
$ xtrabackup --backup --target-dir=/data/backup/ --user=root \
--keyring-file-data=/var/lib/mysql-keyring/keyring --server-id=1
```

After **xtrabackup** is finished taking the backup, you should see the following message:

```
xtrabackup: Transaction log of lsn (5696709) to (5696718) was copied.
160401 10:25:51 completed OK!
```

Warning: **xtrabackup** will not copy the keyring file into the backup directory. In order to prepare the backup, you must make a copy of the keyring file yourself.

Preparing the Backup

In order to prepare the backup you need to specify the keyring-file-data (server-id is stored in the `backup-my.cnf` file, so it can be omitted when preparing the backup, regardless of the *MySQL* version used).

```
$ xtrabackup --prepare --target-dir=/data/backup \
--keyring-file-data=/var/lib/mysql-keyring/keyring
```

After **xtrabackup** is finished preparing the backup, you should see the following message:

```
InnoDB: Shutdown completed; log sequence number 5697064
160401 10:34:28 completed OK!
```

The backup is now prepared and can be restored with the *--copy-back* option. In case the keyring has been rotated, you need to restore the keyring which was used to take and prepare the backup.

Using `keyring_vault` plugin

The support for encrypted InnoDB tablespace backups with `keyring_vault` has been implemented in *Percona XtraBackup* 2.4.11. Keyring vault plugin settings are described here.

Creating Backup

Command like

```
$ xtrabackup --backup --target-dir=/data/backup --user=root
```

will create a backup in the `/data/backup` directory.

After **xtrabackup** is finished taking the backup you should see the following message:

```
xtrabackup: Transaction log of lsn (5696709) to (5696718) was copied.
160401 10:25:51 completed OK!
```

Preparing the Backup

In order to prepare the backup **xtrabackup** will need an access to the keyring. Since **xtrabackup** doesn't talk to *MySQL* server and doesn't read the default `my.cnf` configuration file during prepare, the user will need to specify keyring settings via the command line:

```
$ xtrabackup --prepare --target-dir=/data/backup \
--keyring-vault-config=/etc/vault.cnf
```

Note: Please look here for a description of keyring vault plugin settings.

After **xtrabackup** is finished preparing the backup, you should see the following message:

```
InnoDB: Shutdown completed; log sequence number 5697064
160401 10:34:28 completed OK!
```

The backup is now prepared and can be restored with the *--copy-back* option:

```
$ xtrabackup --copy-back --target-dir=/data/backup --datadir=/data/mysql
```

Incremental Encrypted InnoDB tablespace backups with `keyring_file`

The process of taking incremental backups with InnoDB tablespace encryption is similar to taking the *Incremental Backups* with unencrypted tablespace.

Creating an Incremental Backup

To make an incremental backup, begin with a full backup. The **xtrabackup** binary writes a file called `xtrabackup_checkpoints` into the backup's target directory. This file contains a line showing the `to_lsn`, which is the database's *LSN* at the end of the backup. First you need to create a full backup with the following command:

```
$ xtrabackup --backup --target-dir=/data/backups/base \
--keyring-file-data=/var/lib/mysql-keyring/keyring
```

Warning: **xtrabackup** will not copy the keyring file into the backup directory. In order to prepare the backup, you must make a copy of the keyring file yourself. If you try to restore the backup after the keyring has been changed you'll see errors like `ERROR 3185 (HY000): Can't find master key from keyring, please check keyring plugin is loaded.` when trying to access encrypted table.

If you look at the `xtrabackup_checkpoints` file, you should see contents similar to the following:

```
backup_type = full-backuped
from_lsn = 0
to_lsn = 7666625
last_lsn = 7666634
compact = 0
recover_binlog_info = 1
```

Now that you have a full backup, you can make an incremental backup based on it. Use a command such as the following:

```
$ xtrabackup --backup --target-dir=/data/backups/inc1 \
--incremental-basedir=/data/backups/base \
--keyring-file-data=/var/lib/mysql-keyring/keyring
```

Warning: **xtrabackup** will not copy the keyring file into the backup directory. In order to prepare the backup, you must make a copy of the keyring file yourself. If the keyring hasn't been rotated you can use the same as the one you've backed-up with the base backup. If the keyring has been rotated you'll need to back it up otherwise you won't be able to prepare the backup.

The /data/backups/inc1/ directory should now contain delta files, such as ibdata1.delta and test/table1.ibd.delta. These represent the changes since the LSN 7666625. If you examine the xtrabackup_checkpoints file in this directory, you should see something similar to the following:

```
backup_type = incremental
from_lsn = 7666625
to_lsn = 8873920
last_lsn = 8873929
compact = 0
recover_binlog_info = 1
```

The meaning should be self-evident. It's now possible to use this directory as the base for yet another incremental backup:

```
$ xtrabackup --backup --target-dir=/data/backups/inc2 \
--incremental-basedir=/data/backups/inc1 \
--keyring-file-data=/var/lib/mysql-keyring/keyring
```

Preparing Incremental Backups

The *--prepare* step for incremental backups is not the same as for normal backups. In normal backups, two types of operations are performed to make the database consistent: committed transactions are replayed from the log file against the data files, and uncommitted transactions are rolled back. You must skip the rollback of uncommitted transactions when preparing a backup, because transactions that were uncommitted at the time of your backup may be in progress, and it's likely that they will be committed in the next incremental backup. You should use the *--apply-log-only* option to prevent the rollback phase.

Warning: If you do not use the *--apply-log-only* option to prevent the rollback phase, then your incremental backups will be useless. After transactions have been rolled back, further incremental backups cannot be applied.

Beginning with the full backup you created, you can prepare it and then apply the incremental differences to it. Recall that you have the following backups:

```
/data/backups/base
/data/backups/inc1
/data/backups/inc2
```

To prepare the base backup, you need to run *--prepare* as usual, but prevent the rollback phase:

```
$ xtrabackup --prepare --apply-log-only --target-dir=/data/backups/base \
--keyring-file-data=/var/lib/mysql-keyring/keyring
```

The output should end with some text such as the following:

```
InnoDB: Shutdown completed; log sequence number 7666643
InnoDB: Number of pools: 1
160401 12:31:11 completed OK!
```

To apply the first incremental backup to the full backup, you should use the following command:

```
$ xtrabackup --prepare --apply-log-only --target-dir=/data/backups/base \
--incremental-dir=/data/backups/inc1 \
--keyring-file-data=/var/lib/mysql-keyring/keyring
```

Warning: The backup should be prepared with the keyring that was used when backup was being taken. This means that if the keyring has been rotated between the base and incremental backup that you'll need to use the keyring that was in use when the first incremental backup has been taken.

Preparing the second incremental backup is a similar process: apply the deltas to the (modified) base backup, and you will roll its data forward in time to the point of the second incremental backup:

```
$ xtrabackup --prepare --target-dir=/data/backups/base \
--incremental-dir=/data/backups/inc2 \
--keyring-file-data=/var/lib/mysql-keyring/keyring
```

Note: *--apply-log-only* should be used when merging all incrementals except the last one. That's why the previous line doesn't contain the *--apply-log-only* option. Even if the *--apply-log-only* was used on the last step, backup would still be consistent but in that case server would perform the rollback phase.

The backup is now prepared and can be restored with *--copy-back* option. In case the keyring has been rotated you'll need to restore the keyring which was used to take and prepare the backup.

Restoring a Backup When Keyring Is not Available

While the described restore method works, it requires an access to the same keyring that the server is using. It may not be possible if the backup is prepared on a different server or at a much later time, when keys in the keyring are purged, or, in the case of a malfunction, when the keyring vault server is not available at all.

The `--transition-key=<passphrase>` option should be used to make it possible for **xtrabackup** to process the backup without access to the keyring vault server. In this case, **xtrabackup** derives the AES encryption key from the specified passphrase and will use it to encrypt tablespace keys of tablespaces that are being backed up.

Creating a Backup with a Passphrase

The following example illustrates how the backup can be created in this case:

```
$ xtrabackup --backup --user=root -p --target-dir=/data/backup \
--transition-key=MySecetKey
```

If `--transition-key` is specified without a value, **xtrabackup** will ask for it.

Note: **xtrabackup** scrapes `--transition-key` so that its value is not visible in the `ps` command output.

Preparing the Backup with a Passphrase

The same passphrase should be specified for the *prepare* command:

```
$ xtrabackup --prepare --target-dir=/data/backup
```

There is no `--keyring-vault...` or `--keyring-file...` options here, because **xtrabackup** does not talk to the keyring in this case.

Restoring the Backup with a Generated Key

When restoring a backup you will need to generate a new master key. Here is the example for `keyring_file`:

```
$ xtrabackup --copy-back --target-dir=/data/backup --datadir=/data/mysql \
--transition-key=MySecetKey --generate-new-master-key \
--keyring-file-data=/var/lib/mysql-keyring/keyring
```

In case of `keyring_vault`, it will look like this:

```
$ xtrabackup --copy-back --target-dir=/data/backup --datadir=/data/mysql \
--transition-key=MySecetKey --generate-new-master-key \
--keyring-vault-config=/etc/vault.cnf
```

`xtrabackup` will generate a new master key, store it in the target keyring vault server and re-encrypt the tablespace keys using this key.

Making the Backup with a Stored Transition Key

Finally, there is an option to store a transition key in the keyring. In this case, **`xtrabackup`** will need to access the same keyring file or vault server during prepare and copy-back but does not depend on whether the server keys have been purged.

In this scenario, the three stages of the backup process look as follows.

- Backup

  ```
  $ xtrabackup --backup --user=root -p --target-dir=/data/backup \
  --generate-transition-key

  .. warning::

     This usage of the :option:`--generate-transition-key` option is only
     applicable if |Percona XtraBackup| is used with |Percona Server| version
     lower than 8.0.15-6. For |Percona Server| versions higher than 8.0.15-6,
     :option:`--generate-transition-key` should not be used for making full
     backups with the `keyring_file` plugin.
  ```

- Prepare

  – `keyring_file` variant:

    ```
    $ xtrabackup --prepare --target-dir=/data/backup \
    --keyring-file-data=/var/lib/mysql-keyring/keyring
    ```

  – `keyring_vault` variant:

    ```
    $ xtrabackup --prepare --target-dir=/data/backup \
    --keyring-vault-config=/etc/vault.cnf
    ```

- Copy-back

  – `keyring_file` variant:

    ```
    $ xtrabackup --copy-back --target-dir=/data/backup --datadir=/data/mysql \
    --generate-new-master-key --keyring-file-data=/var/lib/mysql-keyring/keyring
    ```

- `keyring_vault` variant:

```
$ xtrabackup --copy-back --target-dir=/data/backup --datadir=/data/mysql \
--generate-new-master-key --keyring-vault-config=/etc/vault.cnf
```

Part VII

Tutorials, Recipes, How-tos

CHAPTER

TWELVE

HOW-TOS AND RECIPES

Recipes for `xtrabackup`

Making a Full Backup

Backup the InnoDB data and log files located in `/var/lib/mysql/` to `/data/backups/mysql/` (destination). Then, prepare the backup files to be ready to restore or use (make the data files consistent).

Making a backup

```
$ xtrabackup --backup --target-dir=/data/backup/mysql/
```

Preparing the backup twice

```
$ xtrabackup --prepare --target-dir=/data/backup/mysql/
$ xtrabackup --prepare --target-dir=/data/backup/mysql/
```

Success Criteria

- The exit status of xtrabackup is 0.
- In the second *`--prepare`* step, you should see InnoDB print messages similar to `Log file ./ib_logfile0 did not exist: new to be created`, followed by a line indicating the log file was created (creating new logs is the purpose of the second preparation).

Note: You might want to set the *`--use-memory`* option to a value close to the size of your buffer pool, if you are on a dedicated server that has enough free memory. More details *here*.

A more detailed explanation is *here*.

Making an Incremental Backup

Backup all InnoDB data and log files - located in `/var/lib/mysql/` - **once**, then make two daily incremental backups in `/data/backups/mysql/` (destination). Finally, prepare the backup files to be ready to restore or use.

Create one full backup

Making an incremental backup requires a full backup as a base:

```
xtrabackup --backup --target-dir=/data/backups/mysql/
```

It is important that you **do not run** the *--prepare* command yet.

Create two incremental backups

Suppose the full backup is on Monday, and you will create an incremental one on Tuesday:

```
xtrabackup --backup --target-dir=/data/backups/inc/tue/ \
      --incremental-basedir=/data/backups/mysql/
```

and the same policy is applied on Wednesday:

```
xtrabackup --backup --target-dir=/data/backups/inc/wed/ \
       --incremental-basedir=/data/backups/inc/tue/
```

Prepare the base backup

Prepare the base backup (Monday's backup):

```
xtrabackup --prepare --apply-log-only --target-dir=/data/backups/mysql/
```

Roll forward the base data to the first increment

Roll Monday's data forward to the state on Tuesday:

```
xtrabackup --prepare --apply-log-only --target-dir=/data/backups/mysql/ \
   --incremental-dir=/data/backups/inc/tue/
```

Roll forward again to the second increment

Roll forward again to the state on Wednesday:

```
xtrabackup --prepare --apply-log-only --target-dir=/data/backups/mysql/ \
   --incremental-dir=/data/backups/inc/wed/
```

Prepare the whole backup to be ready to use

Create the new logs by preparing it:

```
xtrabackup --prepare --target-dir=/data/backups/mysql/
```

Notes

- You might want to set the `--use-memory` to speed up the process if you are on a dedicated server that has enough free memory. More details *here*.
- A more detailed explanation is *here*.

Make a Streaming Backup

Stream mode sends the backup to `STDOUT` in the `xbstream` format instead of copying it to the directory named by the first argument. You can pipe the output to a local file, or, across the network, to another server.

To extract the resulting `xbstream` file, you **must** use the `xbstream` utility: `xbstream -x < backup.xbstream`.

Examples of Using `xbstream`

Task	Command
Stream the backup into an archive named `backup.xbstream`	`xtrabackup --backup --stream=xbstream --target-dir=./ > backup.xbstream`
Stream the backup into a *compressed* archive named `backup.xbstream`	`xtrabackup --backup --stream=xbstream --compress --target-dir=./ > backup.xbstream`
Encrypt the backup	$ xtrabackup –backup –stream=xbstream ./ > backup.xbstream gzip - | openssl des3 -salt -k “password” > backup.xbstream.gz.des3
Unpack the backup to the current directory	`xbstream -x < backup.xbstream`
Send the backup compressed directly to another host and unpack it	`xtrabackup --backup --compress --stream=xbstream --target-dir=./ | ssh user@otherhost "xbstream -x"`

Send the backup to another server using `netcat`.	On the destination host:
	`$ nc -l 9999 | cat - > /data/backups/`
	`↪backup.xbstream`
	On the source host:
	`$ xtrabackup --backup --stream=xbstream .`
	`↪/ | nc desthost 9999`

Send the backup to another server using a one-liner:	$ ssh user@desthost “(nc -l 9999 > /data/backups/backup.xbstream &)” && xtrabackup –backup –stream=xbstream ./ | nc desthost 9999
Throttle the throughput to 10MB/sec using the `pipe viewer` tool[1]	$ xtrabackup –backup –stream=xbstream ./ | pv -q -L10m ssh user@desthost “cat - > /data/backups/backup.xbstream”

Checksumming the backup during the streaming:	On the destination host:
	`$ nc -l 9999 | tee >(sha1sum >␣`
	`↪destination_checksum) > /data/backups/`
	`↪backup.xbstream`
	On the source host:
	`$ xtrabackup --backup --stream=xbstream .`
	`↪/ | tee >(sha1sum > source_checksum) |␣`
	`↪nc desthost 9999`
	Compare the checksums on the source host:
	`$ cat source_checksum`
	`65e4f916a49c1f216e0887ce54cf59bf3934dbad␣`
	`↪ -`
	Compare the checksums on the destination host:
	`$ cat destination_checksum`
	`65e4f916a49c1f216e0887ce54cf59bf3934dbad␣`
	`↪ -`

Parallel compression with parallel copying backup	`xtrabackup --backup --compress --compress-threads=8 --stream=xbstream --parallel=4 --target-dir=./ > backup.xbstream`

See also:

[1] Install from the official site or from the distribution package (`apt install pv`)

More information about streaming and compressing backups Section *Streaming Backups*

Making a Compressed Backup

In order to make a compressed backup, use the `--compress` option along with the `--backup` and `--target-dir` options. By default `--compress` uses the `quicklz` compression algorithm.

```
$ xtrabackup --backup --compress --target-dir=/data/backup
```

You can also use the `lz4` compression algorithm by setting :option:`--compress` to `lz4`.

```
$ xtrabackup --backup --compress=lz4 --target-dir=/data/backup
```

If you want to speed up the compression you can use the parallel compression, which can be enabled with `--compress-threads` option. The following example uses four threads for compression.

```
$ xtrabackup --backup --compress --compress-threads=4 --target-dir=/data/backup
```

Output should look like this

```
...

[01] Compressing ./imdb/comp_cast_type.ibd to /data/backup/imdb/comp_cast_type.ibd.qp
[01]        ...done
...
130801 11:50:24  xtrabackup: completed OK
```

Preparing the backup

Before you can prepare the backup you'll need to uncompress all the files with qpress (which is available from Percona Software repositories). You can use the following one-liner to uncompress all the files:

```
$ for bf in `find . -iname "*\.qp"`; do qpress -d $bf $(dirname $bf) && rm $bf; done
```

If you used the `lz4` compression algorithm change this script to search for `*.lz4` files:

```
$ for bf in `find . -iname "*\.lz4"`; do lz4 -d $bf $(dirname $bf) && rm $bf; done
```

You can decompress the backup by using the `--decompress` option:

```
$ xtrabackup --decompress --target-dir=/data/backup/
```

See also:

What is required to use the –*decompress* option effectively? `--decompress`

When the files are uncompressed you can prepare the backup with the `--apply-log-only` option:

```
$ xtrabackup --apply-log-only --target-dir=/data/backup/
```

You should check for a confirmation message:

```
130802 02:51:02  xtrabackup: completed OK!
```

Now the files in `/data/backup/` is ready to be used by the server.

Note: *Percona XtraBackup* doesn't automatically remove the compressed files. In order to clean up the backup directory users should remove the `*.qp` files.

Restoring the backup

Once the backup has been prepared you can use the `--copy-back` to restore the backup.

```
$ xtrabackup --copy-back --target-dir=/data/backup/
```

This will copy the prepared data back to its original location as defined by the `datadir` variable in your *my.cnf*.

After the confirmation message, you should check the file permissions after copying the data back.

```
130802 02:58:44  xtrabackup: completed OK!
```

You may need to adjust the file permissions. The following example demonstrates how to do it recursively by using **chown**:

```
$ chown -R mysql:mysql /var/lib/mysql
```

Now, your *data directory* contains the restored data. You are ready to start the server.

How-Tos

How to setup a slave for replication in 6 simple steps with Percona XtraBackup

Data is, by far, the most valuable part of a system. Having a backup done systematically and available for a rapid recovery in case of failure is admittedly essential to a system. However, it is not common practice because of its costs, infrastructure needed or even the boredom associated to the task. *Percona XtraBackup* is designed to solve this problem.

You can have almost real-time backups in 6 simple steps by setting up a replication environment with *Percona XtraBackup*.

All the things you will need

Setting up a slave for replication with *Percona XtraBackup* is really a very straightforward procedure. In order to keep it simple, here is a list of the things you need to follow the steps without hassles:

TheMaster A system with a *MySQL*-based server installed, configured and running. This system will be called `TheMaster`, as it is where your data is stored and the one to be replicated. We will assume the following about this system:

- the *MySQL* server is able to communicate with others by the standard TCP/IP port;
- the *SSH* server is installed and configured;
- you have a user account in the system with the appropriate permissions;
- you have a MySQL's user account with appropriate privileges.
- server has binlogs enabled and server-id set up to 1.

TheSlave Another system, with a *MySQL*-based server installed on it. We will refer to this machine as `TheSlave` and we will assume the same things we did about `TheMaster`, except that the server-id on `TheSlave` is 2.

Percona XtraBackup The backup tool we will use. It should be installed in both computers for convenience.

Note: It is not recommended to mix MySQL variants (Percona Server, MySQL) in your replication setup. This may produce incorrect `xtrabackup_slave_info` file when adding a new slave.

STEP 1: Make a backup on `TheMaster` and prepare it

At `TheMaster`, issue the following to a shell:

```
TheMaster$ xtrabackup --backup --user=yourDBuser --password=MaGiCdB1 --target-dir=/
↪path/to/backupdir
```

After this is finished you should get:

```
xtrabackup: completed OK!
```

This will make a copy of your *MySQL* data dir to the `/path/to/backupdir` directory. You have told *Percona XtraBackup* to connect to the database server using your database user and password, and do a hot backup of all your data in it (all *MyISAM*, *InnoDB* tables and indexes in them).

In order for snapshot to be consistent you need to prepare the data:

```
TheMaster$ xtrabackup --user=yourDBuser --password=MaGiCdB1 \
             --prepare --target-dir=/path/to/backupdir
```

You need to select path where your snapshot has been taken. If everything is ok you should get the same OK message. Now the transaction logs are applied to the data files, and new ones are created: your data files are ready to be used by the MySQL server.

Percona XtraBackup knows where your data is by reading your *my.cnf*. If you have your configuration file in a non-standard place, you should use the flag `--defaults-file =/location/of/my.cnf`.

If you want to skip writing the user name and password every time you want to access *MySQL*, you can set it up in `.mylogin.cnf` as follows:

```
mysql_config_editor set --login-path=client --host=localhost --user=root --password
```

For more information, see *MySQL Configuration Utility <https://dev.mysql.com/doc/refman/8.0/en/mysql-config-editor.html>*.

This is will give you root access to MySQL.

STEP 2: Copy backed up data to TheSlave

Use rsync or scp to copy the data from Master to Slave. If you're syncing the data directly to slave's data directory it's advised to stop the mysqld there.

```
TheMaster$ rsync -avpP -e ssh /path/to/backupdir TheSlave:/path/to/mysql/
```

After data has been copied you can back up the original or previously installed *MySQL* *datadir* (**NOTE**: Make sure mysqld is shut down before you move the contents of its datadir, or move the snapshot into its datadir.):

```
TheSlave$ mv /path/to/mysql/datadir /path/to/mysql/datadir_bak
```

and move the snapshot from `TheMaster` in its place:

```
TheSlave$ xtrabackup --move-back --target-dir=/path/to/mysql/backupdir
```

After you copy data over, make sure *MySQL* has proper permissions to access them.

```
TheSlave$ chown mysql:mysql /path/to/mysql/datadir
```

In case the ibdata and iblog files are located in different directories outside of the datadir, you will have to put them in their proper place after the logs have been applied.

STEP 3: Configure The Master's MySQL server

Add the appropriate grant in order for slave to be able to connect to master:

```
TheMaster|mysql> GRANT REPLICATION SLAVE ON *.*  TO 'repl'@'$slaveip'
 IDENTIFIED BY '$slavepass';
```

Also make sure that firewall rules are correct and that `TheSlave` can connect to `TheMaster`. Test that you can run the mysql client on `TheSlave`, connect to `TheMaster`, and authenticate.

```
TheSlave$ mysql --host=TheMaster --user=repl --password=$slavepass
```

Verify the privileges.

```
mysql> SHOW GRANTS;
```

STEP 4: Configure The Slave's MySQL server

First copy the *my.cnf* file from `TheMaster` to `TheSlave`:

```
TheSlave$ scp user@TheMaster:/etc/mysql/my.cnf /etc/mysql/my.cnf
```

then change the following options in /etc/mysql/my.cnf:

```
server-id=2
```

and start/restart **`mysqld`** on `TheSlave`.

In case you're using init script on Debian based system to start mysqld, be sure that the password for `debian-sys-maint` user has been updated and it's the same as that user's password on the `TheMaster`. Password can be seen and updated in `/etc/mysql/debian.cnf`.

STEP 5: Start the replication

Look at the content of the file `xtrabackup_binlog_info`, it will be something like:

```
TheSlave$ cat /var/lib/mysql/xtrabackup_binlog_info
TheMaster-bin.000001     481
```

Execute the `CHANGE MASTER` statement on a MySQL console and use the username and password you've set up in STEP 3:

```
TheSlave|mysql> CHANGE MASTER TO
                MASTER_HOST='$masterip',
                MASTER_USER='repl',
                MASTER_PASSWORD='$slavepass',
                MASTER_LOG_FILE='TheMaster-bin.000001',
                MASTER_LOG_POS=481;
```

and start the slave:

```
TheSlave|mysql> START SLAVE;
```

STEP 6: Check

You should check that everything went OK with:

```
TheSlave|mysql> SHOW SLAVE STATUS \G
         ...
         Slave_IO_Running: Yes
         Slave_SQL_Running: Yes
         ...
         Seconds_Behind_Master: 13
         ...
```

Both `IO` and `SQL` threads need to be running. The `Seconds_Behind_Master` means the `SQL` currently being executed has a `current_timestamp` of 13 seconds ago. It is an estimation of the lag between `TheMaster` and `TheSlave`. Note that at the beginning, a high value could be shown because `TheSlave` has to "catch up" with `TheMaster`.

Adding more slaves to The Master

You can use this procedure with slight variation to add new slaves to a master. We will use *Percona XtraBackup* to clone an already configured slave. We will continue using the previous scenario for convenience but we will add `TheNewSlave` to the plot.

At `TheSlave`, do a full backup:

```
TheSlave$ xtrabackup --user=yourDBuser --password=MaGiCiGaM \
            --backup --slave-info --target-dir=/path/to/backupdir
```

By using the `--slave-info` *Percona XtraBackup* creates additional file called `xtrabackup_slave_info`.

Apply the logs:

```
TheSlave$ xtrabackup --prepare --use-memory=2G --target-dir=/path/to/backupdir/
```

Copy the directory from the `TheSlave` to `TheNewSlave` (**NOTE**: Make sure mysqld is shut down on `TheNewSlave` before you copy the contents the snapshot into its *datadir*.):

```
rsync -avprP -e ssh /path/to/backupdir TheNewSlave:/path/to/mysql/datadir
```

Add additional grant on the master:

```
TheMaster|mysql> GRANT REPLICATION SLAVE ON *.*  TO 'repl'@'$newslaveip'
             IDENTIFIED BY '$slavepass';
```

Copy the configuration file from `TheSlave`:

```
TheNEWSlave$ scp user@TheSlave:/etc/mysql/my.cnf /etc/mysql/my.cnf
```

Make sure you change the server-id variable in `/etc/mysql/my.cnf` to 3 and disable the replication on start:

```
skip-slave-start
server-id=3
```

After setting `server_id`, start **mysqld**.

Fetch the master_log_file and master_log_pos from the file `xtrabackup_slave_info`, execute the statement for setting up the master and the log file for `The NEW Slave`:

```
TheNEWSlave|mysql> CHANGE MASTER TO
                   MASTER_HOST='$masterip',
                   MASTER_USER='repl',
                   MASTER_PASSWORD='$slavepass',
                   MASTER_LOG_FILE='TheMaster-bin.000001',
                   MASTER_LOG_POS=481;
```

and start the slave:

```
TheNEWSlave|mysql> START SLAVE;
```

If both IO and SQL threads are running when you check the `TheNewSlave`, server is replicating `TheMaster`.

Verifying Backups with replication and pt-checksum

One way to verify if the backup is consistent is by setting up the replication and running pt-table-checksum. This can be used to verify any type of backups, but before setting up replication, backup should be prepared and be able to run (this means that incremental backups should be merged to full backups, encrypted backups decrypted etc.).

Setting up the replication

How to setup a slave for replication in 6 simple steps with Percona XtraBackup guide provides a detailed instructions on how to take the backup and set up the replication.

For checking the backup consistency you can use either the original server where the backup was taken, or another test server created by using a different backup method (such as cold backup, mysqldump or LVM snapshots) as the master server in the replication setup.

Using pt-table-checksum

This tool is part of the *Percona Toolkit*. It performs an online replication consistency check by executing checksum queries on the master, which produces different results on replicas that are inconsistent with the master.

After you confirmed that replication has been set up successfully, you can install or download *pt-table-checksum*. This example shows downloading the latest version of *pt-table-checksum*:

```
$ wget percona.com/get/pt-table-checksum
```

Note: In order for pt-table-checksum to work correctly `libdbd-mysql-perl` will need to be installed on *Debian/Ubuntu* systems or `perl-DBD-MySQL` on *RHEL/CentOS*. If you installed the *percona-toolkit* package from the Percona repositories package manager should install those libraries automatically.

After this command has been run, *pt-table-checksum* will be downloaded to your current working directory.

Running the *pt-table-checksum* on the master will create `percona` database with the `checksums` table which will be replicated to the slaves as well. Example of the *pt-table-checksum* will look like this:

```
$ ./pt-table-checksum
    TS ERRORS  DIFFS     ROWS  CHUNKS SKIPPED    TIME TABLE
    04-30T11:31:50      0      0   633135       8       0   5.400 exampledb.aka_name
04-30T11:31:52      0      0   290859       1       0   2.692 exampledb.aka_title
Checksumming exampledb.user_info:  16% 02:27 remain
Checksumming exampledb.user_info:  34% 01:58 remain
Checksumming exampledb.user_info:  50% 01:29 remain
Checksumming exampledb.user_info:  68% 00:56 remain
Checksumming exampledb.user_info:  86% 00:24 remain
04-30T11:34:38      0      0 22187768     126       0 165.216 exampledb.user_info
04-30T11:38:09      0      0        0       1       0   0.033 mysql.time_zone_name
04-30T11:38:09      0      0        0       1       0   0.052 mysql.time_zone_
↪transition
04-30T11:38:09      0      0        0       1       0   0.054 mysql.time_zone_
↪transition_type
04-30T11:38:09      0      0        8       1       0   0.064 mysql.user
```

If all the values in the `DIFFS` column are 0 that means that backup is consistent with the current setup.

In case backup wasn't consistent *pt-table-checksum* should spot the difference and point to the table that doesn't match. Following example shows adding new user on the backed up slave in order to simulate the inconsistent backup:

```
mysql> grant usage on exampledb.* to exampledb@localhost identified by
↪'thisisnewpassword';
```

If we run the *pt-table-checksum* now difference should be spotted

```
$ ./pt-table-checksum
TS ERRORS  DIFFS     ROWS  CHUNKS SKIPPED    TIME TABLE
04-30T11:31:50      0      0   633135       8       0   5.400 exampledb.aka_name
04-30T11:31:52      0      0   290859       1       0   2.692 exampledb.aka_title
Checksumming exampledb.user_info:  16% 02:27 remain
Checksumming exampledb.user_info:  34% 01:58 remain
Checksumming exampledb.user_info:  50% 01:29 remain
Checksumming exampledb.user_info:  68% 00:56 remain
Checksumming exampledb.user_info:  86% 00:24 remain
04-30T11:34:38      0      0 22187768     126       0 165.216 exampledb.user_info
04-30T11:38:09      0      0        0       1       0   0.033 mysql.time_zone_name
04-30T11:38:09      0      0        0       1       0   0.052 mysql.time_zone_
↪transition
04-30T11:38:09      0      0        0       1       0   0.054 mysql.time_zone_
↪transition_type
04-30T11:38:09      1      0        8       1       0   0.064 mysql.user
```

This output shows that slave and the replica aren't in consistent state and that the difference is in the `mysql.user` table.

More information on different options that pt-table-checksum provides can be found in the *pt-table-checksum* documentation.

How to create a new (or repair a broken) GTID based slave

MySQL has the Global Transaction ID (GTID) to support in replication. *Percona XtraBackup* automatically stores the `GTID` value in the `xtrabackup_binlog_info` when doing the backup of *MySQL* and *Percona Server for MySQL* with the `GTID` mode enabled. This information can be used to create a new (or repair a broken) `GTID` based slave.

STEP 1: Take a backup from any server on the replication environment, master or slave

The following command will take a backup to the `/data/backup` folder:

```
$ xtrabackup --backup --target-dir=/data/backup/
```

In the destination folder, there will be a file with the name `xtrabackup_binlog_info`. This file will contain both the binary log coordinates and the `GTID` information.

```
$ cat xtrabackup_binlog_info
mysql-bin.000002    1232        c777888a-b6df-11e2-a604-080027635ef5:1-4
```

That information is also printed by **xtrabackup** after backup is taken:

```
xtrabackup: MySQL binlog position: filename 'mysql-bin.000002', position 1232, GTID␣
↪of the last change 'c777888a-b6df-11e2-a604-080027635ef5:1-4'
```

STEP 2: Prepare the backup

The backup will be prepared with the following command:

```
TheMaster$ xtrabackup --prepare --target-dir=/data/backup
```

If everything is ok you should get the same OK message. Now the transaction logs are applied to the data files, and new ones are created: your data files are ready to be used by the MySQL server.

STEP 3: Move the backup to the destination server

Use **rsync** or **scp** to copy these data to the destination server. If you are syncing the data directly to already running slave's data directory, it is advised to stop the *MySQL* server there.

```
TheMaster$ rsync -avprP -e ssh /path/to/backupdir/$TIMESTAMP NewSlave:/path/to/mysql/
```

After you copy data over, make sure *MySQL* has proper permissions to access them.

```
NewSlave$ chown mysql:mysql /path/to/mysql/datadir
```

STEP 4: Configure and start replication

The following command will tell the new slave what was the last `GTID` executed on the master when backup was taken.

```
NewSlave > SET GLOBAL gtid_purged="c777888a-b6df-11e2-a604-080027635ef5:1-4";
NewSlave > CHANGE MASTER TO
             MASTER_HOST="$masterip",
             MASTER_USER="repl",
             MASTER_PASSWORD="$slavepass",
             MASTER_AUTO_POSITION = 1;
```

STEP 5: Check the replication status

The following command will show the slave status:

```
NewSlave > show slave status\G
         [..]
         Slave_IO_Running: Yes
         Slave_SQL_Running: Yes
         [...]
         Retrieved_Gtid_Set: c777888a-b6df-11e2-a604-080027635ef5:5
         Executed_Gtid_Set: c777888a-b6df-11e2-a604-080027635ef5:1-5
```

We can see that the slave has retrieved a new transaction with number 5, so transactions from 1 to 5 are already on this slave.

We have created a new slave in our `GTID` based replication environment.

Auxiliary Guides

Enabling the server to communicate via TCP/IP

Most of the Linux distributions do not enable by default to accept TCP/IP connections from outside in their MySQL or Percona Server packages.

You can check it with `netstat` on a shell:

```
$ netstat -lnp | grep mysql
tcp         0        0 0.0.0.0:3306 0.0.0.0:* LISTEN 2480/mysqld
unix 2 [ ACC ] STREAM LISTENING 8101 2480/mysqld /tmp/mysql.sock
```

You should check two things:

- there is a line starting with `tcp` (the server is indeed accepting TCP connections) and
- the first address (`0.0.0.0:3306` in this example) is different than `127.0.0.1:3306` (the bind address is not localhost's).

In the first case, the first place to look is the `my.cnf` file. If you find the option `skip-networking`, comment it out or just delete it. Also check that *if* the variable `bind_address` is set, then it shouldn't be set to localhost's but to the host's IP. Then restart the MySQL server and check it again with `netstat`. If the changes you did had no effect, then you should look at your distribution's startup scripts (like `rc.mysqld`). You should comment out flags like `--skip-networking` and/or change the `bind-address`.

After you get the server listening to remote TCP connections properly, the last thing to do is checking that the port (3306 by default) is indeed open. Check your firewall configurations (`iptables -L`) and that you are allowing remote hosts on that port (in `/etc/hosts.allow`).

And we're done! We have a MySQL server running which is able to communicate with the world through TCP/IP.

Privileges and Permissions for Users

We will be referring to *permissions* to the ability of a user to access and perform changes on the relevant parts of the host's filesystem, starting/stopping services and installing software.

By *privileges* we refer to the abilities of a database user to perform different kinds of actions on the database server.

At a system level

There are many ways for checking the permission on a file or directory. For example, `ls -ls /path/to/file` or `stat /path/to/file | grep Access` will do the job:

```
$ stat /etc/mysql | grep Access
Access: (0755/drwxr-xr-x)  Uid: (    0/    root)   Gid: (    0/    root)
Access: 2011-05-12 21:19:07.129850437 -0300
$ ls -ld /etc/mysql/my.cnf
-rw-r--r-- 1 root root 4703 Apr  5 06:26 /etc/mysql/my.cnf
```

As in this example, `my.cnf` is owned by `root` and not writable for anyone else. Assuming that you do not have `root` 's password, you can check what permissions you have on this types of files with `sudo -l`:

```
$ sudo -l
Password:
You may run the following commands on this host:
(root) /usr/bin/
(root) NOPASSWD: /etc/init.d/mysqld
(root) NOPASSWD: /bin/vi /etc/mysql/my.cnf
(root) NOPASSWD: /usr/local/bin/top
(root) NOPASSWD: /usr/bin/ls
(root) /bin/tail
```

Being able to execute with `sudo` scripts in `/etc/init.d/`, `/etc/rc.d/` or `/sbin/service` is the ability to start and stop services.

Also, If you can execute the package manager of your distribution, you can install or remove software with it. If not, having `rwx` permission over a directory will let you do a local installation of software by compiling it there. This is a typical situation in many hosting companies' services.

There are other ways for managing permissions, such as using *PolicyKit*, *Extended ACLs* or *SELinux*, which may be preventing or allowing your access. You should check them in that case.

At a database server level

To query the privileges that your database user has been granted, at a console of the server execute:

```
mysql> SHOW GRANTS;
```

or for a particular user with:

```
mysql> SHOW GRANTS FOR 'db-user'@'host';
```

It will display the privileges using the same format as for the GRANT statement.

Note that privileges may vary across versions of the server. To list the exact list of privileges that your server support (and a brief description of them) execute:

```
mysql> SHOW PRIVILEGES;
```

Installing and configuring a SSH server

Many Linux distributions only install the ssh client by default. If you don't have the ssh server installed already, the easiest way of doing it is by using your distribution's packaging system:

```
   ubuntu$ sudo apt-get install openssh-server
archlinux$ sudo pacman -S openssh
```

You may need to take a look at your distribution's documentation or search for a tutorial on the internet to configure it if you haven't done it before.

Some links of them are:

- Debian - http://wiki.debian.org/SSH
- Ubuntu - https://help.ubuntu.com/10.04/serverguide/C/openssh-server.html
- Archlinux - https://wiki.archlinux.org/index.php/SSH
- Fedora - http://docs.fedoraproject.org/en-US/Fedora/12/html/Deployment_Guide/s1-openssh-server-config.html
- CentOS - http://www.centos.org/docs/5/html/Deployment_Guide-en-US/s1-openssh-server-config.html
- RHEL - http://docs.redhat.com/docs/en-US/Red_Hat_Enterprise_Linux/6/html/Deployment_Guide/ch-OpenSSH.html

Assumptions in this section

Most of the times, the context will make the recipe or tutorial understandable. To assure that, a list of the assumptions, names and "things" that will appear in this section is given. At the beginning of each recipe or tutorial they will be specified in order to make it quicker and more practical.

`HOST`

A system with a *MySQL*-based server installed, configured and running. We will assume the following about this system:

- the MySQL server is able to *communicate with others by the standard TCP/IP port*;
- a SSH server is installed and configured - see *here* if it is not;
- you have an user account in the system with the appropriate *permissions* and
- you have a MySQL's user account with appropriate *Connection and Privileges Needed*.

`USER` An user account in the system with shell access and appropriate permissions for the task. A guide for checking them is *here*.

`DB-USER` An user account in the database server with appropriate privileges for the task. A guide for checking them is *here*.

- *Recipes for xtrabackup*
- *How-Tos*
- *Auxiliary Guides*

Part VIII

References

CHAPTER

THIRTEEN

FREQUENTLY ASKED QUESTIONS

Does *Percona XtraBackup* 8.0 Support making backups of databases in versions prior to 8.0?

Percona XtraBackup 8.0 does not support making backups of databases created in versions prior to 8.0 of *MySQL*, *Percona Server for MySQL* or *Percona XtraDB Cluster*. As the changes that *MySQL* 8.0 introduced in *data dictionaries*, *redo log* and *undo log* are incompatible with previous versions, it is currently impossible for *Percona XtraBackup* 8.0 to also support versions prior to 8.0.

Why will `innobackupex` not run in *Percona XtraBackup* 8.0?

`innobackupex` has been removed from *Percona XtraBackup* '8.0' in favor of **`xtrabackup`**.

What's the difference between `innobackupex` and `xtrabackup`?

See *Why will innobackupex not run in Percona XtraBackup 8.0?*

Are you aware of any web-based backup management tools (commercial or not) built around *Percona XtraBackup*?

Zmanda Recovery Manager is a commercial tool that uses *Percona XtraBackup* for Non-Blocking Backups:

> *"ZRM provides support for non-blocking backups of MySQL using |Percona XtraBackup|. ZRM with |Percona XtraBackup| provides resource utilization management by providing throttling based on the number of IO operations per second. |Percona XtraBackup| based backups also allow for table level recovery even though the backup was done at the database level (needs the recovery database server to be |Percona Server| with XtraDB)."*

`xtrabackup` binary fails with a floating point exception

In most of the cases this is due to not having install the required libraries (and version) by **`xtrabackup`**. Installing the *GCC* suite with the supporting libraries and recompiling **`xtrabackup`** will solve the issue. See *Compiling and Installing from Source Code* for instructions on the procedure.

How xtrabackup handles the ibdata/ib_log files on restore if they aren't in mysql datadir?

In case the `ibdata` and `ib_log` files are located in different directories outside of the datadir, you will have to put them in their proper place after the logs have been applied.

Backup fails with Error 24: 'Too many open files'

This usually happens when database being backed up contains large amount of files and *Percona XtraBackup* can't open all of them to create a successful backup. In order to avoid this error the operating system should be configured appropriately so that *Percona XtraBackup* can open all its files. On Linux, this can be done with the `ulimit` command for specific backup session or by editing the `/etc/security/limits.conf` to change it globally (**NOTE**: the maximum possible value that can be set up is `1048576` which is a hard-coded constant in the Linux kernel).

How to deal with skipping of redo logs for DDL operations?

To prevent creating corrupted backups when running DDL operations, Percona XtraBackup aborts if it detects that redo logging is disabled. In this case, the following error is printed:

```
[FATAL] InnoDB: An optimized (without redo logging) DDL operation has been performed.␣
↪All modified pages may not have been flushed to the disk yet.
Percona XtraBackup will not be able to take a consistent backup. Retry the backup␣
↪operation.
```

Note: Redo logging is disabled during a sorted index build

To avoid this error, Percona XtraBackup can use metadata locks on tables while they are copied:

- To block all DDL operations, use the *`--lock-ddl`* option that issues `LOCK TABLES FOR BACKUP`.
- If `LOCK TABLES FOR BACKUP` is not supported, you can block DDL for each table before XtraBackup starts to copy it and until the backup is completed using the *`--lock-ddl-per-table`* option.

CHAPTER

FOURTEEN

PERCONA XTRABACKUP 8.0 RELEASE NOTES

Percona XtraBackup 8.0.10

Date March 16, 2020

Installation *Installing Percona XtraBackup 8.0*

Downloads are available from our download site and from *apt* and *yum* repositories.

Percona XtraBackup enables MySQL backups without blocking user queries, making it ideal for companies with large data sets and mission-critical applications that cannot tolerate long periods of downtime. Offered free as an open source solution, it drives down backup costs while providing unique features for *MySQL* backups.

All Percona software is open-source and free.

Bugs Fixed

- PXB-1982: The *history* table showed a wrong value for `lock_time`.
- PXB-2099: `copy-back` did not move undo files to the *data directory*.
- PXB-2107: If the *undo tablespace* was created in a directory which is a symbolic link to another directory then the backup failed at backup stage.
- PXB-2118: Undo log file was renamed incorrectly to undo tablespace name after restore

Percona XtraBackup 8.0.9

Percona is glad to announce the release of Percona XtraBackup 8.0.9 on December 16, 2019. Downloads are available from our download site and from *apt* and *yum* repositories.

Percona XtraBackup enables MySQL backups without blocking user queries, making it ideal for companies with large data sets and mission-critical applications that cannot tolerate long periods of downtime. Offered free as an open source solution, it drives down backup costs while providing unique features for *MySQL* backups.

All Percona software is open-source and free.

Bugs Fixed

- Sometime between December 3rd and December 10th, a change was introduced in AWS (Amazon Web Services) that caused an incompatibility with our Percona XtraBackup `xbcloud` utility. Bug fixed PXB-1978.

Percona XtraBackup 8.0.8

Percona is glad to announce the release of Percona XtraBackup 8.0.8 on November 21, 2019. Downloads are available from our download site and from *apt* and *yum* repositories.

Percona XtraBackup enables MySQL backups without blocking user queries, making it ideal for companies with large data sets and mission-critical applications that cannot tolerate long periods of downtime. Offered free as an open source solution, it drives down backup costs while providing unique features for *MySQL* backups.

All Percona software is open-source and free.

New Features and Improvements

- Support log archiving feature in PXB 8.0. More information in PXB-1912 and in the Redo Log section of MySQL documentation
- For the MyRocks storage engine, support the creation of renewable checkpoints (controlled via `--rocksdb-checkpoint-max-age` and `--rocksdb-checkpoint-max-count`) to minimize the amount of binary logs to apply after the backup was completed. Using renewable checkpoints, Percona XtraBackup only copies the SST files that were created after the previous checkpoint. More information in PXB-1915.
- Two options (*–-backup-lock-timeout* and *-–backup-lock-retry-count*) were added to enable the configuring of the timeout for acquiring metadata locks in `FLUSH TABLES WITH READ LOCK`, `LOCK TABLE FOR BACKUP`, and `LOCK BINLOG FOR BACKUP` statements. More information in PXB-1914

Bugs Fixed

- An encrypted table could not be restored when `ADD INDEX` or `DROP INDEX` commands had been run on the table. Bug fixed PXB-1905
- In some cases `xtrabackup --prepare` could fail to decrypt a table but reported that the operation completed ok. Bug fixed PXB-1936
- `xtrabackup --move-back` did not complete successfully when the encrypted binlog file. Bug fixed PXB-1937.
- Percona XtraBackup could crash during the prepare stage when making an incremental backup when a multi valued index was being added or dropped for JSON data. Bug fixed PXB-1913.

Other bugs fixed: PXB-1928, PXB-1938, PXB-1951, PXB-1953, PXB-1954.

Percona XtraBackup 8.0.7

Percona is glad to announce the release of Percona XtraBackup 8.0.7 on August 7, 2019. Downloads are available from our download site and from *apt* and *yum* repositories.

Percona XtraBackup enables MySQL backups without blocking user queries, making it ideal for companies with large data sets and mission-critical applications that cannot tolerate long periods of downtime. Offered free as an open source solution, it drives down backup costs while providing unique features for *MySQL* backups.

In release 8.0.7, Percona XtraBackup enables making backups of databases that contain the encrypted system tablespace. Encrypted *mysql* tablespace is now also supported.

Percona XtraBackup 8.0.7 implements the support of the `lz4` compression algorithm so that you could make compressed backups using *lz4* (*–compress=lz4*) in addition to the default *quicklz* method.

All Percona software is open-source and free.

New Features and Improvements

- Add support of the system tablespace encryption. More information in PXB-1649.
- Implemented the support of the *lz4* compression algorithm. More information in PXB-1857.

Bugs Fixed

- When the *encrypted tablespaces* feature was enabled, encrypted and compressed tables were not usable on the joiner node (Percona XtraDB Cluster) via SST (State Snapshot Transfer) with the *xtrabackup-v2* method. Bug fixed PXB-1867.
- `xbcloud` did not update date related fields of the HTTP header when retrying a request. Bug fixed PXB-1874.
- `xbcloud` did not retry to send the request after receiving the HTTP 408 error (request timeout). Bug fixed PXB-1875.
- `xtrabackup` did not accept decimal fractions as values of the `innodb_max_dirty_pages_pct` option. Bug fixed PXB-1807.
- If the user tried to merge an already prepared incremental backup, a misleading error was produced without informing that incremental backups may not be used twice. Bug fixed PXB-1862.

Other bugs fixed: PXB-1493, PXB-1557, PXB-1887, PXB-1870, PXB-1879, PXB-1901.

Percona XtraBackup 8.0.6

Percona is glad to announce the release of Percona XtraBackup 8.0.6 on May 9, 2019. Downloads are available from our download site and from *apt* and *yum* repositories.

Percona XtraBackup enables MySQL backups without blocking user queries, making it ideal for companies with large data sets and mission-critical applications that cannot tolerate long periods of downtime. Offered free as an open source solution, it drives down backup costs while providing unique features for *MySQL* backups.

In version 8.0.6, Percona XtraBackup introduces the support of the MyRocks storage engine with Percona Server for MySQL version 8.0.15-6 or higher.

Percona XtraBackup 8.0.6 enables saving backups to an Amazon S3, MinIO, and Google Cloud Storage (using interoperability mode) when using xbcloud. The following example demonstrates how to use an Amazon S3 storage to make a full backup:

```
  $ xtrabackup --backup --stream=xbstream --extra-lsndir=/tmp --target-dir=/tmp | \
  xbcloud put --storage=s3 \
  --s3-endpoint='s3.amazonaws.com' \
  --s3-access-key='YOUR-ACCESSKEYID' \
  --s3-secret-key='YOUR-SECRETACCESSKEY' \
  --s3-bucket='mysql_backups'
  --parallel=10 \
  ${date -I}-full_backup

All |percona| software is open-source and free
```

New Features

- The MyRocks storage engine is now supported with Percona XtraBackup. More information in PXB-1754.
- Amazon S3 is now supported in xbcloud. More information in PXB-1813.

Bugs Fixed

- Percona XtraBackup could fail to restore the undo tablespace created during or before incremental backup. Bug fixed PXB-1780.
- A backup could fail if `log_bin_index` was defined in `my.cnf`. Bug fixed PXB-1801.
- When the row format was changed during the backup, xtrabackup could crash during the incremental prepare stage. Bug fixed PXB-1824.
- During the `prepare` phase, *Percona XtraBackup* could freeze and never finish execution. Bug fixed PXB-1819.
- Percona XtraBackup could crash during the `prepare` stage when making a backup of a host running MySQL Server v8.0.16. Bug fixed PXB-1839.

Other bugs fixed: PXB-1809, PXB-1810, PXB-1832, PXB-1837.

Percona XtraBackup 8.0.5

Percona is glad to announce the release of Percona XtraBackup 8.0.5 on March 4, 2019. Downloads are available from our download site and from *apt* and *yum* repositories.

Percona XtraBackup enables MySQL backups without blocking user queries, making it ideal for companies with large data sets and mission-critical applications that cannot tolerate long periods of downtime. Offered free as an open source solution, it drives down backup costs while providing unique features for *MySQL* backups.

Percona XtraBackup 8.0.5 introduces the support of undo tablespaces created using the new syntax (`CREATE UNDO TABLESPACE`) available since MySQL 8.0.14. Percona XtraBackup also supports the binary log encryption introduced in *MySQL* 8.0.14.

Two new options were added to *xbstream*. Use the *`--decompress`* option with *xbstream* to decompress individual qpress files. With the *`--decompress-threads`* option, specify the number of threads to apply when decompressing. Thanks to Rauli Ikonen for this contribution.

This release of Percona XtraBackup is a **General Availability** release ready for use in a production environment.

All Percona software is open-source and free.

Please note the following about this release:

- The deprecated innobackupex has been removed. Use the xtrabackup command to back up your instances: `$ xtrabackup --backup --target-dir=/data/backup`
- When migrating from earlier database server versions, backup and restore and using Percona XtraBackup 2.4 and then use `mysql_upgrade` from *MySQL* 8.0.x
- If using `yum` or `apt` repositories to install *Percona XtraBackup* 8.0.5, ensure that you have enabled the new *tools* repository. You can do this with the **`percona-release enable tools release`** command and then install the *percona-xtrabackup-80* package.

New Features

- PXB-1548: Percona XtraBackup enables updating the `ib_buffer_pool` file with the latest pages present in the buffer pool using the *`--dump-innodb-buffer-pool`* option. Thanks to Marcelo Altmann for contribution.
- PXB-1768: Added support for undo tablespaces created with the new *MySQL* 8.0.14 syntax.
- PXB-1781: Added support for binary log encryption introduced in *MySQL* 8.0.14.
- PXB-1797: For *xbstream*, two new options were added. The *`--decompress`* option enables *xbstream* to decompress individual qpress files. The *`--decompress-threads`* option controls the number of threads to apply when decompressing. Thanks to Rauli Ikonen for this contribution.

Bugs Fixed

- Using `--lock-ddl-per-table` caused the server to scan all records of partitioned tables which could lead to the "out of memory" error. Bugs fixed PXB-1691 and PXB-1698.
- When Percona XtraBackup was started run with the *`--slave-info`*, incorrect coordinates were written to the xtrabackup_slave_info file.. Bug fixed PXB-1737
- Percona XtraBackup could crash at the prepare stage when making an incremental backup if the variable `innodb-rollback-segments` was changed after starting the *MySQL* Server. Bug fixed PXB-1785.
- The full backup could fail when *Percona Server for MySQL* was started with the `--innodb-encrypt-tables` parameter. Bug fixed PXB-1793.

Other bugs fixed: PXB-1632, PXB-1715, PXB-1770, PXB-1771, PXB-1773.

Percona XtraBackup 8.0.4

Percona is glad to announce the release of Percona XtraBackup 8.0.4 on December 10, 2018. Downloads are available from our download site and from *apt* and *yum* repositories.

Percona XtraBackup enables MySQL backups without blocking user queries, making it ideal for companies with large data sets and mission-critical applications that cannot tolerate long periods of downtime. Offered free as an open source solution, it drives down backup costs while providing unique features for *MySQL* backups.

This release of Percona Xtrabackup is a **General Availability** release ready for use in a production environment.

Please note the following about this release:

- The deprecated innobackupex has been removed. Use the xtrabackup command to back up your instances: `$ xtrabackup --backup --target-dir=/data/backup`
- When migrating from earlier database server versions, backup and restore and using Percona XtraBackup 2.4 and then use `mysql_upgrade` from *MySQL* 8.0.x
- If using `yum` or `apt` repositories to install *Percona XtraBackup* 8.0.4, ensure that you have enabled the new *tools* repository. You can do this with the **`percona-release enable tools release`** command and then install the *percona-xtrabackup-80* package.

All Percona software is open-source and free. We are grateful to the community for the invaluable contributions to *Percona XtraBackup*. We would especially like to highlight the input of *Alexey Kopytov* who has been actively offering improvements and submitting bug reports for *Percona XtraBackup*.

New Features

- *Percona XtraBackup* 8.0.4 is based on *MySQL* 8.0.13 and fully supports Percona Server for *MySQL* 8.0 series and *MySQL* 8.0 series.

Bugs Fixed

- PXB-1699: *xtrabackup –prepare* could fail on backups of MySQL 8.0.13 databases
- PXB-1704: *xtrabackup –prepare* could hang while performing insert buffer merge
- PXB-1668: When the *–throttle* option was used, the applied value was different from the one specified by the user (off by one error)
- PXB-1679: PXB could crash when `ALTER TABLE ... TRUNCATE PARTITION` command was run during a backup without locking DDL

Percona XtraBackup 8.0-3-rc1

Percona is glad to announce the release of *Percona XtraBackup* 8.0-3-rc1 on October 31 2018. Downloads are available from our download site and from *apt* and *yum* repositories.

This is a **Release Candidate** quality release and it is not intended for production. If you want a high quality, Generally Available release, use the current Stable version (the most recent stable version at the time of writing is 2.4.12 in the 2.4 series).

Things to Note

- `innobackupex` was previously deprecated and has been removed
- Due to the new MySQL redo log and data dictionary formats the Percona XtraBackup 8.0.x versions will only be compatible with MySQL 8.0.x and the upcoming Percona Server for MySQL 8.0.x
- For experimental migrations from earlier database server versions, you will need to backup and restore and using XtraBackup 2.4 and then use `mysql_upgrade` from MySQL 8.0.x

Improvements

- PXB-1655: The `--lock-ddl` option is supported when backing up MySQL 8

Bugs Fixed

- PXB-1678: Incremental backup prepare with the `--apply-log-only` option could roll back uncommitted transactions
- PXB-1672: The MTS slave without GTID could be backed up when the `--safe-slave-backup` option was applied.

CHAPTER

FIFTEEN

GLOSSARY

UUID Universally Unique IDentifier which uniquely identifies the state and the sequence of changes node undergoes. 128-bit UUID is a classic DCE UUID Version 1 (based on current time and MAC address). Although in theory this UUID could be generated based on the real MAC-address, in the Galera it is always (without exception) based on the generated pseudo-random addresses ("locally administered" bit in the node address (in the UUID structure) is always equal to unity).

Complete structure of the 128-bit UUID field and explanation for its generation are as follows:

From	To	Length	Content
0	31	32	Bits 0-31 of Coordinated Universal Time (UTC) as a count of 100-nanosecond intervals since 00:00:00.00, 15 October 1582, encoded as big-endian 32-bit number.
32	47	16	Bits 32-47 of UTC as a count of 100-nanosecond intervals since 00:00:00.00, 15 October 1582, encoded as big-endian 16-bit number.
48	59	12	Bits 48-59 of UTC as a count of 100-nanosecond intervals since 00:00:00.00, 15 October 1582, encoded as big-endian 16-bit number.
60	63	4	UUID version number: always equal to 1 (DCE UUID).
64	69	6	most-significants bits of random number, which generated from the server process PID and Coordinated Universal Time (UTC) as a count of 100-nanosecond intervals since 00:00:00.00, 15 October 1582.
70	71	2	UID variant: always equal to binary 10 (DCE variant).
72	79	8	8 least-significant bits of random number, which generated from the server process PID and Coordinated Universal Time (UTC) as a count of 100-nanosecond intervals since 00:00:00.00, 15 October 1582.
80	80	1	Random bit ("unique node identifier").
81	81	1	Always equal to the one ("locally administered MAC address").
82	127	46	Random bits ("unique node identifier"): readed from the `/dev/urandom` or (if `/dev/urandom` is unavailable) generated based on the server process PID, current time and bits of the default "zero node identifier" (entropy data).

LSN Each InnoDB page (usually 16kb in size) contains a log sequence number, or LSN. The LSN is the system version number for the entire database. Each page's LSN shows how recently it was changed.

innodb_file_per_table By default, all InnoDB tables and indexes are stored in the system tablespace on one file. This option causes the server to create one tablespace file per table. To enable it, set it on your configuration file,

```
[mysqld]
innodb_file_per_table
```

or start the server with `--innodb_file_per_table`.

innodb_expand_import This feature of *Percona Server for MySQL* implements the ability to import arbitrary *.ibd* files exported using the *Percona XtraBackup* `--export` option.

See the the full documentation for more information.

innodb_data_home_dir The directory (relative to *datadir*) where the database server stores the files in a shared tablespace setup. This option does not affect the location of *innodb_file_per_table*. For example:

```
[mysqld]
innodb_data_home_dir = ./
```

innodb_data_file_path Specifies the names, sizes and location of shared tablespace files:

```
[mysqld]
innodb_data_file_path=ibdata1:50M;ibdata2:50M:autoextend
```

innodb_log_group_home_dir Specifies the location of the *InnoDB* log files:

```
[mysqld]
innodb_log_group_home=/var/lib/mysql
```

innodb_buffer_pool_size The size in bytes of the memory buffer to cache data and indexes of *InnoDB*'s tables. This aims to reduce disk access to provide better performance. By default:

```
[mysqld]
innodb_buffer_pool_size=8MB
```

InnoDB Storage engine which provides ACID-compliant transactions and foreign key support, among others improvements over *MyISAM*. It is the default engine for *MySQL* as of the 8.0 series.

MyISAM Previous default storage engine for *MySQL* for versions prior to 5.5. It doesn't fully support transactions but in some scenarios may be faster than *InnoDB*. Each table is stored on disk in 3 files: *.frm*, *.MYD*, *.MYI*.

XtraDB *Percona XtraDB* is an enhanced version of the InnoDB storage engine, designed to better scale on modern hardware, and including a variety of other features useful in high performance environments. It is fully backwards compatible, and so can be used as a drop-in replacement for standard InnoDB. More information here.

my.cnf This file refers to the database server's main configuration file. Most Linux distributions place it as `/etc/mysql/my.cnf` or `/etc/my.cnf`, but the location and name depends on the particular installation. Note that this is not the only way of configuring the server, some systems does not have one even and rely on the command options to start the server and its defaults values.

datadir The directory in which the database server stores its databases. Most Linux distribution use `/var/lib/mysql` by default.

xbcrypt To support encryption and decryption of the backups, a new tool xbcrypt was introduced to *Percona XtraBackup*. This utility has been modeled after The xbstream binary to perform encryption and decryption outside of *Percona XtraBackup*.

xbstream

To support simultaneous compression and streaming, *Percona XtraBackup* uses the xbstream format. For more information see *`--stream`*

ibdata Default prefix for tablespace files, e.g. `ibdata1` is a 10MB auto-extensible file that *MySQL* creates for the shared tablespace by default.

.frm For each table, the server will create a file with the `.frm` extension containing the table definition (for all storage engines).

.ibd On a multiple tablespace setup (*innodb_file_per_table* enabled), *MySQL* will store each newly created table on a file with a `.ibd` extension.

.MYD Each *MyISAM* table has `.MYD` (MYData) file which contains the data on it.

.MYI Each *MyISAM* table has `.MYI` (MYIndex) file which contains the table's indexes.

.exp Files with the `.exp` extension are created by *Percona XtraBackup* per each *InnoDB* tablespace when the `--export` option is used on prepare. These files can be used to import those tablespaces on *Percona Server for MySQL* 5.5 or lower versions, see *restoring individual tables*".

.MRG Each table using the **`MERGE`** storage engine, besides of a *.frm* file, will have *.MRG* file containing the names of the *MyISAM* tables associated with it.

.TRG File containing the Triggers associated to a table, e.g. *:file:'mytable.TRG*. With the *.TRN* file, they represent all the Trigger definitions.

.TRN File containing the Triggers' Names associated to a table, e.g. *:file:'mytable.TRN*. With the *.TRG* file, they represent all the Trigger definitions.

.ARM Each table with the **`Archive Storage Engine`** has `.ARM` file which contains the metadata of it.

.ARZ Each table with the **`Archive Storage Engine`** has `.ARZ` file which contains the data of it.

.CSM Each table with the **`CSV Storage Engine`** has `.CSM` file which contains the metadata of it.

.CSV Each table with the **`CSV Storage`** engine has `.CSV` file which contains the data of it (which is a standard Comma Separated Value file).

.opt *MySQL* stores options of a database (like charset) in a file with a `.opt` extension in the database directory.

.par Each partitioned table has .par file which contains metadata about the partitions.

CHAPTER

SIXTEEN

INDEX OF FILES CREATED BY PERCONA XTRABACKUP

- Information related to the backup and the server
  - **backup-my.cnf** This file contains information to start the mini instance of InnoDB during the *--prepare*. This is **NOT** a backup of original `my.cnf`. The InnoDB configuration is read from the file `backup-my.cnf` created by **xtrabackup** when the backup was made. *--prepare* uses InnoDB configuration from `backup-my.cnf` by default, or from *--defaults-file*, if specified. InnoDB configuration in this context means server variables that affect data format, i.e. `innodb_page_size` option, `innodb_log_block_size`, etc. Location-related variables, like `innodb_log_group_home_dir` or `innodb_data_file_path` are always ignored by *--prepare*, so preparing a backup always works with data files from the backup directory, rather than any external ones.
  - **xtrabackup_checkpoints** The type of the backup (e.g. full or incremental), its state (e.g. prepared) and the *LSN* range contained in it. This information is used for incremental backups. Example of the `xtrabackup_checkpoints` after taking a full backup:

    ```
    backup_type = full-backuped
    from_lsn = 0
    to_lsn = 15188961605
    last_lsn = 15188961605
    ```

    Example of the `xtrabackup_checkpoints` after taking an incremental backup:

    ```
    backup_type = incremental
    from_lsn = 15188961605
    to_lsn = 15189350111
    last_lsn = 15189350111
    ```

  - **xtrabackup_binlog_info** The binary log file used by the server and its position at the moment of the backup. Result of the **SHOW MASTER STATUS**.
  - **xtrabackup_binlog_pos_innodb** The binary log file and its current position for *InnoDB* or *XtraDB* tables.
  - **xtrabackup_binary** The **xtrabackup** binary used in the process.
  - **xtrabackup_logfile** Contains data needed for running the: *--prepare*. The bigger this file is the *--prepare* process will take longer to finish.
  - **<table_name>.delta.meta** This file is going to be created when performing the incremental backup. It contains the per-table delta metadata: page size, size of compressed page (if the value is 0 it means the tablespace isn't compressed) and space id. Example of this file could looks like this:

```
page_size = 16384
zip_size = 0
space_id = 0
```

- Information related to the replication environment (if using the `--slave-info` option):
  - **`xtrabackup_slave_info`** The `CHANGE MASTER` statement needed for setting up a slave.
- Information related to the *Galera* and *Percona XtraDB Cluster* (if using the `--galera-info` option):
  - **`xtrabackup_galera_info`** Contains the values of `wsrep_local_state_uuid` and `wsrep_last_committed` status variables

CHAPTER

SEVENTEEN

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CHAPTER

EIGHTEEN

VERSION CHECKING

Some Percona software contains "version checking" functionality which is a feature that enables Percona software users to be notified of available software updates to improve your environment security and performance. Alongside this, the version check functionality also provides Percona with information relating to which software versions you are running, coupled with the environment confirmation which the software is running within. This helps enable Percona to focus our development effort accordingly based on trends within our customer community.

The purpose of this document is to articulate the information that is collected, as well as to provide guidance on how to disable this functionality if desired.

Usage

Version Check was implemented in Percona Toolkit 2.1.4, and was enabled by default in version 2.2.1. Currently it is supported as a `--[no]version-check` option by a number of tools in Percona Toolkit, Percona XtraBackup, and PMM (Percona Monitoring and Management).

When launched with Version Check enabled, the tool that supports this feature connects to a Percona's *version check service* via a secure HTTPS channel. It compares the locally installed version for possible updates, and also checks versions of the following software:

- Operating System
- Percona Monitoring and Management (PMM)
- MySQL
- Perl
- MySQL driver for Perl (DBD::mysql)
- Percona Toolkit

Then it checks for and warns about versions with known problems if they are identified as running in the environment.

Each version check request is logged by the server. Stored information consists of the checked system unique ID followed by the software name and version. The ID is generated either at installation or when the *version checking* query is submitted for the first time.

Note: Prior to version 3.0.7 of Percona Toolkit, the system ID was calculated as an MD5 hash of a hostname, and starting from Percona Toolkit 3.0.7 it is generated as an MD5 hash of a random number. Percona XtraBackup continues to use hostname-based MD5 hash.

As a result, the content of the sent query is as follows:

```
85624f3fb5d2af8816178ea1493ed41a;DBD::mysql;4.044
c2b6d625ef3409164cbf8af4985c48d3;MySQL;MySQL Community Server (GPL) 5.7.22-log
85624f3fb5d2af8816178ea1493ed41a;OS;Manjaro Linux
85624f3fb5d2af8816178ea1493ed41a;Percona::Toolkit;3.0.11-dev
85624f3fb5d2af8816178ea1493ed41a;Perl;5.26.2
```

Disabling Version Check

Although the *version checking* feature does not collect any personal information, you might prefer to disable this feature, either one time or permanently. To disable it one time, use `--no-version-check` option when invoking the tool from a Percona product which supports it. Here is a simple example which shows running pt-diskstats tool from the Percona Toolkit with *version checking* turned off:

```
pt-diskstats --no-version-check
```

Disabling *version checking* permanently can be done by placing `no-version-check` option into the configuration file of a Percona product (see correspondent documentation for exact file name and syntax). For example, in case of Percona Toolkit this can be done in a global configuration file `/etc/percona-toolkit/percona-toolkit.conf`:

```
# Disable Version Check for all tools:
no-version-check
```

In case of Percona XtraBackup this can be done in its configuration file in a similar way:

```
[xtrabackup]
no-version-check
```

Frequently Asked Questions

Why is this functionality enabled by default?

We believe having this functionality enabled improves security and performance of environments running Percona Software and it is good choice for majority of the users.

Why not rely on Operating System's built in functionality for software updates?

In many environments the Operating Systems repositories may not carry the latest version of software and newer versions of software often installed manually, so not being covered by operating system wide check for updates.

Why do you send more information than just the version of software being run as a part of version check service?

Compatibility problems can be caused by versions of various components in the environment, for example problematic versions of Perl, DBD or MySQL could cause operational problems with Percona Toolkit.

Part IX

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