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## 1. Setup

### Database Setup

* A console application was created to generate **multiple databases**.
* For this test, a database named **test\_db\_1** was created, containing **100 tables** (orders\_1 to orders\_100).
* Each table contained approximately **128,975 records**.
* The total size of all **.ibd files** in **test\_db\_1** was approximately **8.59 GB**.

### System Configuration

* **Operating System:** Ubuntu 20.04.6 LTS
* **Kernel:** Linux 5.4.0-205-generic
* **Architecture:** x86\_64
* **Virtualization:** Microsoft Hyper-V
* **CPU:** Intel(R) Core(TM) i7-7700 CPU @ 3.60GHz
* **Cores:** 1 (Single-core, no hyper-threading)
* **Clock Speed:** 2003.516 MHz
* **Hypervisor Vendor:** Microsoft

## 2. Performance Tests & Results

### MySQL Workbench

* **Export Time:** 6 minutes 5 seconds
* **Export File Size:** 7.31 GB
* **Import Time:** 18 minutes 59 seconds
* **Total Time:** 25 minutes 4 seconds

### HeidiSQL

* **Export Time:** 24 minutes
* **Export File Size:** 12.5 GB
* **Import Process:** Not feasible (file failed to load properly after 1.5 hours)

### mysqldump (CLI)

* **Export Time:** 5 minutes
* **Export File Size:** 7.31 GB
* **Import Time:** 17 minutes
* **Total Time:** 22 minutes

### Percona XtraBackup

* **Backup Time:** 2 minutes (partial backup)
* **Backup Size:** 8.7 GB
* **Restore Time:** 40 seconds
* **Total Time:** 2 minutes 40 seconds

## 3. Performance Comparison Table

| **Tool** | **MySQL Workbench** | **HeidiSQL** | **mysqldump (CLI)** | **Percona XtraBackup** |
| --- | --- | --- | --- | --- |
| **Backup Type** | Logical (SQL dump) | Logical (SQL dump) | Logical (SQL dump) | **Physical (Raw Data Copy)** |
| **Export Time** | 6 minutes 5 seconds | 24 minutes | **5 minutes** | **2 minutes** |
| **Export File Size** | 7.31 GB | 12.5 GB | 7.31 GB | **8.7 GB** |
| **Import Time** | 18 minutes 59 seconds | Not feasible (file did not load) | **17 minutes** | **40 seconds** |
| **Total Time** | **25 minutes 4 seconds** | N/A | **22 minutes** | **2 minutes 40 seconds** |
| **Performance** | Efficient, fast export/import | Slow export, unfeasible import | **Fastest logical export/import** | **Fastest backup & restore overall** |

## 4. Why Is Percona XtraBackup Faster?

| **Feature** | **Logical Backup (mysqldump, MySQL Workbench, HeidiSQL)** | **Physical Backup (Percona XtraBackup)** |
| --- | --- | --- |
| **Backup Method** | Reads each row and generates SQL dumps | Copies raw InnoDB files (.ibd, .frm) |
| **Speed** | Slower (row-by-row processing) | **Faster** (direct file copy) |
| **MySQL Instance Locking** | **Required** (affects database availability) | **No Locking** (hot backup possible) |

## 5. Pros & Cons of Percona XtraBackup

### Advantages

✔ **Fastest Backup and Restore** → Copies raw data files instead of executing slow SQL queries.  
✔ **No Downtime (Hot Backup)** → Keeps MySQL running while backing up.  
✔ **Efficient for Large Databases** → Handles 100GB+ datasets efficiently.  
✔ **Binary-Compatible Backups** → Produces exact byte-for-byte copies of database files.

### Disadvantages

✖ **InnoDB Only** → Does not support MyISAM (although MySQL 8 primarily uses InnoDB).  
✖ **Requires Extra Storage** → Full .ibd file copies require sufficient disk space.  
✖ **More Complex Setup** → Requires running **xtrabackup prepare** before restoration.  
✖ **No Partial Row Exports** → Unlike mysqldump, it cannot export individual records.

## 6. Conclusion

* **Percona XtraBackup outperformed all other tools**, completing a **backup in 2 minutes** and a **restore in 40 seconds**, making it the fastest solution.
* **mysqldump (CLI) was the fastest logical backup tool**, completing in **22 minutes** with a **7.31 GB file size**.
* **MySQL Workbench provided decent performance**, completing in **25 minutes 4 seconds**.
* **HeidiSQL was unsuitable for large database imports**, as the exported file was too large to load efficiently.
* **Percona XtraBackup is the best choice for large-scale databases requiring minimal downtime.**

## 7. Required Permissions for Percona XtraBackup

A dedicated **backup user** with specific privileges is needed for Percona XtraBackup. Use the following SQL command to grant the necessary permissions:

GRANT RELOAD, LOCK TABLES, SELECT, PROCESS, REPLICATION CLIENT, CREATE TABLESPACE, BACKUP\_ADMIN ON \*.\* TO 'backup\_user'@'localhost';

### Explanation of Permissions:

* **RELOAD** → Required for FLUSH TABLES operations.
* **LOCK TABLES** → Allows table locking during backup.
* **SELECT** → Grants read access to all tables.
* **PROCESS** → Enables tracking of MySQL processes.
* **REPLICATION CLIENT** → Provides access to binlog positions.
* **CREATE TABLESPACE** → Needed for importing tablespaces.
* **BACKUP\_ADMIN** → Allows LOCK INSTANCE FOR BACKUP (MySQL 8+).

Without these privileges, Percona XtraBackup may fail to complete the backup process.

## 8. Types of Backups in Percona XtraBackup

| **Backup Type** | **Description** | **Best For** |
| --- | --- | --- |
| **Full Backup** | Copies **all** MySQL data files (.ibd, ibdata1) | Disaster recovery, periodic backups |
| **Incremental Backup** | Backs up **only changes** since the last backup | Frequent backups with less storage |
| **Partial Backup** | Backs up **specific databases or tables** | Selective data backups |
| **Compressed Backup** | Uses gzip/Qpress to reduce storage usage | Cloud storage, limited disk space |
| **Encrypted Backup** | Secures backup data with AES encryption | Sensitive data, regulatory compliance |
| **Streaming Backup** | Sends backup directly to another server | Remote/offsite backups |

# 

# XtraBackup Commands

## Introduction

## 1. Full Backup

### 1.1 Take a Full Backup

Run the following command to take a full backup:

sudo xtrabackup --backup --target-dir="/home/ubuntu/full\_backup" --datadir=/var/lib/mysql

### 1.2 Prepare the Backup

Preparing the backup ensures consistency before restoration.

sudo xtrabackup --prepare --target-dir="/home/ubuntu/full\_backup"

### 1.3 Restore the Backup

#### **Option 1: Restore Without Deleting Backup**

sudo systemctl stop mysql  
sudo xtrabackup --copy-back --target-dir="/home/ubuntu/full\_backup"  
sudo chown -R mysql:mysql /var/lib/mysql  
sudo systemctl start mysql

#### **Option 2: Restore and Delete Backup**

sudo systemctl stop mysql  
sudo xtrabackup --move-back --target-dir="/home/ubuntu/full\_backup"  
sudo chown -R mysql:mysql /var/lib/mysql  
sudo systemctl start mysql

### 1.4 Important Notes

* The **datadir (/var/lib/mysql/) must be empty** before restoring.
* The **MySQL server must be stopped** before restoring.
* **Cannot restore to a running mysqld instance.**

## 2. Incremental Backup

### 2.1 Take a Full Backup

sudo xtrabackup --backup --target-dir="/home/ubuntu/full\_backup" --datadir=/var/lib/mysql

### 2.2 Take Incremental Backups

Each incremental backup must reference the previous backup.

#### **First Incremental Backup**

sudo xtrabackup --backup --target-dir="/home/ubuntu/incremental\_1" --incremental-basedir="/home/ubuntu/full\_backup"

#### **Second Incremental Backup**

sudo xtrabackup --backup --target-dir="/home/ubuntu/incremental\_2" --incremental-basedir="/home/ubuntu/incremental\_1"

### 2.3 Prepare the Backups

#### **Prepare the Base Backup**

sudo xtrabackup --prepare --apply-log-only --target-dir="/home/ubuntu/full\_backup"

#### **Apply Incremental Backups**

sudo xtrabackup --prepare --apply-log-only --target-dir="/home/ubuntu/full\_backup" --incremental-dir="/home/ubuntu/incremental\_1"  
sudo xtrabackup --prepare --target-dir="/home/ubuntu/full\_backup" --incremental-dir="/home/ubuntu/incremental\_2"

### 2.4 Restore the Backup

sudo systemctl stop mysql  
sudo xtrabackup --copy-back --target-dir="/home/ubuntu/full\_backup"  
sudo chown -R mysql:mysql /var/lib/mysql  
sudo systemctl start mysql

## 3. Compressed Backup

### 3.1 Create a Compressed Backup

sudo xtrabackup --backup --compress --target-dir="/home/ubuntu/compressed"

### 3.2 Decompress the Backup

sudo xtrabackup --decompress --target-dir="/home/ubuntu/compressed"  
sudo xtrabackup --decompress --remove-original --target-dir="/home/ubuntu/compressed"

### 3.3 Prepare and Restore

sudo xtrabackup --prepare --target-dir="/home/ubuntu/compressed"  
sudo systemctl stop mysql  
sudo xtrabackup --copy-back --target-dir="/home/ubuntu/compressed"  
sudo chown -R mysql:mysql /var/lib/mysql  
sudo systemctl start mysql

## 4. Partial Backup

### 4.1 Take Partial Backup

#### **Backup a Single Table**

sudo xtrabackup --backup --datadir=/var/lib/mysql --target-dir="/data/backups" --tables="test\_db\_1.orders\_50"

#### **Backup Specific Tables from a File**

echo "test\_db\_1.orders\_1" > /tmp/tables.txt  
sudo xtrabackup --backup --datadir=/var/lib/mysql --target-dir="/data/backups" --tables-file=/tmp/tables.txt

#### **Backup Specific Databases**

sudo xtrabackup --backup --datadir=/var/lib/mysql --target-dir="/data/backups" --databases="test\_db\_1 finance.sales"

### 4.2 Prepare the Backup

sudo xtrabackup --prepare --export --target-dir="/data/backups"

### 4.3 Restore the Backup (Manual Steps)

1. **Recreate Table Schema**

CREATE TABLE test\_db\_1.orders\_50 (  
 id INT PRIMARY KEY,  
 name VARCHAR(100),  
 amount DECIMAL(10,2)  
) ENGINE=InnoDB;

1. **Discard Existing Tablespace**

ALTER TABLE test\_db\_1.orders\_50 DISCARD TABLESPACE;

1. **Copy .ibd File**

sudo cp /data/backups/test\_db\_1/orders\_50.ibd /var/lib/mysql/test\_db\_1/

1. **Import Tablespace**

ALTER TABLE test\_db\_1.orders\_50 IMPORT TABLESPACE;

## 5. Encrypted Backup

### 5.1 Generate Encryption Key

openssl rand -base64 24 > /data/backups/keyfile

### 5.2 Create Encrypted Backup

sudo xtrabackup --backup --target-dir="/data/backups" --encrypt=AES256 --encrypt-key-file="/data/backups/keyfile"

### 5.3 Decrypt Encrypted Backup

sudo xtrabackup --decrypt=AES256 --encrypt-key-file="/data/backups/keyfile" --target-dir="/data/backups" --remove-original

### 5.4 Prepare and Restore

sudo xtrabackup --prepare --target-dir="/data/backups"  
sudo systemctl stop mysql  
sudo xtrabackup --copy-back --target-dir="/data/backups"  
sudo chown -R mysql:mysql /var/lib/mysql  
sudo systemctl start mysql