MySQL Backup and Security

Best practices on how to run MySQL on Linux in a secure way

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Introduction

- Learning best practises about configuring and running MySQL in a secure way
- Security mechanisms built into MySQL and how to improve them by using OS features
- Discussion of MySQL backup possibilities/tools and strategies
  - Physical vs. logical backup
  - OSS tools suitable for backup purposes
  - Commercial backup solutions

Improving MySQL security

- Essential part of the post-installation process: Security
- Default installation pretty secure already
- Some additional steps have to be performed
- Also utilize additional security features provided by the OS (where applicable)

MySQL Server post-installation

- Set a password for the **`root`** account

```
$ mysql -u root mysql
mysql> SET PASSWORD FOR
  root@localhost=PASSWORD('new_password');
```

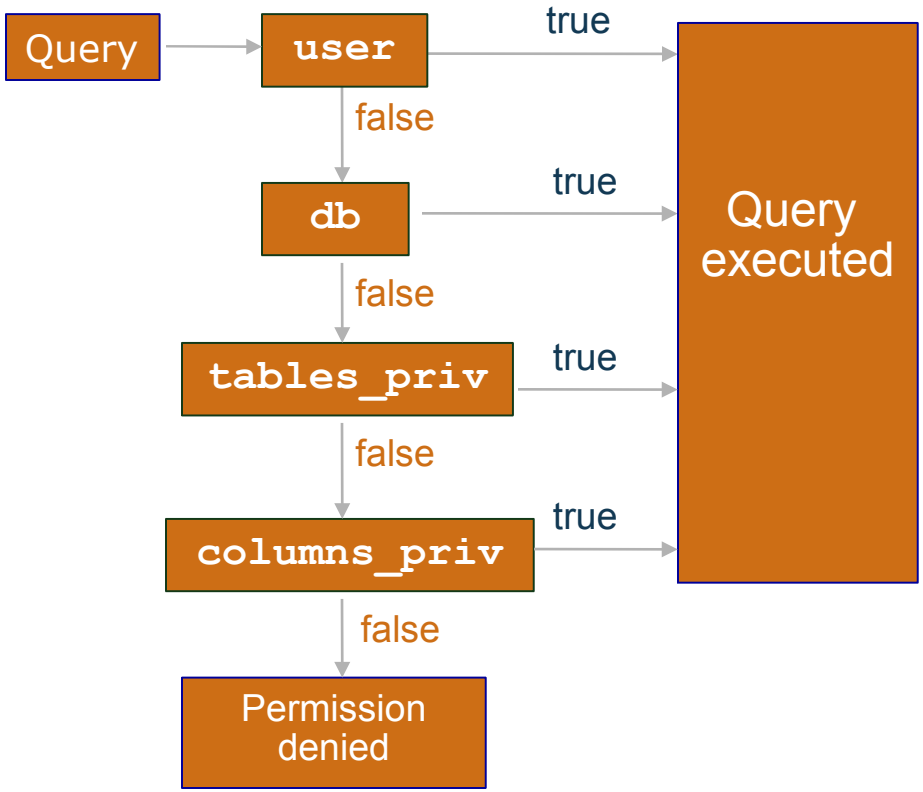
- Remove the **`anonymous`** account (or assign a password to it)
- Remove the **`test`** database (you usually don't need it)
- **`mysql_secure_installation`** script does all of the above (Unix only)

Access Control Check

- **Connect**
  - Server checks in the **`user`** table for a matching entry for the **username**, **host** and **password**
- **Query**
  - Server checks the **`user`**, **`db`**, **`tables_priv`** and **`column_privs`** tables

Query Access Control

Do you have sufficient privileges to execute the query?



MySQL Server security hints

- **`bind-address`** option in **`my.cfg`** binds the TCP port to a specific interface (e.g. **`127.0.0.1`**)
- **`skip-networking`** option only allows connections via the local socket file
- Allow access from selected hosts only
- Restrict access to the **`mysql.user`** table to the **`root`** user
- Learn how to use the **`SHOW GRANTS`**, **`SET PASSWORD`** and **`GRANT`**/**`REVOKE`** statements
- Use phpMyAdmin or MySQL Administrator for user administration
- Do **not** edit **`mysql.user`** directly!

MySQL Server security hints

- Restrict **`PROCESS/SUPER/FILE`** privileges to a minimum
- Do not store plain-text passwords in the database. Use **`MD5()`**, **`SHA1()`** or some other one-way hashing function instead.
- Disable **`LOAD DATA LOCAL`** by setting **`local-infile=0`** in **`my.cnf`**
- Always run run **`mysqld`** using a non-privileged user account

MySQL Server security hints

- For the paranoid:
  - replace the **`root`** account with a different(harder to guess) one to avoid brute-force dictionary attacks
  - remove/clean the client's history file (**`~/.mysql_history`**), if you edited or added user accounts/passwords

Views and Stored Procedures

- **Views** to restrict access to certain columns of tables
- **Stored Procedures** shield tables from being accessed/modified by the user/application directly
- Available since MySQL 5.0.x

Improving access restrictions

- Lock down permissions on the data directory with **`chown`** and **`chmod`**
  - users can't **corrupt** table data
  - users can't **access data** they aren't supposed to see
- Log files must also be kept secure:
  - users might again **see data** they aren't supposed to see
  - queries such as **`GRANT`** are stored in the logfiles, anyone with log file access could then **obtain user passwords**
- Generally don't allow shell logins to the DB server for normal users

Reducing security risks with Linux

- Use **`iptables`** to firewall the server
- Run MySQL in a **`chroot()`** jail
- Enable SELinux or Novell AppArmor
- Run the MySQL server in a virtual machine
  - Xen / Sun xVM
  - Solaris Zones/Container
  - UML (User Mode Linux)
  - VMware / Parallels / VirtualBox

Securing data and communication

- Encrypt network traffic
  - OpenSSL
  - SSH tunnel
  - OpenVPN
  - Cipe
- Encrypt the Data Directory
  - cryptoloop devices
  - dm_crypt kernel module

Backing up MySQL data

- When do you need backups?
- What needs to be backed up?
- When should backups be performed?
- Where will the backups be stored?
- How can backups be performed?

When Do You Need Backups?

- Hardware failure
  - A system crash may cause some of the data in the databases to be lost
  - A hard-disk failure will most certainly lead to lost data
- User/Application failure
  - Accidental DROP TABLE or malformed DELETE FROM statements
  - Editing the table files with text editors, usually leading to corrupt tables

What needs to be backed up?

- Database content
  - for full backups
  - logical or physical backup
- Log files
  - for incremental backups
  - point-in-time recovery

When should backups be performed?

- On a regular basis
- Not during high usage peaks (off hours)
- Static data can be backed up less frequently

Where to store backups?

- On the database server
  - At least on a separate file system/volume or hard disk drive
- Copied to another server
  - On or off site
- Backed up to tape/disk
  - Stored on or off site
- Choose multiple locations

The Data Directory

- Databases and most log and status files are stored in the data directory by default
- Default directory compiled into the server
  - **`/usr/local/mysql/data/`** (tarball installation)
  - **`/var/lib/mysql`** (RPM packages)
- Data directory location can be specified during server startup with
  `--datadir=/path/to/datadir/`
- Find out the location by asking the server
  `mysql> SHOW VARIABLES like 'data%';`

The Binary Log

- Contains all SQL commands that change data
- Also contains additional information about each query (e.g. query execution time)
- Binary log is stored in an efficient binary format
- Use **`mysqlbinlog`** to decipher the log contents
- Log turned on with **`--log-bin[=file_name]`**
- Update logs are created in sequence
  e.g. **`file_name-bin.001`**, **`file_name-bin.002`**, etc.
- Binary log is transaction-compatible
- **`mysqld`** creates binary log index file which contains names of the binary log files used

Managing The Binary Log

- Purpose of the Binary Log:
  - Enable replication
  - Ease crash recovery
- **`SHOW MASTER LOGS`** shows all binary log files residing on the server
- **`FLUSH LOGS`** or restarting the server creates a new file
- **`RESET MASTER`** deletes all binary log files
- **`PURGE MASTER`** deletes all binary log files up to a certain point
- Don't delete logs that slaves still need

The Error Log

- When started with **`mysqld_safe`**, all **error messages** are directed to the error log
- The log contains info on when **`mysqld`** was **started** and **stopped** as well as **errors** found when running

```
$ cat /var/log/mysql.err
000929 15:29:45  mysqld started
/usr/sbin/mysqld: ready for connections
000929 15:31:15  Aborted connection 1 to db: 'unconnected'
user: 'root' host: `localhost' (Got an error writing communication
    packets)
000929 15:31:15  /usr/local/mysql/bin/mysqld: Normal shutdown

000929 15:31:15  /usr/local/mysql/bin/mysqld: Shutdown Complete

000929 15:31:54  mysqld started
/usr/sbin/mysqld: ready for connections
```

mysqldump

- **mysqldump** dumps table structure and data into SQL statements
  $ mysqldump mydb > mydb.20050925.sql
- You can dump **individual tables** or **whole databases**
- The default output from **mysqldump** consists of **SQL statements:**
  - **CREATE TABLE** statements for table structure
  - **INSERT** statements for the data
- **mysqldump** can also be used directly as input into another **mysqld** server (without creating any files)
  - **$ mysqldump --opt world | mysql -hwork.mysql.com world**

Recovering With Backups

DB Recovery = Last full backup & binlog

- To restore tables to the state before a crash requires both the **backup files** and the **binary log**
  - Restore the tables to the state they were at the **time of the backup** from the backup files
  - Extract the queries issued **between** the **backup** and **now** from synchronised binary logs
- If you are recovering data lost due to **unwise** queries, remember **not** to issue them again

Example SQL level restore

- Restore the last full backup

```
mysql < backup.sql
```

- apply all incremental changes done after the last full backup

```
mysqlbinlog hostname-bin.000001 | mysql
```

MySQL table files backup

- Also called “physical” backup
- MyISAM Database files can simply be copied after issuing `FLUSH TABLES WITH READ LOCK;`
- The `mysqlhotcopy` Perl script automates this process
- Locking all tables for consistency can be expensive, if the file backup operation takes a long time

mysqlhotcopy

- **`mysqlhotcopy`** is a Perl script with which you can easily backup databases
- It can **only** be run on the **same** machine as where the databases are
- It does the following
  - **`LOCK TABLES`**
  - **`FLUSH TABLES`**
  - Copies the table files to the desired location with **`cp`** or **`scp`**
  - **`UNLOCK TABLES`**
- The user has to have **write access** to the target directory

Backing Up InnoDB Databases

- Use **`mysqldump --single transaction`** to make an on-line backup
- To take a '**binary**' backup, do the following:
  1. Shutdown the MySQL server
  2. Copy your **data** files, InnoDB **log** files, **`.frm`** files and **`my.cnf`** file(s) to a safe location
  3. Restart the server
- It is a **good** idea to backup with **`mysqldump`** also, since an error might occur in a binary file **without** you noticing it

OSS backup tools

- The usual suspects: **`cp`**, **`tar`**, **`cpio`**, **`gzip`**, **`zip`** called in a shell script via a **`cron`** job
- **`rsync`** or **`unison`** for bandwidth-friendly, remote backups
- Complete network-based backup solutions like afbackup, Amanda or Bacula provide more sophisticated features (e.g. catalogs)

Linux backup support

- LVM snapshots
- DRBD (“RAID1 over the network”)
- Distributed file systems
  - OpenAFS
  - GFS
  - Lustre
  - Novell iFolder

Backup using LVM snapshots

- Linux LVM snapshots provide a very convenient and fast backup solution for backing up entire databases without disruption
- Snapshot volume size does not need to be very large (10-15% are sufficient in a typical scenario)
- Backup of files from a snapshot volume can be performed with any tool
- I/O performance may be degraded due to the additional LVM logging

Linux LVM snapshot creation

Basic principle:

```
mysql> FLUSH TABLES WITH READ LOCK
$ lvcreate -s --size=<size> --name=backup
<LV>
mysql> UNLOCK TABLES
$ mount /dev/<VG>/backup /mnt
$ tar czvf backup.tar.gz /mnt/*
$ umount /mnt
$ lvremove /dev/<VG>/backup
```

The mylvmbackup script

- A Perl script for quickly creating MySQL backups using LVM snapshots
- Snapshots are mounted to a temporary directory and all data is backed up using **`tar`** or **`rsync`**
- Timestamped archive names allow running **`mylvmbackup`** many times without risking to overwrite old archives.
- Requires Perl, DBI and DBD::mysql
- Available from http://www.lenzg.org/mylvmbackup/

MySQL replication

- Backing up a replication slave is less time-critical (Master is not blocked for updates)
- A slave can use different storage engines
- One Master can replicate to many slaves
- Keep the limitations of MySQL replication in mind
- Make sure to back up the `master.info` and `relay-log.info` files as well as any `SQL_LOAD-*` files (if `LOAD DATA INFILE` is replicated)

Commercial backup solutions

- Acronis True Image
- ARCServe
- Arkeia
- InnoDB HotBackup
- SEP sesam
- Veritas vxfs snapshots
- Zmanda Recovery Manager (ZRM)

Backup Method Comparison

- Output from **`mysqldump`** is portable to any other DBMS (without the **`--opt`** option) whereas copied files only work with MySQL
- Full backups are expensive
- Restoring from logs can be tricky
- The file copying methods are **much faster** than **`mysqldump`**
- So it comes down to **your** preferences:
  - Which **tool** do you prefer to use
  - Speed vs. portability

Backup Principles

- Perform backups regularly
- Turn on the binary update log
  - Update logs are needed to restore the database without losing any data
- Synchronise update logs with the backup files
  - Use **`FLUSH LOGS`**
- Name your backups consistently and understandably
  - Include the date in the file name **`mydb.20050925.sql`**
- Store your backups on a different file system than where your databases are

General backup notes

- Putting the binary logs on a different file system (or even a different drive) than the data directory is recommended (increases performance and avoids data loss)
- Verify the backup is consistent and complete!
- Define **backup schedules** and **policies** as well as **recovery procedures**
- **Test** that these actually work!

The MySQL Online Backup API

- An API to perform a streaming MySQL online backup, independent of the Storage Engine
- Transactional tables will contain data only from committed transactions
- Non-transactional tables will contain data only from completed statements
- Referential integrity will be maintained between all tables backed up with a specific backup command
- Now available on MySQL Forge: http://forge.mysql.com/wiki/OnlineBackup

Thank you!

Questions, Comments?

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