Installation & Configuration

2.1 MySQL Installation

Pre-Installation Requirements

System Requirements:

- **OS**: Linux (Ubuntu, CentOS, RedHat), Windows, macOS
- **CPU**: Minimum 1 core, 2+ cores recommended
- **RAM**: Minimum 1GB, 8GB+ for production
- **Disk Space**: Minimum 20GB for datadir and logs

Dependencies:

- libaio (Linux async I/O)
- libnuma (NUMA support)
- GCC compiler (for source compilation)

Installation Methods

1. Package Manager (Recommended for Linux)

```
# Ubuntu/Debian
sudo apt update
sudo apt install -y mysql-server mysql-client

# CentOS/RedHat
sudo yum install -y mysql-server mysql-client
```

2. Binary Tarball

```
# Download from mysql.com
cd /usr/local
tar xzf mysql-8.0.26-linux-x86_64.tar.gz
ln -s mysql-8.0.26-linux-x86_64 mysql
```

 # Create data directory

mkdir -p /var/lib/mysql

chown mysql:mysql /var/lib/mysql

chmod 750 /var/lib/mysql

3. RPM Packages

 # Download RPM

rpm -ivh mysql-community-server-8.0.26-1.el7.x86_64.rpm

rpm -ivh mysql-community-client-8.0.26-1.el7.x86_64.rpm

4. Docker Container

```
docker run --name mysql8 \
  -e MYSQL_ROOT_PASSWORD=password \
  -e MYSQL_DATABASE=testdb \
  -d mysql:8.0.26
```

Post-Installation Setup

Initialize Data Dictionary:

sudo mysql_install_db --user=mysql --basedir=/usr/local/mysql --datadir=/var/lib/mysql

 # Or: mysqld --initialize (MySQL 5.7+)

Start Service:

sudo systemctl start mysql

sudo systemctl enable mysql *# Enable on boot*

sudo systemctl status mysql *# Check status*

Verify Installation:

mysql --version

mysql -u root -p -e "SELECT VERSION();"

2.2 Configuration Files and Parameters

MySQL Configuration File Hierarchy

MySQL reads configuration in this order:

1. /etc/my.cnf
2. /etc/mysql/my.cnf
3. ~/.my.cnf (user home directory)
4. Command-line options (highest priority)

Configuration File Format

Basic Structure:

```
[mysqld]            # Server configuration
option_name = value

[mysqld_safe]       # mysqld_safe wrapper
option_name = value

[client]            # Client programs
option_name = value

[mysql]             # mysql client
option_name = value
```

Common Configuration Parameters

Server Identity:

```
[mysqld]
server_id = 1                # Unique identifier
port = 3306                  # MySQL port
bind_address = 0.0.0.0       # Listen address
socket = /var/run/mysqld/mysqld.sock
```

Memory Allocation:

```
[mysqld]
# InnoDB Buffer Pool (cache for data and indexes)
# Recommended: 60-80% of available RAM
innodb_buffer_pool_size = 8G    # For 16GB server

# Query Buffer
sort_buffer_size = 2M          # Per-connection sort buffer
read_buffer_size = 2M          # Per-connection read buffer
tmp_table_size = 32M           # Temporary table size
max_heap_table_size = 32M      # Memory table size limit
```

Connection Settings:

```
[mysqld]
max_connections = 200          # Maximum simultaneous connections
max_user_connections = 50      # Per-user limit
max_allowed_packet = 256M      # Maximum query size
interactive_timeout = 28800    # Connection idle timeout (seconds)
wait_timeout = 28800           # Non-interactive timeout
```

Logging Configuration:

```
[mysqld]
```

 # Error Log

log_error = /var/log/mysql/error.log

 # General Query Log (use sparingly - performance impact)

general_log = 0

general_log_file = /var/log/mysql/general.log

 # Slow Query Log

slow_query_log = 1

slow_query_log_file = /var/log/mysql/slow-query.log

long_query_time = 2 *# Log queries taking > 2 seconds*

 # Binary Log (for replication and recovery)

log_bin = /var/log/mysql/mysql-bin

binlog_format = ROW *# Row-based replication*

max_binlog_size = 100M

binlog_expire_logs_seconds = 864000 *# 10 days retention*

InnoDB Specific:

[mysqld]

default_storage_engine = InnoDB

 # Buffer Pool

innodb_buffer_pool_size = 8G

innodb_buffer_pool_instances = 8 *# Multiple pool instances*

 # Log Files

innodb_log_file_size = 256M

innodb_log_group_home_dir = /var/lib/mysql

 # Flush Settings (balance between performance and durability)

innodb_flush_log_at_trx_commit = 2

 # 0 = Not safe (fastest)

 # 1 = Safest (default, durability guaranteed)

 # 2 = Balance (good for most)

innodb_flush_method = O_DIRECT *# Bypass OS cache*

Dynamic vs Static Parameters

Dynamic Parameters: Can be changed while MySQL is running

SET GLOBAL max_connections = 300;

SET SESSION sql_mode = 'STRICT_TRANS_TABLES';

Static Parameters: Require restart to take effect

[mysqld]

server_id = 2 *# Must restart*

port = 3307 *# Must restart*

datadir = /var/lib/mysql *# Must restart*

Viewing Current Configuration

-- Show all variables

SHOW VARIABLES;

-- Show specific variables

SHOW VARIABLES LIKE '%buffer_pool%';

SHOW VARIABLES LIKE 'max_connections';

```
-- Show in key=value format
SHOW VARIABLES WHERE variable_name = 'innodb_buffer_pool_size';

-- Alternative: from shell
mysql -u root -p -e "SHOW VARIABLES LIKE '%log%';"
```

2.3 Logging Configuration

Error Log

Purpose: Records MySQL startup/shutdown messages and errors

Configuration:

[mysqld]

log_error = /var/log/mysql/error.log

log_error_verbosity = 2 *# 1=errors, 2=errors+warnings, 3=errors+warnings+info*

Viewing Error Log:

tail -50 /var/log/mysql/error.log

grep ERROR /var/log/mysql/error.log

Common Error Log Messages:

[ERROR] InnoDB: Undo log error code 6. Meaning: No more space left

[Warning] No default storage engine available

[ERROR] Failed to initialize datadir

General Query Log

Purpose: Records all SQL statements sent to MySQL

Configuration:

[mysqld]

general_log = 0 *# Off by default*

general_log_file = /var/log/mysql/general.log

log_output = FILE *# FILE or TABLE*

Enable at Runtime:

SET GLOBAL general_log = 'ON';

SET GLOBAL log_output = 'TABLE';

-- Query the log table

SELECT * FROM mysql.general_log ORDER BY event_time DESC LIMIT 10;

-- Disable after debugging

SET GLOBAL general_log = 'OFF';

Warning: General log creates significant I/O overhead. Use only for debugging.

Slow Query Log

Purpose: Records queries exceeding specified time threshold

Configuration:

[mysqld]

slow_query_log = 1

slow_query_log_file = /var/log/mysql/slow-query.log

long_query_time = 2 *# Log queries > 2 seconds*

log_queries_not_using_indexes = 1 *# Log full table scans*

log_throttle_queries_not_using_indexes = 10

Enable at Runtime:

SET GLOBAL slow_query_log = 'ON';

SET GLOBAL long_query_time = 1;

Analyzing Slow Query Log:

 # View raw log

tail -50 /var/log/mysql/slow-query.log

 # Parse with mysqldumpslow

mysqldumpslow /var/log/mysql/slow-query.log | head -20

 # Advanced parsing with Percona Tools

pt-query-digest /var/log/mysql/slow-query.log

Slow Query Log Format:

Time: 2026-01-14T16:30:45.123456Z

User@Host: root@localhost

Query_time: 3.456 Lock_time: 0.001 Rows_sent: 0 Rows_examined: 1000000

SELECT * FROM large_table WHERE id > 50000;

Binary Log

Purpose: Records data changes for replication and point-in-time recovery

Configuration:

[mysqld]

log_bin = /var/log/mysql/mysql-bin

binlog_format = ROW *# ROW, STATEMENT, MIXED*

max_binlog_size = 100M

binlog_expire_logs_seconds = 864000 *# 10 days*

server_id = 1 *# Required for replication*

Binlog Formats:

- **STATEMENT**: Logs SQL statements (compact but risky with non-deterministic functions)
- **ROW**: Logs row changes (safe but larger, recommended for replication)
- **MIXED**: Hybrid approach (default in most versions)

Viewing Binary Logs:

 # List all binary logs

mysql -u root -p -e "SHOW BINARY LOGS;"

 # View binary log contents

mysqlbinlog /var/log/mysql/mysql-bin.000001

```
# View specific time range
mysqlbinlog --start-datetime="2026-01-14 10:00:00" \
        --stop-datetime="2026-01-14 11:00:00" \
        /var/log/mysql/mysql-bin.000001
```

2.4 SQL Modes

What are SQL Modes?

SQL modes define how MySQL handles data validation and interpretation. They affect:

- Strict data validation
- Handling invalid values
- Behavior with NULL values
- Date/time interpretation

Common SQL Modes

STRICT_TRANS_TABLES

```
-- Rejects invalid data in transactional engines (InnoDB)
SET GLOBAL sql_mode = 'STRICT_TRANS_TABLES';

-- Without: INSERT silently truncates
INSERT INTO users (email) VALUES ('verylongemailaddress@example.com@extra');

-- With STRICT: Error raised
-- Error 1406: Data too long for column
```

STRICT_ALL_TABLES

```
-- Same as STRICT_TRANS_TABLES but also for non-transactional engines
SET GLOBAL sql_mode = 'STRICT_ALL_TABLES';
```

NO_ZERO_DATE

```
-- Rejects '0000-00-00' dates
SET GLOBAL sql_mode = 'NO_ZERO_DATE';
```

-- Without: Date stored as 0000-00-00

INSERT INTO events (date) VALUES ('0000-00-00');

-- With mode: Error raised

-- Error 1292: Incorrect date value

NO_ZERO_IN_DATE

-- Rejects dates with zero month or day (e.g., 2026-00-15)

SET GLOBAL sql_mode = 'NO_ZERO_IN_DATE';

ERROR_FOR_DIVISION_BY_ZERO

-- Treats division by zero as error (not NULL)

SET GLOBAL sql_mode = 'ERROR_FOR_DIVISION_BY_ZERO';

SELECT 10 / 0; *-- Error instead of NULL*

NO_ENGINE_SUBSTITUTION

-- Raises error if specified storage engine not available

-- Without: Falls back to default engine silently

SET GLOBAL sql_mode = 'NO_ENGINE_SUBSTITUTION';

Recommended SQL Mode Configuration

Production Environment:

[mysqld]

sql_mode =
'STRICT_TRANS_TABLES,ERROR_FOR_DIVISION_BY_ZERO,NO_ENGINE_SUBSTITUTION'

Development Environment (stricter):

[mysqld]

sql_mode =
'STRICT_ALL_TABLES,NO_ZERO_DATE,NO_ZERO_IN_DATE,ERROR_FOR_DIVISION_BY_ZERO,
NO_ENGINE_SUBSTITUTION,ONLY_FULL_GROUP_BY'

Viewing and Setting SQL Modes

-- View current SQL mode

SELECT @@sql_mode;

SHOW VARIABLES LIKE 'sql_mode';

-- Set session SQL mode

SET SESSION sql_mode = 'STRICT_TRANS_TABLES,ERROR_FOR_DIVISION_BY_ZERO';

-- Set global SQL mode

SET GLOBAL sql_mode = 'STRICT_TRANS_TABLES,ERROR_FOR_DIVISION_BY_ZERO';

-- Verify

SELECT @@GLOBAL.sql_mode;

SELECT @@SESSION.sql_mode;

2.5 SHOW Statements for Information Gathering

Server Status Commands

```
-- Show server version and current time
SELECT VERSION();
SELECT NOW();

-- Show current user
SELECT USER();
SELECT CURRENT_USER();

-- Show current database
SELECT DATABASE();
```

Configuration and Status Information

```
-- Show all variables
SHOW VARIABLES;
SHOW VARIABLES LIKE '%buffer%';

-- Show connection information
SHOW PROCESSLIST;
SHOW FULL PROCESSLIST;  -- Show full query text

-- Show server status
SHOW STATUS;
SHOW STATUS LIKE 'Threads%';
SHOW STATUS LIKE 'Questions';
SHOW STATUS LIKE 'Connections';
```

Database and Table Information

-- List databases

SHOW DATABASES;

SHOW SCHEMAS;

-- Show tables in current database

SHOW TABLES;

SHOW TABLES FROM database_name;

-- Show table structure

DESCRIBE table_name;

DESC table_name;

SHOW COLUMNS FROM table_name;

-- Show table creation statement

SHOW CREATE TABLE table_name\G

SHOW CREATE DATABASE database_name\G

Index and Key Information

-- Show indexes on table

SHOW INDEX FROM table_name;

SHOW KEYS FROM table_name;

-- Show table statistics

SHOW TABLE STATUS LIKE 'table_name'\G

Privilege and User Information

-- Show current privileges

```
SHOW GRANTS FOR CURRENT_USER();

SHOW GRANTS FOR 'user'@'host';
```

-- Show all users

```
SELECT user, host FROM mysql.user;
```

-- Show user privileges

```
SELECT * FROM mysql.user WHERE user = 'username'\G
```

2.6 Summary: Key Takeaways

1. **Installation**: Multiple methods available (package manager, binary, RPM, Docker)
2. **Configuration**: Central /etc/mysql/my.cnf file with [mysqld], [client] sections
3. **Key Parameters**:
    - Memory: innodb_buffer_pool_size, sort_buffer_size
    - Connections: max_connections, interactive_timeout
    - Logging: error, general, slow query, binary logs
4. **SQL Modes**: STRICT_TRANS_TABLES and ERROR_FOR_DIVISION_BY_ZERO recommended
5. **SHOW Commands**: Essential for information gathering and diagnostics