MariaDB Komplettkurs

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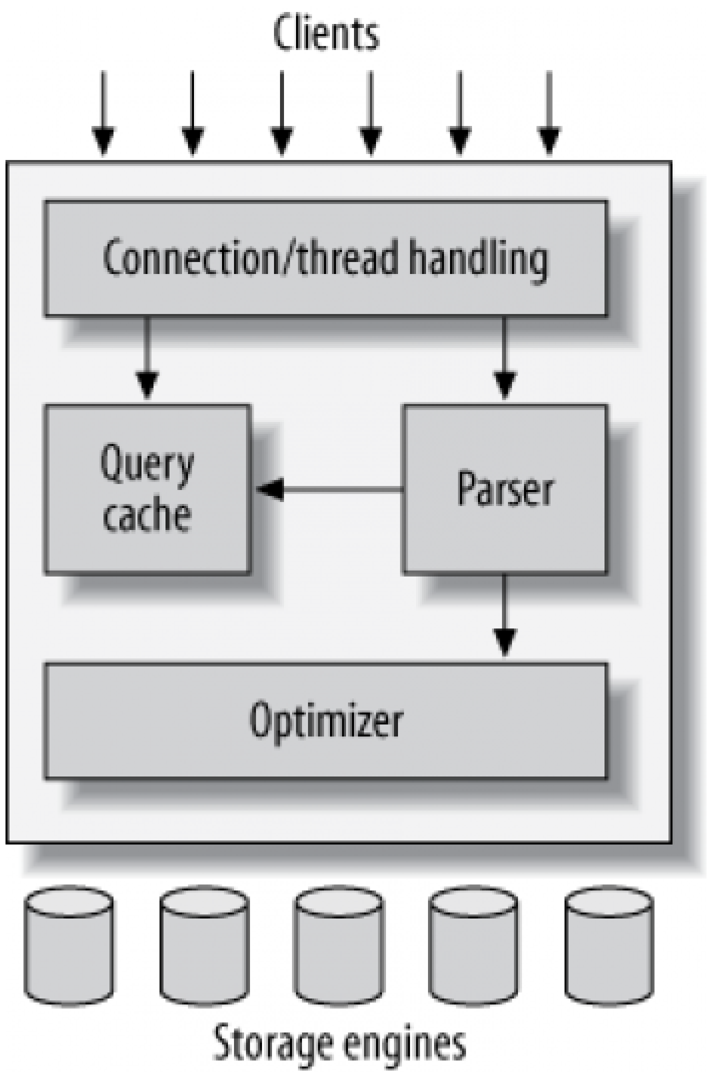
Architecture of MariaDB

Architecture Server (Steps)



Query Cache Usage and Performance

Performance query cache

- Always try to optimize innodb with disabled query cache first (innodb_buffer_pool)
- If you use query_cache system can only use on CPU-Core. !!

How to enable query cache

```
## have_query_cache means compiled in mysql
## query_cache_type off means not enable by config
-- query cache is diabled
mysql> show variables like '%query_cache%';
+------------------------------+---------+
| Variable_name                | Value   |
+------------------------------+---------+
| have_query_cache             | YES     |
| query_cache_limit            | 1048576 |
| query_cache_min_res_unit     | 4096    |
| query_cache_size             | 1048576 |
| query_cache_type             | OFF     |
| query_cache_wlock_invalidate | OFF     |
+------------------------------+---------+
6 rows in set (0.01 sec)

root@trn01:/etc/mysql/mysql.conf.d# tail mysqld.cnf
[mysqld]
pid-file        = /var/run/mysqld/mysqld.pid
socket          = /var/run/mysqld/mysqld.sock
datadir         = /var/lib/mysql
log-error       = /var/log/mysql/error.log
## By default we only accept connections from localhost
bind-address    = 0.0.0.0
## Disabling symbolic-links is recommended to prevent assorted security risks
symbolic-links=0
query-cache-type=1

systemctl restart mysql

mysql> show variables like '%query_cache%';
+------------------------------+---------+
| Variable_name                | Value   |
+------------------------------+---------+
| have_query_cache             | YES     |
| query_cache_limit            | 1048576 |
| query_cache_min_res_unit     | 4096    |
| query_cache_size             | 1048576 |
| query_cache_type             | ON      |
| query_cache_wlock_invalidate | OFF     |
+------------------------------+---------+
6 rows in set (0.01 sec)
```

```
mysql> show status like '%Qcache%';
+-------------------------+---------+
| Variable_name           | Value   |
+-------------------------+---------+
| Qcache_free_blocks      | 1       |
| Qcache_free_memory      | 1031832 |
| Qcache_hits             | 0       |
| Qcache_inserts          | 0       |
| Qcache_lowmem_prunes    | 0       |
| Qcache_not_cached       | 0       |
| Qcache_queries_in_cache | 0       |
| Qcache_total_blocks     | 1       |
+-------------------------+---------+
8 rows in set (0.00 sec)

## status in session zurücksetzen.
mysql> flush status;
Query OK, 0 rows affected (0.00 sec)
```

Performance bottleneck - mutex

https://mariadb.com/de/resources/blog/flexible-mariadb-server-query-cache/

Something planned ?

- Nope ;o(Demand is new
- You might be able to use Demand together with maxscale
- Refer to: https://mariadb.com/de/resources/blog/flexible-mariadb-server-query-cache/

```
A mutual exclusion object (mutex) is a programming object that allows multiple program
threads to share a resource (such as a folder) but not simultaneously. Mutex is set to
unlock when the data is no longer needed or when a routine is finished. Mutex creates
a bottleneck effect. The blocking means only one query can look at the Query Cache at
a time and other queries must wait. A query that must wait to look in the cache only
to find it isn't in the cache will be slowed instead of being accelerated.
```

Optimizer-Basics

General

- All optimizer today are cost-based

Cost-Based

```
## How much costs are needed to get the information
```

Storage Engines

Why ?

```
Let's you choose:
How your data is stored
```

What ?

- Performance, features and other characteristics you want

What do they do ?

- In charge for: Responsible for storing and retrieving all data stored in MySQL
- Each storage engine has its:
  - Drawbacks and benefits
- Server communicates with them through the storage engine API
  - this interface hides differences
  - makes them largely transparent at query layer
  - api contains a couple of dozen low-level functions e.g. “begin a transaction”, “fetch the row that has this primary key”

Storage Engine do not ....

- Storage Engines do not parse SQL
- Storage Engines do not communicate with each other

They simply .....

- They simply respond to requests from the server

Which are the most important one ?

- MyISAM/Aria
- InnoDB
- Memory
- CSV
- Blackhole (/dev/null)
- Archive
- Partition
- Federated/FederatedX

Installation

Installation Centos

Setup Repo and Install

```
Here is your custom MariaDB YUM repository entry for CentOS. Copy and paste it into a
file under /etc/yum.repos.d/ (we suggest naming the file MariaDB.repo or something
similar).

## MariaDB 10.4 CentOS repository list - created 2021-04-20 08:58 UTC
## http://downloads.mariadb.org/mariadb/repositories/
[mariadb]
name = MariaDB
baseurl = http://yum.mariadb.org/10.4/centos8-amd64
module_hotfixes=1
gpgkey=https://yum.mariadb.org/RPM-GPG-KEY-MariaDB
gpgcheck=1

The configuration item module_hotfixes=1 is a workaround for what we have been told is
a dnf bug. See MDEV-20673 for more details.

After the file is in place, install and start MariaDB with:

sudo dnf install MariaDB-server
sudo systemctl start mariadb
```

Secure installation

```
mariadb-secure-installation
## OR: if not present before 10.4
mysql_secure_installation
```

Installation SLES15

- https://downloads.mariadb.org/mariadb/repositories/#distro=SLES&distro_release=sles15-amd64--sles15&mirror=timo&version=10.5

Installation (Ubuntu)

Setup repo and install

- https://downloads.mariadb.org/mariadb/repositories/

```
### repo
sudo apt-get install software-properties-common
sudo apt-key adv --fetch-keys 'https://mariadb.org/mariadb_release_signing_key.asc'
## does an apt update after setting repo - automatically
sudo add-apt-repository 'deb [arch=amd64,arm64,ppc64el]
https://mirror.dogado.de/mariadb/repo/10.5/ubuntu focal main'
sudo apt install mariadb-server
```

Secure installation

```
mariadb-secure-installation
## OR: if not present before 10.4
mysql_secure_installation
```

Start/Status/Stop/Enable von MariaDB

start/stop/status

```
## als root - user
systemctl status mariadb
systemctl stop mariadb
systemctl start mariadb
```

enable

```
## enable to be started after reboot
systemctl enable mariadb
```

Does mariadb listen to the outside world

How to check ?

```
lsof -i | grep mariadb
## localhost means it does NOT listen to the outside now
## mariadbd  5208           mysql   19u  IPv4  56942      0t0  TCP localhost:mysql
(LISTEN)
```

Configuration

Adjust configuration and restart

```
## change config in /etc/mysql/50-server.cnf
## After that restart server - so that it takes your new config
systemctl restart mariadb
echo $? # Was call restart succesful -> 0
```

Set global server system variable

Find out current value

```
## show global variable
show global variables like '%automatic_sp%'
## or // variable_name needs to be in captitals
use information_schema
select * from global_variables where variable_name like '%AUTOMATIC_SP%';

## If you know the exact name
select @@global.automatic_sp_privileges;
select @@GLOBAL.automatic_sp_privileges;
```

Set global Variable

```
## will be set like so till next restart of mysql server
set global automatic_sp_privileges = 0
```

automatic_sp_privileges can only be set globally

```
## Refer to: server system variable doku

## Has same value in global an session scope
MariaDB [information_schema]> select @@automatic_sp_privileges; select
@@global.automatic_sp_privileges;
+---------------------------+
| @@automatic_sp_privileges |
+---------------------------+
|                         0 |
+---------------------------+
1 row in set (0.000 sec)

+----------------------------------+
| @@global.automatic_sp_privileges |
+----------------------------------+
|                                0 |
+----------------------------------+
1 row in set (0.000 sec)
```

Reference:

- https://mariadb.com/kb/en/server-system-variables/#automatic_sp_privileges

Information Schema / Status / Processes

Show server/session status

Through mysql

```
## in mysql interface (client)
mysql
status;
```

With mysqladmin

```
mysqladmin status
## or if you want to know more
mysqladmin extended status
```

with mysql -> show status

```
mysql> show status;
mysql> show global status;
mysql> # setzt session status zurück
mysql> flush status;
mysql> show status;
```

Kill long running process

```
## Session 1
## sleep for 120 seconds
select sleep(120)

## Session 2
show processlist
## kill process you have identified for sleep(120)
MariaDB [(none)]> show processlist;
+----+------+-----------+----------+---------+------+------------+------------------
+----------+
| Id | User | Host      | db       | Command | Time | State      | Info             |
Progress |
+----+------+-----------+----------+---------+------+------------+------------------
+----------+
| 36 | root | localhost | NULL     | Query   |    0 | starting   | show processlist  |
0.000 |
| 37 | root | localhost | training | Query   |    4 | User sleep | select sleep(120) |
0.000 |
+----+------+-----------+----------+---------+------+------------+------------------
+----------+
2 rows in set (0.000 sec)
## take 37
kill 37

## Session 1: query terminates
ERROR 2013 (HY000): Lost connection to MySQL server during query
```

Kill (kickout user) and stop server

```
MariaDB [mysql]> show processlist;
+----+----------+-----------+----------+---------+------+----------+------------------
+----------+
| Id | User     | Host      | db       | Command | Time | State    | Info
| Progress |
+----+----------+-----------+----------+---------+------+----------+------------------
+----------+
| 30 | root     | localhost | mysql    | Sleep   |   10 |          | NULL
|    0.000 |
| 34 | root     | localhost | mysql    | Query   |    0 | starting | show processlist
|    0.000 |
| 43 | training | localhost | training | Sleep   |    5 |          | NULL
|    0.000 |
+----+----------+-----------+----------+---------+------+----------+------------------
+----------+
3 rows in set (0.000 sec)

MariaDB [mysql]> quit
Bye
root@its-lu20s04:~# mysql -e 'kill 43' && systemctl stop mariadb
root@its-lu20s04:~#
```

Security and User Rights

Get Rights of user

Root can show rights of a specific user

```
## shows the right of the logged in user (you as a user)
show grants;

## show grants for a specific user
## no need for ' (quotes) if there are not special chars withing
## e.g.
show grants for training@localhost;
## if there are special chars, use quotes
show grants for 'mariadb.sys'@localhost;

## if you want to see rights of a user that has rights from everywhere
show grants for training@'%';
```

If you cannot remember the exact user (user@host) look it up

```
## within mysql client
use mysql
select * from user \G
```

Secure with SSL server/client

Create CA and Server-Key

```
## On Server - create ca and certificates
sudo mkdir -p /etc/mysql/ssl
sudo cd /etc/mysql/ssl

## create ca.
sudo openssl genrsa 4096 > ca-key.pem

## create ca-certificate
## Common Name: MariaDB Admin
sudo openssl req -new -x509 -nodes -days 365000 -key ca-key.pem -out ca-cert.pem

## create server-cert
## Common Name: MariaDB Server
## Password: --- leave empty ----
sudo openssl req -newkey rsa:2048 -days 365000 -nodes -keyout server-key.pem -out
server-req.pem

## Next process the rsa - key
sudo openssl rsa -in server-key.pem -out server-key.pem

## Now sign the key
sudo openssl x509 -req -in server-req.pem -days 365000 -CA ca-cert.pem -CAkey ca-
key.pem -set_serial 01 -out server-cert.pem
```

Verify certificates

```
openssl verify -CAfile ca-cert.pem server-cert.pem
```

Configure Server

```
## create file
## /etc/my.cnf.d/z_ssl.cnf
[mysqld]
ssl-ca=/etc/mysql/ssl/ca-cert.pem
ssl-cert=/etc/mysql/ssl/server-cert.pem
ssl-key=/etc/mysql/ssl/server-key.pem
### Set up TLS version here. For example TLS version 1.2 and 1.3 ##
tls_version = TLSv1.2,TLSv1.3

## Set ownership
chown -vR mysql:mysql /etc/mysql/ssl/
```

Restart and check for errors

```
systemctl restart mariadb
journalctl -u mariadb
```

Setup on clients

```
## from
## copy /etc/mysql/ssl/ca-cert.pem
## to client
cd /etc/mysql
tar cvfz ssl.tar.gz ssl
scp ssl.tar.gz 11trainingdo@ip:/tmp
```

```
sudo vi /etc/mysql/mariadb.conf.d/50-mysql-clients.cnf

Append/edit in [mysql] section:

### MySQL Client Configuration ##
ssl-ca=/etc/mysql/ssl/ca-cert.pem

###  Force TLS version for client too
##tls_version = TLSv1.2,TLSv1.3
#### This option is disabled by default ###
#### ssl-verify-server-cert ###

## only works if you have no self-signed certificate
ssl-verify-server-cert

```

Test connection on client

```
mysql --ssl -uxyz -p -h <ip-of-server>
mysql>status
SSL:                    Cipher in use is TLS_AES_256_GCM_SHA384
```

Force to use ssl

```
## on server
## now client can only connect, when using ssl
mysql> grant USAGE on *.* to remote@10.10.9.144 require ssl;
```

On client to enable ssl by default for root

```
vi /root/.my.cnf
[mysql]
ssl

## now mysql will always use ssl
mysql -uxyz -p -h10.10.9.110
```

Ref

- https://www.cyberciti.biz/faq/how-to-setup-mariadb-ssl-and-secure-connections-from-clients/

```
```

Create User/Grant/Revoke - Management of users

Create user

```
create user training@localhost identified by 'deinpasswort';
```

Drop user (=delete user)

```
drop user training@localhost
```

Change User (e.g. change authentication)

```
## change pass
alter user training@localhost identified by 'newpassword';
```

Set global or db rights for a user

```
grant all on *.* to training@localhost
## only a specific db
grant all on mydb.* to training@localhost
```

Revoke global or dg right from a suer

```
revoke select on *.* from training@localhost
## only from a specific db
revoke select on training.* from training@localhost
```

Refs:

- https://mariadb.com/kb/en/grant/#the-grant-option-privilege
- https://mariadb.com/kb/en/revoke/

User- and Permission-concepts (best-practice)

```
MariaDB [mysql]> create database eventplanner;
Query OK, 1 row affected (0.000 sec)

MariaDB [mysql]> create user eventplanner@localhost identified by 'eventplanner';
Query OK, 0 rows affected (0.001 sec)

MariaDB [mysql]> grant all on eventplanner.* to eventplanner@localhost;
Query OK, 0 rows affected (0.003 sec)
```

SELinux

Welche Ports sind freigegeben? (MariaDb startet damit)

Welche Ports

```
semanage port -l | grep mysql
```

Database - Objects

Create Database

```
create schema training
create database training
```

Show structure of table

show create table

```
use mysql;
show create table user
```

describe table

```
use mysql;
describe user;
```

Show all tables within db

show all tables in database

```
## connect with db training
mysql training
mysql> show tables;
|training|
```

describe

```
MariaDB [training]> describe mitarbeiter;
+---------+---------------------+------+-----+---------+-------+
| Field   | Type                | Null | Key | Default | Extra |
+---------+---------------------+------+-----+---------+-------+
| id      | tinyint(3) unsigned | NO   | PRI | NULL    |       |
| name    | varchar(50)         | YES  |     | NULL    |       |
| vorname | varchar(30)         | YES  |     | NULL    |       |
+---------+---------------------+------+-----+---------+-------+
3 rows in set (0.001 sec)
```

show create

```
MariaDB [training]> show create table mitarbeiter;
+-------------+-----------------------------------------------------------------------
--------------------------------------------------------------------------------------
--------------------------------------------+
| Table       | Create Table
|
+-------------+-----------------------------------------------------------------------
--------------------------------------------------------------------------------------
--------------------------------------------+
| mitarbeiter | CREATE TABLE `mitarbeiter` (
  `id` tinyint(3) unsigned NOT NULL,
  `name` varchar(50) DEFAULT NULL,
  `vorname` varchar(30) DEFAULT NULL,
  PRIMARY KEY (`id`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4 |
+-------------+-----------------------------------------------------------------------
--------------------------------------------------------------------------------------
--------------------------------------------+
1 row in set (0.000 sec)
```

Triggers

Ref with walkthrough

- https://mariadb.com/kb/en/trigger-overview/

Locking

Identify Deadlocks in innodb

Example

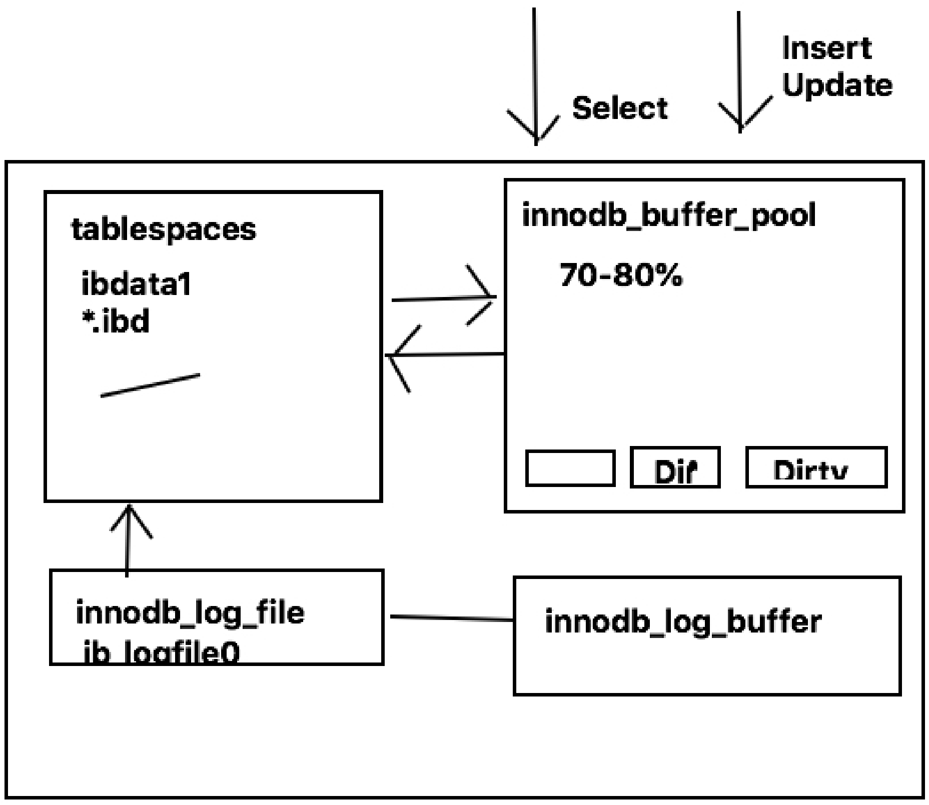
```
##
SELECT l.*, t.*
    FROM information_schema.INNODB_LOCKS l
    JOIN information_schema.INNODB_TRX t
        ON l.lock_trx_id = t.trx_id
    WHERE trx_state = 'LOCK WAIT' \G
```

Refs

- https://mariadb.com/kb/en/information-schema-innodb_locks-table/

InnoDB - Storage Engine

InnoDB - Storage Engine - Structure



Important InnoDB - configuration - options to optimized performance

Innodb buffer pool

- How much data fits into memory
- Free buffers = pages of 16 Kbytes
- Free buffer * 16Kbytes = free innodb buffer pool in KByte

```
## does not in windows -> pager grep
pager grep -i 'free buffers'
## does not work with workbench or heidisql because of formatting + \G only
works in client
show engine innodb status \G
Free buffers       7905
1 row in set (0.00 sec)
```

Innodb buffer pool stats with status

```
## Also works in heidisql or workbench
show status like '%buffer%';
```

Overview innodb server variables / settings

- https://dev.mysql.com/doc/refman/5.7/en/innodb-parameters.html

Change innodb_buffer_pool

```
## /etc/mysql/mysql.conf.d/mysqld.cnf
## 70-80% of memory on dedicated mysql
[mysqld]
innodb-buffer-pool-size=6G

##
systemctl restart mysql

##
mysql
mysql>show variables like 'innodb%buffer%';
```

innodb_flush_method

```
Ideally O_DIRECT on Linux, but please test it, if it really works well.
```

innodb_flush_log_at_trx_commit

```
When is fliushing done from innodb_log_buffer to log.
Default: 1 : After every commit
-> best performance 2. -> once per second

## Good to use 2, if you are willing to loose 1 second of data on powerfail
```

innodb_flush_neighbors

```
## on ssd disks set this to off, because there is no performance improvement
innodb_flush_neighbors=0

## Default = 1
```

innodb_log_file_size

```
## Should holw 60-120 min of data flow
## Calculate like so:
https://www.percona.com/blog/2008/11/21/how-to-calculate-a-good-innodb-log-file-size/
```

skip-name-resolv.conf

```
## work only with ip's - better for performance
/etc/my.cnf
skip-name-resolve
```

- https://nixcp.com/skip-name-resolve/

Ref:

- https://dev.mysql.com/doc/refman/5.7/en/innodb-buffer-pool-resize.html

Privilegs for show engine innodb status

```
 show engine innodb status \G
ERROR 1227 (42000): Access denied; you need (at least one of) the PROCESS privilege(s)
for this operation
```

Training Data

Setup training data "contributions"

Walkthrough

- Complete process takes about 10 minutes

```
cd /usr/src
apt update; apt install -y git
git clone https://github.com/jmetzger/dedupe-examples.git
cd dedupe-examples
cd mysql_example
## Eventually you need to enter (in mysql_example/mysql.cnf)
## Only necessary if you cannot connect to db by entering "mysql"
## password=<your_root_pw>
./setup.sh
```

Backup and Restore (Point-In-Time aka PIT)

Backup with mysqldump - best practices

Dumping (best option) without active binary log

```
mysqldump --all-databases --single-transaction > /usr/src/all-databases
## if you want to include procedures use --routines
## with event - scheduled tasks
mysqldump --all-databases --single-transaction --routines --events > /usr/src/all-
databases
```

Useful options for PIT

```
## —quick not needed, because included in —opt which is enabled by default

## on local systems using socket, there are no huge benefits concerning --compress
## when you dump over the network use it for sure
mysqldump --all-databases --single-transaction --gtid --master-data=2 --routines --
events --flush-logs --compress > /usr/src/all-databases.sql;
```

With PIT_Recovery you can use --delete-master-logs

- All logs before flushing will be deleted

```
mysqldump --all-databases --single-transaction --gtid --master-data=2 --routines --
events --flush-logs --compress --delete-master-logs > /usr/src/all-databases.sql;
```

Version with zipping

```
mysqldump —-all-databases —-single-transaction —-gtid —-master-data=2 —-routines
--events —-flush-logs --compress | gzip > /usr/src/all-databases.sql.gz
```

Performance Test mysqldump (1.7 Million rows in contributions)

```
date; mysqldump --all-databases --single-transaction --gtid --master-data=2 --routines
--events --flush-logs --compress > /usr/src/all-databases.sql; date
Mi 20. Jan 09:40:44 CET 2021
Mi 20. Jan 09:41:55 CET 2021
```

Seperated sql-structure files and data-txt files including master-data for a specific database

```
 # backups needs to be writeable for mysql
 mkdir /backups
 chmod 777 /backups
 chown mysql:mysql /backups
 mysqldump --tab=/backups contributions
 mysqldump --tab=/backups --master-data=2 contributions
 mysqldump --tab=/backups --master-data=2 contributions > /backups/master-data.tx
```

Create new database base on sakila database

```
cd /usr/src
mysqldump sakila > sakila-all.sql
echo "create database mynewdb" | mysql
mysql mynewdb < sakila-all.sql
```

Flashback

- Redoes insert/update/delete entries from binlog (binlog_format = 'ROW')

Referenz:

- https://mariadb.com/kb/en/flashback/

mariabackup

Walkthrough

```
## user eintrag in /root/.my.cnf
[mariabackup]
user=root
## pass is not needed here, because we have the user root with unix_socket - auth

mkdir /backups
## target-dir needs to be empty or not present
mariabackup --target-dir=/backups/20210120 --backup
## apply ib_logfile0 to tablespaces
## after that ib_logfile0 ->  0 bytes
mariabackup --target-dir=/backups/20210120 --prepare

### Recover
systemctl stop mariadb
mv /var/lib/mysql /var/lib/mysql.bkup
mariabackup --target-dir=/backups/20200120 --copy-back
chmod -R mysql:mysql /var/lib/mysql
systemctl start mariadb
```

Ref.

https://mariadb.com/kb/en/full-backup-and-restore-with-mariabackup/

Use xtrabackup for MariaDB 5.5

For mariadb 5.5 you can use xtrabackup instead of mariabackup

- https://www.percona.com/doc/percona-xtrabackup/2.4/index.html

Ready-made-back-scripts

- https://gist.github.com/skarllot/2576266

Simple-Backup-Script

Backup Script

```
cat backup-test.sh
##!/bin/bash

DATABASES=$(echo "select schema_name from information_schema.schemata where
schema_name != 'performance_schema' and schema_name != 'information_schema';" | mysql)
for i in $DATABASES
do
  mysqldump $i > /usr/src/dump_$i.sql
done
```

Performance

io-Last/CPU-Last

IO-gebundene - Last (Input/Output)

```
Gegeben wenn:
- Hoher waiting wert in top (wa-wert in CPU-Liste)
- + Hohelast   1,5, 15 min     1,2   1.5  2 (Load) -> top
```

CPU-Gebundene - Last

```
Gegeben wenn:
- NUR: Hohe Last -> Wert in top -> 2 1.5 0.5 (Load)
- Waiting-wert: 0
```

Views and performance

General

```
SHOW CREATE VIEW
```

Views and Algorithms

- Views can use 3 algorithms:
    - merge
    - simple rewrites (translates the query)
- temptable
    - Creates a temptable to retrieve information
    - In this case no indexes can be used
- Shows up explain with derived
- undefined
    - MySQL chooses, if to use merge or temptable
    - prefers merge over temptable if possible

Example

```
+----+-------------+------------+------+---------------+------+---------+------+------
+-------+
| id | select_type | table      | type | possible_keys | key  | key_len | ref  | rows
| Extra |
+----+-------------+------------+------+---------------+------+---------+------+------
+-------+
|  1 | PRIMARY     | <derived2> | ALL  | NULL          | NULL | NULL    | NULL |   33
| NULL  |
|  2 | DERIVED     | task       | ALL  | NULL          | NULL | NULL    | NULL |   33
| NULL  |
+----+-------------+------------+------+---------------+------+---------+------+------
+-------+
```

Handling (best practice)

- You can define the algorithm when creating the view
- If you define merge and mysql cannot handle it
    - you will get a warning

Example of handling

```
mysql> CREATE ALGORITHM=MERGE VIEW priority_counts AS SELECT priority_id, COUNT(1) AS
quanity FROM task GROUP BY priority_id;
Query OK, 0 rows affected, 1 warning (0.12 sec)

mysql> SHOW WARNINGS;
+---------+------+--------------------------------------------------------------------
-----------+
| Level   | Code | Message
|
+---------+------+--------------------------------------------------------------------
```

```
-----------+
| Warning | 1354 | View merge algorithm can't be used here for now (assumed undefined
algorithm) |
+---------+------+---------------------------------------------------------------------
-----------+
1 row in set (0.08 sec)
```

Reference

- Ref: https://dba.stackexchange.com/questions/54481/determining-what-algorithm-mysql-view-is-using

Partitions and Explain

Walkthrough

```
-- EXPLAIN PARTITIONS

DROP TABLE IF EXISTS audit_log;
CREATE TABLE audit_log (
  yr    YEAR NOT NULL,
  msg   VARCHAR(100) NOT NULL)
ENGINE=InnoDB
PARTITION BY RANGE (yr) (
  PARTITION p0 VALUES LESS THAN (2010),
  PARTITION p1 VALUES LESS THAN (2011),
  PARTITION p2 VALUES LESS THAN (2012),
  PARTITION p3 VALUES LESS THAN MAXVALUE);
INSERT INTO audit_log(yr,msg) VALUES (2005,'2005'),(2006,'2006'),(2011,'2011'),
(2020,'2020');
EXPLAIN PARTITIONS SELECT * from audit_log WHERE yr in (2011,2012)\G
```

Partitions sliced by hash of field

```
CREATE TABLE employees (
    id INT NOT NULL,
    fname VARCHAR(30),
    lname VARCHAR(30),
    hired DATE NOT NULL DEFAULT '1970-01-01',
    separated DATE NOT NULL DEFAULT '9999-12-31',
    job_code INT,
    store_id INT
)
PARTITION BY HASH(store_id)
PARTITIONS 4;
```

3 Phases of DataSize

Phase 1: Table content is small (only some rows)

```
## table scan is quicker than index search
## e.g. 10 entries

## so eventually index is not needed
```

Phase 2: Index is good !!

```
## performance gain by using index
## Step 1: Obtaining id's from index (primary key id)
## Step 2: Retrieving data
```

Phase 3: Index is not improve performance / or would makes performance worse

```
Step 1: lookup in index:
1
70
1040
2100
35000
-> there is a lot of space (other rows) in between.

Step 2: Lookup data, but a lot lookups needed



-> random reads
-> So mysql might be better off to do a table scan.
```

Optimal use of indexes

Describe and indexes

Walkthrough

Step 1:

```
## Database  and Table with primary key
create database descindex;
use descindex;
create table people (id int unsigned auto_increment, first_name varchar(25), last_name
varchar(25), primary key (id), passcode mediumint unsigned);
## add an index
## This will always !! translate into an alter statement.
create index idx_last_name_first_name on people (last_name,first_name)
##
create unique index idx_passcode on people (passcode)

desc people;
+------------+-----------------------+------+-----+---------+----------------+
| Field      | Type                  | Null | Key | Default | Extra          |
+------------+-----------------------+------+-----+---------+----------------+
| id         | int(10) unsigned      | NO   | PRI | NULL    | auto_increment |
| first_name | varchar(25)           | YES  |     | NULL    |                |
| last_name  | varchar(25)           | YES  |     | NULL    |                |
| passcode   | mediumint(8) unsigned | YES  |     | NULL    |                |
+------------+-----------------------+------+-----+---------+----------------+
4 rows in set (0.01 sec)
```

Step 2:

```
## Add simple combined index on first_name, last_name
create index idx_first_name_last_name on people (first_name, last_name);
Query OK, 0 rows affected (0.05 sec)
Records: 0  Duplicates: 0  Warnings: 0
desc people;

-- show the column where the combined index starts (MUL = Multi)

+------------+-----------------------+------+-----+---------+----------------+
| Field      | Type                  | Null | Key | Default | Extra          |
+------------+-----------------------+------+-----+---------+----------------+
| id         | int(10) unsigned      | NO   | PRI | NULL    | auto_increment |
| first_name | varchar(25)           | YES  | MUL | NULL    |                |
| last_name  | varchar(25)           | YES  |     | NULL    |                |
| passcode   | mediumint(8) unsigned | YES  |     | NULL    |                |
+------------+-----------------------+------+-----+---------+----------------+
4 rows in set (0.01 sec)
```

Step 3:

```
## Add a unique index on passcode
create index idx_passcode on people (passcode)
mysql> desc people;

-- Line with UNI shows this indexes.
+------------+-----------------------+------+-----+---------+----------------+
| Field      | Type                  | Null | Key | Default | Extra          |
+------------+-----------------------+------+-----+---------+----------------+
| id         | int(10) unsigned      | NO   | PRI | NULL    | auto_increment |
| first_name | varchar(25)           | YES  | MUL | NULL    |                |
| last_name  | varchar(25)           | YES  |     | NULL    |                |
| passcode   | mediumint(8) unsigned | YES  | UNI | NULL    |                |
+------------+-----------------------+------+-----+---------+----------------+
4 rows in set (0.01 sec)
```

Step 4:

```
## Get to know all your indexes on a table
show indexes for people
mysql> show index from people;
+--------+------------+--------------------------+--------------+-------------+-------
----+-------------+----------+--------+------+------------+---------+---------------+
| Table  | Non_unique | Key_name                 | Seq_in_index | Column_name |
Collation | Cardinality | Sub_part | Packed | Null | Index_type | Comment |
Index_comment |
+--------+------------+--------------------------+--------------+-------------+-------
----+-------------+----------+--------+------+------------+---------+---------------+
| people |          0 | PRIMARY                  |            1 | id          | A
|           0 |     NULL | NULL   |      | BTREE      |         |               |
| people |          0 | idx_passcode             |            1 | passcode    | A
|           0 |     NULL | NULL   | YES  | BTREE      |         |               |
| people |          1 | idx_first_name_last_name |            1 | first_name  | A
|           0 |     NULL | NULL   | YES  | BTREE      |         |               |
| people |          1 | idx_first_name_last_name |            2 | last_name   | A
|           0 |     NULL | NULL   | YES  | BTREE      |         |               |
+--------+------------+--------------------------+--------------+-------------+-------
----+-------------+----------+--------+------+------------+---------+---------------+
4 rows in set (0.01 sec)
```

Find out indexes

Show index from table

```
create database showindex;
use showindex;
CREATE TABLE `people` (
  `id` int(10) unsigned NOT NULL AUTO_INCREMENT,
  `first_name` varchar(25) DEFAULT NULL,
  `last_name` varchar(25) DEFAULT NULL,
  `passcode` mediumint(8) unsigned DEFAULT NULL,
  PRIMARY KEY (`id`),
  UNIQUE KEY `idx_passcode` (`passcode`),
  KEY `idx_first_name_last_name` (`first_name`,`last_name`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1
show index from people
```

Show create table

```
show create table peple
```

show index from

```
show index from contributions
```

Index and Functions (Cool new feature in MySQL 5.7)

No index can be used on an index:

```
explain select * from actor where upper(last_name) like 'A%';
+----+-------------+-------+------------+------+---------------+------+---------+-----
-+------+----------+-------------+
| id | select_type | table | partitions | type | possible_keys | key  | key_len | ref
| rows | filtered | Extra       |
+----+-------------+-------+------------+------+---------------+------+---------+-----
-+------+----------+-------------+
|  1 | SIMPLE      | actor | NULL       | ALL  | NULL          | NULL | NULL    | NULL
|  200 |   100.00 | Using where |
+----+-------------+-------+------------+------+---------------+------+---------+-----
-+------+----------+-------------+
```

Workaround with virtual columns (possible since mysql 5.7)

```
## 1. Create Virtual Column with upper
alter table sakila add idx_last_name_upper varchar(45) GENERATED ALWAYS AS
upper(last_name);
## 2. Create an index on that column
create index idx_last_name_upper on actor (last_name_upper);
```

Now we try to search the very same

```
explain select * from actor where last_name_upper like 'A%';
+----+-------------+-------+------------+-------+---------------------+---------------
------+---------+------+------+----------+-------------+
| id | select_type | table | partitions | type  | possible_keys       | key
| key_len | ref  | rows | filtered | Extra       |
+----+-------------+-------+------------+-------+---------------------+---------------
------+---------+------+------+----------+-------------+
|  1 | SIMPLE      | actor | NULL       | range | idx_last_name_upper |
idx_last_name_upper | 183     | NULL |    7 |   100.00 | Using where |
+----+-------------+-------+------------+-------+---------------------+---------------
------+---------+------+------+----------+-------------+
1 row in set, 1 warning (0.00 sec)
```

Preview MysQL 8

- MySQL 8 support functional indexes

Index and Likes

1. like 'Will%' - Index works

explain select last_name from donors where last_name like 'Will%';

2. like '%iams' - Index does not work

```
-- because like starts with a wildcard
explain select last_name from donors where last_name like '%iams';
```

3. How to fix 3, if you are using this often ?

```
## Walkthrough
## Step 1: modify table
alter table donors add last_name_reversed varchar(70) GENERATED ALWAYS AS
(reverse(last_name));
create index idx_last_name_reversed on donors (last_name_reversed);

## besser - Variante 2 - untested
alter table donors add last_name_reversed varchar(70) GENERATED ALWAYS AS
(reverse(last_name)), add index idx_last_name_reversed on donors (last_name_reversed);

## Step 2: update table - this take a while
update donors set last_name_reversed = reversed(last_name)
## Step 3: work with it
select last_name,last_name_reversed from donor where last_name_reversed like
reverse('%iams');
```

```
## Version 2 with pt-online-schema-change
```

profiling-get-time-for-execution-of.query

- Get better values, how long queries take

Example

```
set profiling = 1
## Step 2 - Execute query
select last_name as gross from donors where last_name like lower('WILLI%')

## Step 3 - Show profiles
show profiles;
+----------+------------+--------------------------------------------------------------
----------------------+
| Query_ID | Duration   | Query
|
+----------+------------+--------------------------------------------------------------
----------------------+
|        1 | 0.01993525 | select last_name as gross from donors where last_name like
lower('WILLI%')        |
4 rows in set, 1 warning (0.00 sec)

## Step 4 - Show profile for a specific query
mysql> show profile for query 1;
+----------------------+----------+
| Status               | Duration |
+----------------------+----------+
| starting             | 0.000062 |
| checking permissions | 0.000006 |
| Opening tables       | 0.000021 |
| init                 | 0.000017 |
| System lock          | 0.000007 |
| optimizing           | 0.000007 |
| statistics           | 0.000083 |
| preparing            | 0.000012 |
| executing            | 0.000004 |
| Sending data         | 0.022251 |
| end                  | 0.000005 |
| query end            | 0.000008 |
| closing tables       | 0.000007 |
| freeing items        | 0.001792 |
| cleaning up          | 0.000016 |
+----------------------+----------+
15 rows in set, 1 warning (0.00 sec)
```

Find out cardinality without index

Find out cardinality without creating index

```
select count(distinct donor_id) from contributions;
```

```
select count(distinct(vendor_city)) from contributions;
+------------------------------+
| count(distinct(vendor_city)) |
+------------------------------+
|                         1772 |
+------------------------------+
1 row in set (4.97 sec)
```

Monitoring

What to monitor?

What to monitor

System

- Last auf dem System (top)
- Festplatte (z.B. 85% voll ?) df /var/lib/mysql
- Swap (Wenn geswappt wird ist Hopfen und Malz verloren)

Erreichbarkeit

- Server per ping erreichen (mysqladmin ping -h ziel-ip)
- Einlogbar ? (myadmin ping -h ziel-ip -u control_user

Platte aka IO-Subsystem (iostats)

- http://schulung.t3isp.de/documents/pdfs/mysql/mysql-performance.pdf

--	--	--
Read/Write requests	IOPS (Input/Output operations per second)	--
Average IO wait	Time that queue operations have to wait for disk access	--
Average Read/Write time	Time it takes to finish disk access operations (latency)	--
Read/Write bandwidth	Data transfer from and towards your disk	--

Gneral mysql metrics

```
mysql -E -e "select variable_value from information_schema.session_status where
variable_name = 'uptime'";

# max connections
MariaDB [(none)]> show status like 'max_used_connections';
+----------------------+-------+
| Variable_name        | Value |
+----------------------+-------+
| Max_used_connections | 1     |
+----------------------+-------+
1 row in set (0.001 sec)

MariaDB [(none)]> show variables like 'max_connections';
+-----------------+-------+
| Variable_name   | Value |
+-----------------+-------+
| max_connections | 151   |
+-----------------+-------+
1 row in set (0.001 sec)

mysqladmin status
## you will find uptime here in seconds
```

Metric	Comments	Suggested

		Alert
Uptime	Seconds since the server was started. We can use this to detect respawns.	When uptime is < 180. (seconds)
Threads_connected	Number of clients currently connected. If none or too high, something is wrong.	None
Max_used_connections	Max number of connections at a time since server started. (max_used_connections / max_connections) indicates if you could run out soon of connection slots.	When connections usage is > 85%.
Aborted_connects	Number of failed connection attempts. When growing over a period of time either some credentials are wrong or we are being attacked.	When aborted connects/min > 3.

InnoDB

Metric	Coments	Suggested Alert
Innodb_row_lock_waits	Number of times InnoDB had to wait before locking a row.	None
Innodb_buffer_pool_wait_free	Number of times InnoDB had to wait for memory pages to be flushed. If too high, innodb_buffer_pool_size is too small for current write load.	None

Query tracking

Metric	Comments	Suggested Alert
Slow_queries	Number of queries that took more than long_query_time seconds to execute. Slow queries generate excessive disk reads, memory and CPU usage. Check slow_query_log to find them.	None
Select_full_join	Number of full joins needed to answer queries. If too high, improve your indexing or database schema.	None
Created_tmp_disk_tables	Number of temporary tables (typically for joins) stored on slow spinning disks, instead of faster RAM.	None
(Full table scans) Handler_read% Number of times the system reads the first row of a table index. (if 0 a table scan is done -		

because no key was read). Sequential reads might indicate a faulty index. None		

Track Errors

```
journalctl -u mariadb | grep -i Error
```

Ref

- https://blog.serverdensity.com/how-to-monitor-mysql/

Monitoring with pmm (Percona Management Monitoring)

https://pmmdemo.percona.com

Documentation

Replication

Slave einrichten - gtid (mit mariabackup)

Step 0.5a: Installation on ubuntu/debian

```
apt update
apt install mariadb-backup
## check if available
mariabackup --version

## prepare for mariabackup if you use it with root and with unix_socket
/root/.my.cnf
[mariabackup]
user=root
```

Step 1: mariabackup on master

```
mkdir /backups
## target-dir needs to be empty or not present
mariabackup --target-dir=/backups/20210121 --backup
## apply ib_logfile0 to tablespaces
## after that ib_logfile0 ->  0 bytes
mariabackup --target-dir=/backups/20210121 --prepare
```

Step 2: Transfer to new slave (from master)

```
## root@master:
rsync -e ssh -avP /backups/20210121 student@10.10.9.144:/home/student/
```

Step 3: Setup replication user on master

```
## as root@master
##mysql>
CREATE USER repl@'10.10.9.%' IDENTIFIED BY 'password';
GRANT REPLICATION SLAVE ON *.*  TO 'repl'@'10.10.9.%';
```

Step 3a (Optional): Test repl user (connect) from slave

```
## as root@slave
## you be able to connect to
mysql -urepl -p -h10.10.9.110
## test if grants are o.k.
show grants
```

Step 4a: Set server-id on master -> 1

```
[mysqld]
server-id=1
```

```
systemctl restart mariadb
###
```

Step 4b: Set server-id on slave -> 3 + same config as server 1 + log_slave_update

```
[mysqld]
server-id              = 3
## activate master bin log, if this slave might be a master later
log_bin                = /var/log/mysql/mysql-bin.log
binlog_format = ROW
log_slave_update = 1

systemctl restart mariadb
### auf dem master config mit rsync rüberschrieben
### root@master
rsync -e ssh -avP /etc/mysql/mariadb.conf.d/z_uniruhr.cnf kurs@10.10.9.144:/home/kurs/
```

Step 5: Restore Data on slave

```
systemctl stop mariadb
mv /var/lib/mysql /var/lib/mysql.bkup
mariabackup --target-dir=/home/student/20210121 --copy-back
chown -R mysql:mysql /var/lib/mysql
systemctl start mariadb
```

Step 6: master.txt for change command

```
## root@slave
$ cat xtrabackup_binlog_info
mariadb-bin.000096 568 0-1-2

SET GLOBAL gtid_slave_pos = "0-1-2";
## /root/master.txt
## get information from master-databases.sql dump
CHANGE MASTER TO
   MASTER_HOST="10.10.9.110",
   MASTER_PORT=3306,
   MASTER_USER="repl",
   MASTER_PASSWORD="password",
   MASTER_USE_GTID=slave_pos;

mysql < master.txt
## or: copy paste into mysql>

## mysql>
start slave

## in mysql -> show slave status
mysql>show slave status
## Looking for
```

```
Slave_IO_Running: Yes
Slave_SQL_Running: Yes
```

Walkthrough

https://mariadb.com/kb/en/setting-up-a-replication-slave-with-mariabackup/

Slave einrichten - master_pos

Step 1: mysqldump on master

```
mkdir -p /backups/mysqldumpdir
## in version 5.5. there is not --git so use it without --gtid
mysqldump --all-databases --single-transaction --master-data=2 --routines --events --
compress > /backups/mysqldumpdir/master-databases.sql;
```

Step 2: Transfer to new slave (from master)

```
## root@master:
rsync -e ssh -avP /backups/mysqldumpdir/master-databases.sql
kurs@10.10.9.144:/home/kurs/
```

Step 3 (Optional): Be sure that slave is really fresh (no data yet)

```
## if old not wanted data is present, e.g. other databases, start with fresh-
installation by so:
## as root
cd /var/lib
mv mysql mysql.bkup
mariadb-install-db --user=mysql
```

Step 4: Setup replication user on master

```
## as root@master
##mysql>
CREATE USER repl@'10.10.9.%' IDENTIFIED BY 'password';
GRANT REPLICATION SLAVE ON *.*  TO 'repl'@'10
```

Step 4a (Optional): Test repl user (connect) from slave

```
## as root@slave
## you be able to connect to
mysql -urepl -p -h10.10.9.110
## test if grants are o.k.
show grants
```

Step 5a: Set server-id on master -> 1

```
[mysqld]
server-id=1

systemctl restart mariadb
###
```

Step 5b: Set server-id on slave -> 2 + same config as server 1

```
[mysqld]
server-id               = 2
## activate master bin log, if this slave might be a master later
log_bin                 = /var/log/mysql/mysql-bin.log

systemctl restart mariadb
### auf dem master config mit rsync rüberschrieben
### root@master
rsync -e ssh -avP /etc/mysql/mariadb.conf.d/z_uniruhr.cnf kurs@10.10.9.144:/home/kurs/
### root@slave
mv /home/kurs/z_uniruhr.cnf /etc/mysql/mariadb.conf.d/
chown root:root /etc/mysql/mariadb.conf.d
systemctl restart mariadb
```

Step 6: Restore Data on slave

```
## root@slave
cd /home/kurs
mysql < master-databases.sql
```

Step 7: master.txt for change command

```
## root@slave
## /root/master.txt
## get information from master-databases.sql dump
CHANGE MASTER TO
   MASTER_HOST="10.10.9.110",
   MASTER_PORT=3310,
   MASTER_USER="repl",
   MASTER_PASSWORD="password",
   MASTER_LOG_FILE='mysqld-bin.000001',
   MASTER_LOG_POS=568;
## Version 1
mysql < master.txt
## or: copy paste into mysql>

## in mysql -> show slave status
mysql>show slave status
## Looking for
Slave_IO_Running: Yes
Slave_SQL_Running: Yes
```

Step 8: not working on 5.5.

```
Switch to using gtid later on:

show slave status; # look for using_gtid
stop slave;
CHANGE MASTER TO MASTER_USE_GTID = slave_pos;
show slave status; # look for using_gtid
start slave;
```

Walkthrough

https://mariadb.com/kb/en/setting-up-a-replication-slave-with-mariabackup/

MaxScale installieren

Why do Loadbalancing with MaxScale ?

- Cluster node transparent to application
  - Application does not see single nodes
- If one node fails you will have no downtime
  - In opposite: To talking to this node directly

License Implications since 2.x

- MariaDB MaxScale >= 2.0 is licensed under MariaDB BSL.
- maximum of three servers in a commercial context.
  - Any more, and you'll need to buy their commercial license.
- MariaDB MaxScale 2.1.0 will be released under BSL 1.1 from the start
- Each release transitions in about max 4 years to GPL

The MaxScale load-balancer and its components

- Routers
- Listeners
- Filters
- Servers (backend database server)

Filters

- Logging Filters
- Statement rewriting filters
- Result set manipulation filters
- Firewill filter
- Pipeline control filters
  - e.g. tee and send to a second server
- Ref: https://mariadb.com/kb/en/mariadb-maxscale-25-regex-filter/

Documentation - maxctrl

- https://mariadb.com/kb/en/mariadb-maxscale-25-maxctrl/

Installation and Setup

Installation

```
apt update
apt install apt-transport-https curl

## Setting up the repos
curl -sS https://downloads.mariadb.com/MariaDB/mariadb_repo_setup | sudo bash
```

```
## Installing maxscale
apt install maxscale
```

Setup (Part 1: MaxScale db-user)

- Do this on one of the galera nodes
- Adjust IP !!

```
## IP FROM MAXSCALE
## Setup privileges on cluster nodes
## It is sufficient to set it on one node, because
## it will be synced to all the other nodes
## on node 1
CREATE USER 'maxscale'@'10.10.11.139' IDENTIFIED BY 'P@ssw0rd';
##
GRANT SELECT ON mysql.db TO 'maxscale'@'10.10.11.139';
GRANT SELECT ON mysql.user TO 'maxscale'@'10.10.11.139';
GRANT SELECT ON mysql.tables_priv TO 'maxscale'@'10.10.11.139';
##
GRANT SELECT ON mysql.columns_priv TO 'maxscale'@'10.10.11.139';
GRANT SELECT ON mysql.proxies_priv TO 'maxscale'@'10.10.11.139';
##
GRANT SHOW DATABASES ON *.* TO 'maxscale'@'10.10.11.139';
## Needed for maxscale
GRANT SELECT ON mysql.procs_priv TO 'maxscale'@'10.10.11.139';
GRANT SELECT ON mysql.roles_mapping TO 'maxscale'@'10.10.11.139';

## Additionally for cluster operations (rejoin,switchover,failover for master/slave
replications
## these permissions are needed
GRANT super, reload, process, show databases, event on *.* to
'maxscale'@'10.10.11.139';
## GRANT select on mysql.user to 'maxscale'@'10.10.11.139';
```

```
## On maxscale - server
apt update
apt install mariadb-client
## Test the connection
## Verbindung sollte aufgebaut werden
mysql -u maxscale -p -h <ip-eines-der-nodes>
mysql>show databases
```

SETUP (PART 2: CONFIGURATION)

```
## /etc/maxscale.cnf

[maxscale]

threads=auto
syslog=0
maxlog=1
```

```
log_warning=1
log_notice=1
log_info=0
log_debug=0

[TheMonitor]
type=monitor
module=mariadbmon
servers=server1,server2,server3
user=maxscale
password=P@ssw0rd
auto_rejoin=true
auto_failover=true

[RW-Split-Router]
type=service
router=readwritesplit
servers=server1,server2,server3
user=maxscale
password=P@ssw0rd
max_slave_connections=100%


[RW-Split-Listener]
type=listener
service=RW-Split-Router
protocol=MariaDBClient
port=3306

[server1]
type=server
address=142.93.98.60
port=3306
protocol=MariaDBBackend

[server2]
type=server
address=142.93.103.153
port=3306
protocol=MariaDBBackend

[server3]
type=server
address=142.93.103.246
port=3306
protocol=MariaDBBackend
```

```
## Start

systemctl start maxscale
```

```
## What does the log say ?

## /var/log/maxscale/maxscale.log
```

maxctrl

```
maxctrl list servers
maxctrl show server server1
maxctrl list services
maxctrl show service ReadWrite-Split-Router
```

Reference: MaxScale-Proxy mit Monitoring

MaxScale MariaDB-Monitor

Walkthrough:Automatic Failover Master Slave

https://mariadb.com/kb/en/mariadb-maxscale-25-automatic-failover-with-mariadb-monitor/

Tools

Percona-toolkit-Installation

Walkthrough

```
## Howto
## https://www.percona.com/doc/percona-toolkit/LATEST/installation.html

## Step 1: repo installieren mit deb -paket
wget https://repo.percona.com/apt/percona-release_latest.focal_all.deb;
apt update;
apt install -y curl;
dpkg -i percona-release_latest.focal_all.deb;
apt update;
apt install -y percona-toolkit;
```

pt-query-digist - analyze slow logs

Requires

- Install percona-toolkit

Usage

```
## first enable slow_query_log
set global slow_query_log = on
set global long_query_time = 0.2
## to avoid, that i have to reconnect with new session
set session long_query_time = 0.2

## produce slow query - for testing
select * from contributions where vendor_last_name like 'W%';
mysql > quit

##
cd /var/lib/mysql
## look for awhile wih -slow.log - suffix
pt-query-digest mysql-slow.log > /usr/src/report-slow.txt
less report-slow.txt
```

pt-online-schema-change howto

Requirements

- Install percona-toolkit

What does it do ?

```
## Altering table without blocking them
## Do a dry-run beforehand
pt-online-schema-change --alter "ADD INDEX idx_city (city)" --dry-run
D=contributions,t=donors
##
pt-online-schema-change --alter "ADD INDEX idx_city (city)" --execute
D=contributions,t=donors
```

Problems -> high cpu load

```
## fine - tune params
## e.g. --max-load
## refer to docs
https://www.percona.com/doc/percona-toolkit/3.0/pt-online-schema-
change.html#:~:text=pt%2Donline%2Dschema%2Dchange%20works%20by%20creating%20an%20empty,i
```

Ubuntu-with-Vagrant

Walkthrough

```
## Step 1: Download git for windows
https://git-scm.com/downloads
## Step 2: Install Virtualbox
https://download.virtualbox.org/virtualbox/6.1.18/VirtualBox-6.1.18-142142-Win.exe
## Step 3: Auf dem Desktop, rechte Maustaste -> git bash here
## in the bash
mkdir myvirtualmachine
vagrant init ubuntu/focal64
vagrant up
## and the you are in the machine (shell)
vagrant ssh
## within machine switch from vagrant user to root without password
sudo su -
## there you go - install whatever
```

Include provisioning in Vagrantfile

```
  config.vm.provision "shell", inline: <<-SHELL
    apt-get update
    apt-get install -y mysql-server-5.7 wget
    cd /usr/src
    touch foo
    wget https://downloads.mysql.com/docs/sakila-db.tar.gz
    tar xzvf sakila-db.tar.gz
    cd sakila-db
    mysql < sakila-schema.sql
    mysql < sakila-data.sql
  SHELL
end
```

Destroy machine

```
vagrant destroy -f
```

mysql-client

\G Spezialausgabe

```
## Spalten werden als Zeilen angezeigt
## nur im mysql-client
mysql

mysql> show variables like 'bind%'  \G
```

Pager

```
## pager innerhalb von mysql verwenden
mysql> pager less
mysql> -- Jetzt wird der Linux Pager less verwendet
mysql> -- so schalte ich ihn wieder ab
mysql> pager
```

Extras

User Variables

```
## only valid within one session
set @host='localhost';

## You can use it in select
select @host;

## You can use it in the where clause
select mysql.user where host=@host;

## not possible to use it within create user
## DOES NOT WORK !
set @mypass='password';
create user someuser@somehost identified by @mypass;
```

Installation sakila-db

```
cd /usr/src
wget https://downloads.mysql.com/docs/sakila-db.tar.gz
tar xzvf sakila-db.tar.gz

cd sakila-db
mysql < sakila-schema.sql
mysql < sakila-data.sql
```

Documentation

Server System Variables

- https://mariadb.com/kb/en/server-system-variables/#bind_address

MySQL - Performance - PDF

- http://schulung.t3isp.de/documents/pdfs/mysql/mysql-performance.pdf

Source-Code MariaDB

- https://github.com/MariaDB/server

Diagnosis and measurement of performance

Best practices to narrow down performance problems

Pre-Requisites

- System is slow

Analyze - Checklist - Step 1

```
## Are there slow queries ?
## look for time
show full processlist

### or time - in seconds
select * from information_schema.processlist where time > 10;
```

Re-Execute SELECT or where from UPDATE / DELETE

```
## Is it still slow ?
## Eventually kill
mysql>show processlist
mysql>--kill <Thread-id>
mysql>-- example
mysql>kill 44
```

Explain what is going on

```
Explain Select....
```

Performance and optimization of SQL statements

Do not use '*' whenever possible

Why ?

- You are adding .. to he server:
    - I/O
    - memory
    - CPU
- You are preventing covering indexes

Walkthrough. (Look at the time)

Using '*'

```
## using '* '
pager grep "rows in set";
select * from donors where last_name like 'Willia%'; select * from donors where
last_name like 'Willia%';
-- time between 0.02 and 0.04 secs
-- 2424 rows in set (0.02 sec)
-- reset pager
pager

## corresponding Explain (QEP)
explain select * from donors where last_name like 'Willia%';
+----+-------------+--------+------------+-------+-------------------+----------------
---+---------+------+------+----------+-----------------------+
| id | select_type | table  | partitions | type  | possible_keys     | key
| key_len | ref  | rows | filtered | Extra                 |
+----+-------------+--------+------------+-------+-------------------+----------------
---+---------+------+------+----------+-----------------------+
|  1 | SIMPLE      | donors | NULL       | range | donors_donor_info |
donors_donor_info | 213     | NULL | 4748 |   100.00 | Using index condition |
+----+-------------+--------+------------+-------+-------------------+----------------
---+---------+------+------+----------+-----------------------+
1 row in set, 1 warning (0.00 sec)
```

using specific fields

```
pager grep 'rows in set'; select last_name,first_name from donors where last_name like
'Willia%'; pager;
PAGER set to 'grep 'rows in set''
2424 rows in set (0.01 sec)
```

```
 explain select last_name,first_name from donors where last_name like 'Willia%';
+----+-------------+--------+------------+-------+-------------------+----------------
---+---------+------+------+----------+--------------------------+
| id | select_type | table  | partitions | type  | possible_keys     | key
| key_len | ref  | rows | filtered | Extra                    |
+----+-------------+--------+------------+-------+-------------------+----------------
```

```
---+---------+------+------+----------+--------------------------+
|  1 | SIMPLE      | donors | NULL       | range | donors_donor_info |
donors_donor_info | 213     | NULL | 4748 |   100.00 | Using where; Using index |
+----+-------------+--------+------------+-------+-------------------+----------------
---+---------+------+------+----------+--------------------------+
1 row in set, 1 warning (0.00 sec)
```

- Uses cover index (indicator in Extra: using index)

Ref:

- https://www.oreilly.com/library/view/high-performance-mysql/9780596101718/ch04.html

Optimizer-hints (and why you should not use them)

Tell the optimizer what to do and what not to do

- https://dev.mysql.com/doc/refman/5.7/en/optimizer-hints.html#optimizer-hints-syntax

Replication

Replikation Read/Write

- https://proxysql.com/blog/configure-read-write-split/

Performance

Best Practices

Indexes

2 Indexes vs. Combined Index

- In most cases a combined index is better than 2 indexes.

Joins

Field-Type

- Do not use varchar() or char() aka string types of join field
- better: integer (unsigned) && same size
  - e.g. actor_id id int unsigned

Views

General

- Only use views with merge
- NO temptable please, these CANNOT be indexed.

Where

No functions in where please

- Why ? Index cannot be used.
- example:
  - select first_name from actor where upper(first_name) like 'A%'

Alternative solution

- use a virtual field and index virtual field (possible from mysql > 5.7)
- Massive improvements in mysqL 8

Example sys-schema and Reference

Examples

```
mysql> select * from sys.host_summary\G
*************************** 1. row ***************************
                  host: localhost
            statements: 1347
     statement_latency: 7.55 m
 statement_avg_latency: 336.50 ms
           table_scans: 15
              file_ios: 612857
       file_io_latency: 1.66 m
   current_connections: 1
     total_connections: 7
          unique_users: 1
        current_memory: 0 bytes
total_memory_allocated: 0 bytes
1 row in set (0.01 sec)
```

Ref:

- https://github.com/mysql/mysql-sys/blob/master/README.md

Change schema online (pt-online-schema-change)

- https://www.percona.com/doc/percona-toolkit/3.0/pt-online-schema-change.html

Optimizer-Hints

Tell the optimizer what to do and what not to do

- https://dev.mysql.com/doc/refman/5.7/en/optimizer-hints.html#optimizer-hints-syntax

Documentation / Literature

Effective MySQL

- https://www.amazon.com/Effective-MySQL-Optimizing-Statements-Oracle/dp/0071782796

Last Training

- https://github.com/jmetzger/training-mysql-developers-basics

MySQL - Performance - PDF

- http://schulung.t3isp.de/documents/pdfs/mysql/mysql-performance.pdf

MariaDB Galera Cluster

- http://schulung.t3isp.de/documents/pdfs/mariadb/mariadb-galera-cluster.pdf

MySQL Galera Cluster

- https://galeracluster.com/downloads/

Questions and Answers

Questions and Answers

1. Do you recommend Aurora

```
In my current humble opinion Aurora is a double edged sword.
Aurora looks promising for scalablity, but a lot of stuff is modified
mysql-stuff and in my opinion has a lot of restrictions.

You should be aware, that moving to Aurora might be a tasks
and reverting back even more.
```

- Refer to: https://ahmedahamid.com/aurora-mysql/

I would like to point you to a performance measurement report here:

- https://galeracluster.com/2019/09/everdata-reports-galera-cluster-outshines-amazon-aurora-and-rds/

2. Get rid of unattended - upgrades problem (dirty hack)

```
ps aux | grep unatt
kill <process-id-von-unattended-upgrades>
```

3. Archive Data

```

https://www.percona.com/doc/percona-toolkit/LATEST/pt-archiver.html
```

4. Does innodb do defragmentation by itself ?

```
## Some background while doing research.
## Nil performance benefits of defragmentation in index.
```

```
https://stackoverflow.com/questions/48569979/mariadb-table-defragmentation-using-
optimize
```

5. Defragmentation

```
## Optimize table
ALTER TABLE contributions engine = InnoDB



## mariadb has a patch for defragmentation
https://mariadb.org/defragmenting-unused-space-on-innodb-tablespace/

## alter table xyz engine=InnoDB - defragements
## but is also invasive.
## with ibdata1 innodb_file_per_table it lets the size grow
```

6. Is it possible to do select, update, deletes without using innodb_buffer in specific

```
No, this is not possible
```

7. Unit test framework in MySQL

```
No, there is no testing framework with MySQL
```

8. MariaDB - Advantages

- flashback
- Verschlüsselung von Tabellen // mariabackup
- Einige Storage Engine (Aria -> MyISAM - crash-recovery)
- JSON anders implementiert
- galera
- feature: defragementation

  ```
  MysqL 8 does not:
  decode
  set profiling (still available but deprecated )
  ```

9. Select without locking

```
SET TRANSACTION ISOLATION LEVEL READ UNCOMMITTED ;
BEGIN ;
SELECT * FROM TABLE_NAME ;
COMMIT ;
```

migration-mysql-update-5.6->5.7

```
===========

1. Sicherung.
xtrabackup
Mysqldump
16 GB
————

1.

Neue Location -> 5.6
<-  Xtrbackup
Server runterfahren
Update 5.7
Fahrt den Server wieder hoch



2.  Source-Host (Old Host) -> mysqldump
Neuen -> Installation von MySQL 5.7
Test-einspielen.
< mysqldump

4-5 Stunden.

—> Konfiguration von mysql -> was wollt ihr übernehmen.

3. Replications - Slave auf neuem System -> 5.7
Hängt in den Master.
Sicheren Transport
—> ssh -tunnel .
-> Firewall-Regeln.
—> ssl -absicherung
```

MySQL Do-Nots

mysql-do-nots

1. No function in where (column_name)

```
## Never use a function for the column name in where
## e.g.
select * from donors where upper(last_name) like 'Willia%'
```

Why ?

- Not index can be used

```
## Not filtering possible by indx -> possible_keys -> NULL
 explain select last_name from donors where upper(last_name) like 'WILLI%';
+----+-------------+--------+------------+-------+---------------+-------------------
+---------+------+--------+----------+--------------------------+
| id | select_type | table  | partitions | type  | possible_keys | key               |
key_len | ref  | rows   | filtered | Extra                    |
+----+-------------+--------+------------+-------+---------------+-------------------
+---------+------+--------+----------+--------------------------+
|  1 | SIMPLE      | donors | NULL       | index | NULL          | donors_donor_info |
687     | NULL | 701948 |   100.00 | Using where; Using index |
+----+-------------+--------+------------+-------+---------------+-------------------
+---------+------+--------+----------+--------------------------+
1 row in set, 1 warning (0.00 sec)
```