MariaDB Komplettkurs

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- Questions and Answers
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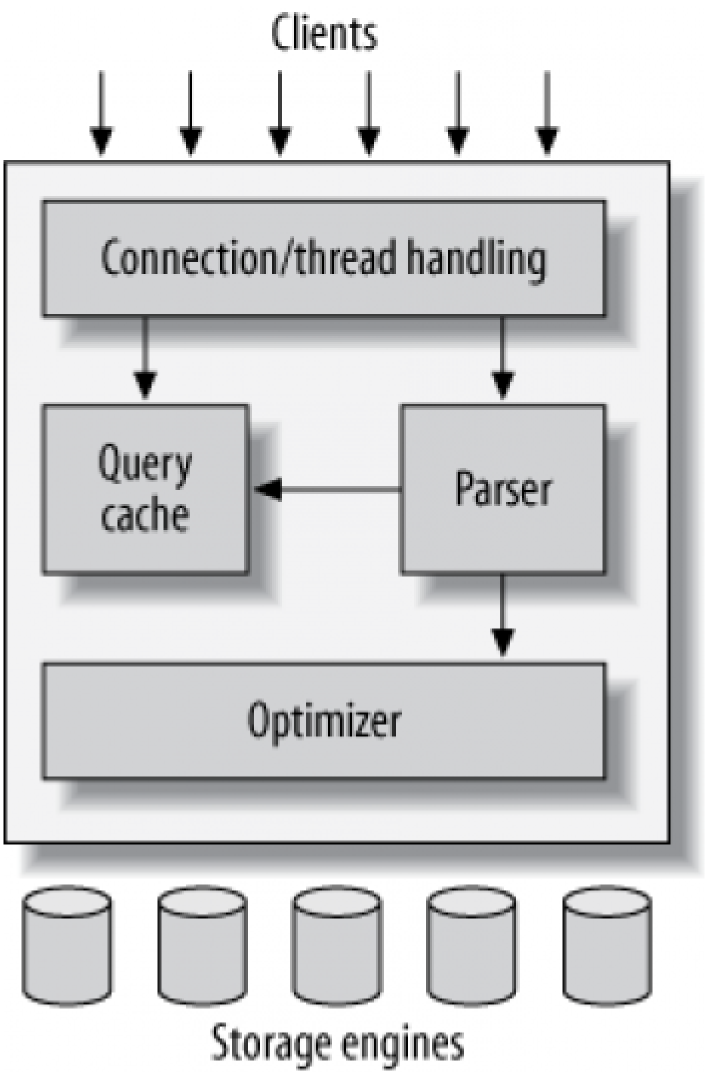
Architecture of MariaDB

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 (Ubuntu)

- 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 von MariaDB

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

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### Does mariadb listen to the outside world

```

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)

```

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## 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

```

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### 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

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## Information Schema / Status / Processes

### Show server status


### Through mysql
```

in mysql interface (client)

mysql status;

```
### With mysqladmin
```

mysqladmin status

or if you want to know more

mysqladmin extended status

```
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### 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

```
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### 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:~~#

```
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```

```
## Security and User Rights

### Get Rights of user

### 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 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)

Database - Objects

Create Database

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)


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```

```
## InnoDB - Storage Engine

### InnoDB - Storage Engine - Structure


![InnoDB Structure](/images/InnoDB-Structure.jpg)

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### 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
```

pager grep -i 'free buffers' show engine innodb status \G Free buffers 7905 1 row in set (0.00 sec)

```
### 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

```
### 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

~~~
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## Training Data

### Setup training data "contributions"


### Walkthrough

  * Complete process takes about 10 minutes

```bash
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
```

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 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 : ```

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

```
   * undefined
     * MySQL chooses, if to use merge or temptable
     * prefers merge over temptable if possible



### 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
```

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)

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


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### 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;

```
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### 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.

```



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```

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

### Backup with mysqldump - best practices


### 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

```
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### Flashback


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

### Referenz:

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

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### 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/

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### 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



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## Optimal use of indexes

### 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

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### 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

```

<div class="page-break"></div>

### 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)

```

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### 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)

```

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## 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](https://www.percona.com/doc/percona-monitoring-and-
management/2.x/details/commands/pmm-admin.html)

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## Replication

### Slave einrichten -gtid


### 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/mysqldumpdir/20210121 kurs@10.10.9.144:/home/kurs/

```
### 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

```
### 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
```

[mysqld] server-id = 3

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 5: Restore Data on slave
```

systemctl stop mariadb mv /var/lib/mysql /var/lib/mysql.bkup4 mariabackup --target-dir=/backups/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/

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### 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/

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### 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 !!

```bash
```

```
## 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,
```

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

Be aware of subselects - Example 1

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)
```