MyRocks in the Wild Wild West!

Alternate Storage Engine for MySQL

Alkin Tezuysal
Sr. Technical Manager

FOSDEM – Feb 1st 2020

PERCONA

Who are we?

@ask_dba - Alkin Tezuysal

Born to Sail, Forced to Work

- Open Source Database Evangelist
- Global Database Operations Expert
- Story Teller
- Inspiring Technical and Strategic Leader
- Creative Team Builder
- Speaker, Mentor, and Coach

Agenda

- Intro and basics
- Advanced internals and limitations
- Benchmarks
- Tuning suggestions
- Conclusion

Overview of MyRocks

- What's MyRocks?
  - Storage engine for MySQL
  - Based on RocksDB, a fork of LevelDB
  - Persistent key-value store
  - Implemented at Facebook and introduced in 2016
  - Used by FB in production
  - Was only available as source code at first

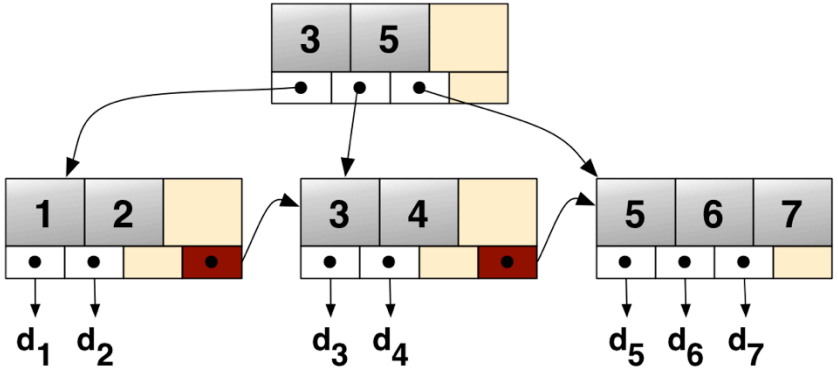
Overview of MyRocks

- **What's MyRocks?**
  - **Percona Server:**
    - Announced for Q1 2017
    - Fully supported: 5.7.20, 8.0
  - **MariaDB:**
    - Plugin alpha since 10.2.5
    - Stable since 10.3.7/10.2.16
  - **Getting more mature**
  - **Not widely used**

Overview of MyRocks

- Based on LSM tree
- Optimized for writes
- Space-efficient
- Fast data load (with correct setup)
- Fast read-free replication
- No foreign keys, no serializable
- No Full Text or Spatial keys
- MyRocks has TTL for data

LSM vs B-tree



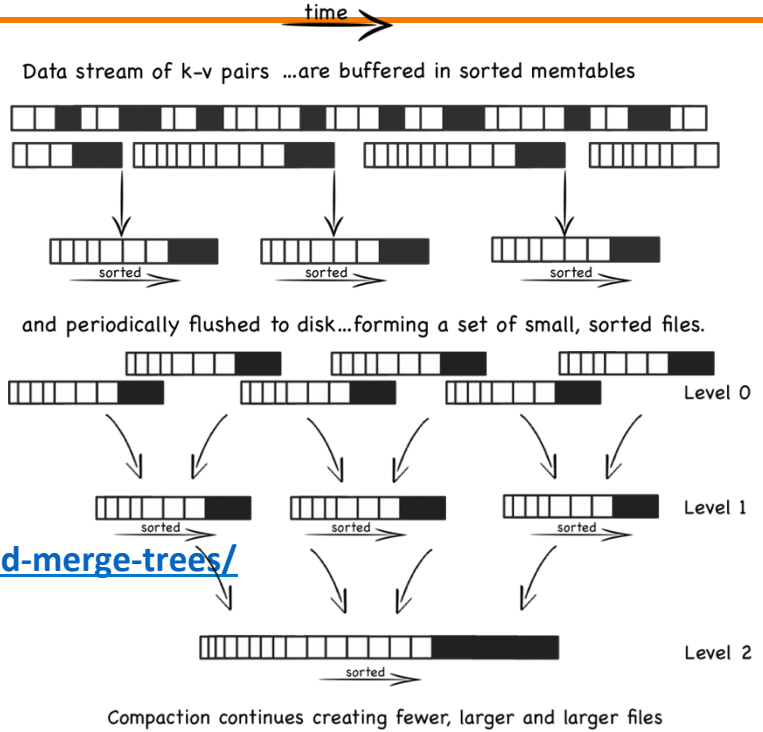


Image credit: [b+tree](#) [lsm](#)

http://www.benstopford.com/2015/02/14/log-structured-merge-trees/

PERCONA

LSM vs B-tree

LSM: write-optimized	B-tree: read-optimized
Sequential writes first	In-place
Compaction in background	Live tree re-balancing
Fast access only to leaves in the fast levels: memory, L0	Fast access to all leaves

Innodb vs MyRocks

- MyRocks: better writes
- MyRocks: 2-5x less size than InnoDB
- InnoDB supports FKs and Serializable
- InnoDB supports XA
- Handle locking differently

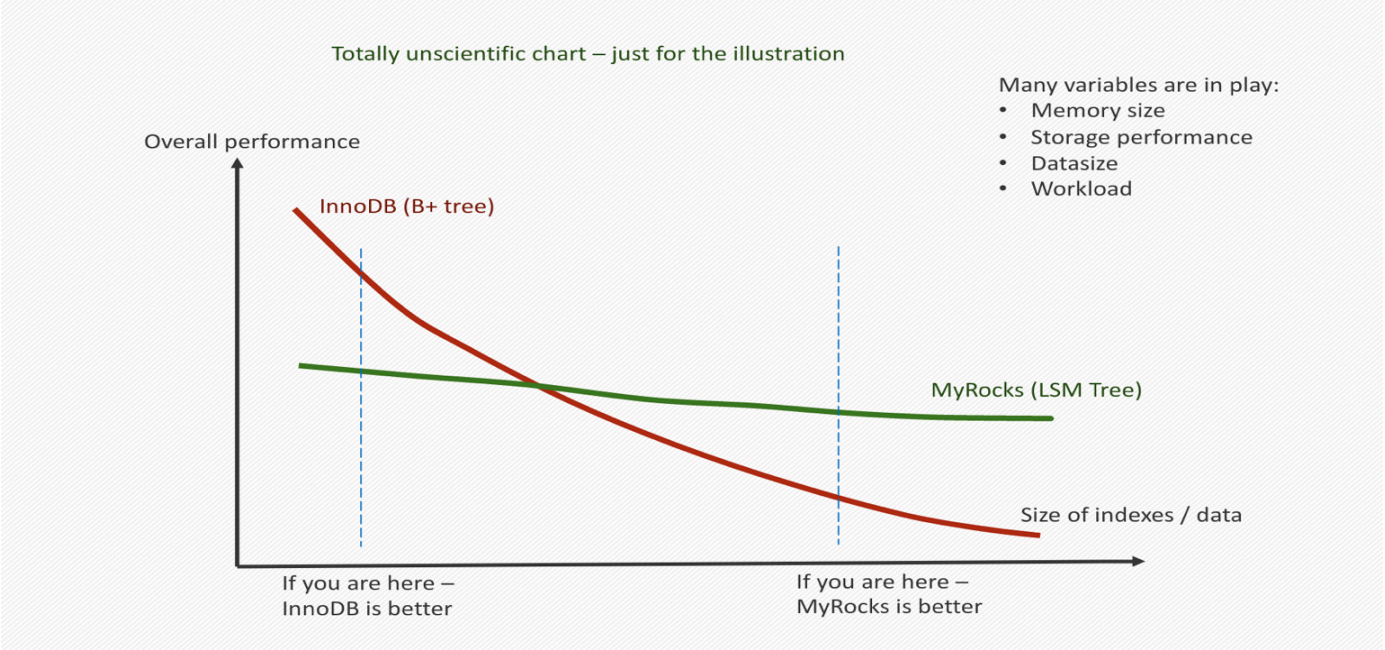
Innodb vs MyRocks

- InnoDB can be used with advanced replication: Galera, Percona Xtradb Cluster, Group Replication
- InnoDB supports STATEMENT and MIXED binlog format
- MyRocks doesn’t support transactions larger than available memory

Why use MyRocks engine?

- Large datasets
  - Larger than memory available
    - *100G is not that large*
  - Multiple indexes
- Write-intensive load
- Mostly point selects *(it's complicated)
- No FKs/Serializable/XA required

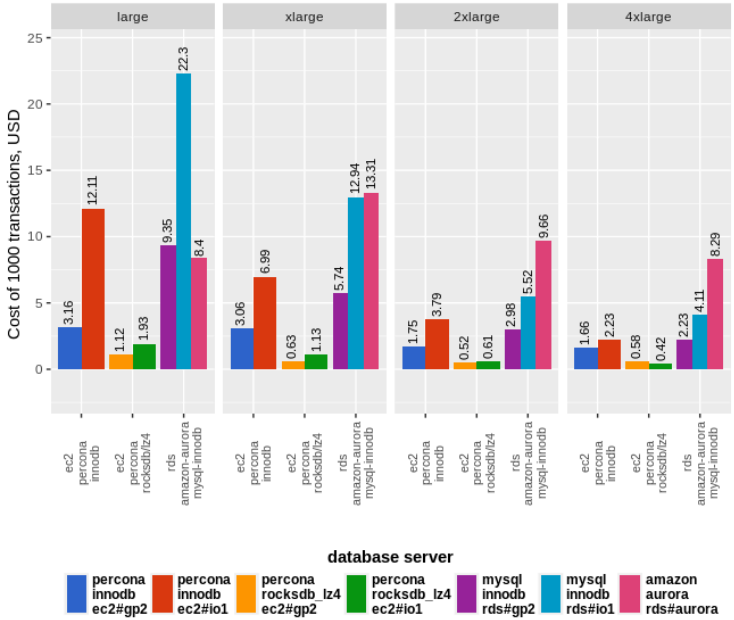
Why use MyRocks engine?



© Vadim Tkachenko “How to Rock with MyRocks”

Why use MyRocks engine?

- **Costs**
  - Cloud costs specifically
  - Good for Flash
  - Resource utilization



https://www.percona.com/blog/2019/07/19/assessing-mysql-performance-a

Installation and Configuration

- Easily installed for Percona Server with percona-release.

```
# yum install Percona-Server-server-57.x86_64
# yum install Percona-Server-rocksdb-57.x86_64
# ps-admin --enable-rocksdb
mysql> SHOW ENGINES;
  ROCKSDB | YES     | RocksDB storage engine
mysql> create table test (id int primary key) engine=ROCKSDB;
Query OK, 0 rows affected (0.03 sec)
```

- No downtime required

Installation and Configuration

- Configuration options can be reviewed

```
mysql> SHOW VARIABLES LIKE 'rocksdb%';
rocksdb_block_cache_size: 536870912
rocksdb_default_cf_options:
compression=kLZ4Compression;bottommost_compression=kLZ4Compressi
on
```

- Percona Server 8.0 brings a lot of improvements to defaults

Installation and Configuration

- Some things are configurable per column family

```
CREATE TABLE t1 (a INT, b INT,
PRIMARY KEY(a) COMMENT 'cfname=cf1’,
KEY kb(b) COMMENT 'cfname=cf2’)

rocksdb_override_cf_options='cf1={compression=kNoCompression};
cf2={compression=kZSTD}'
```

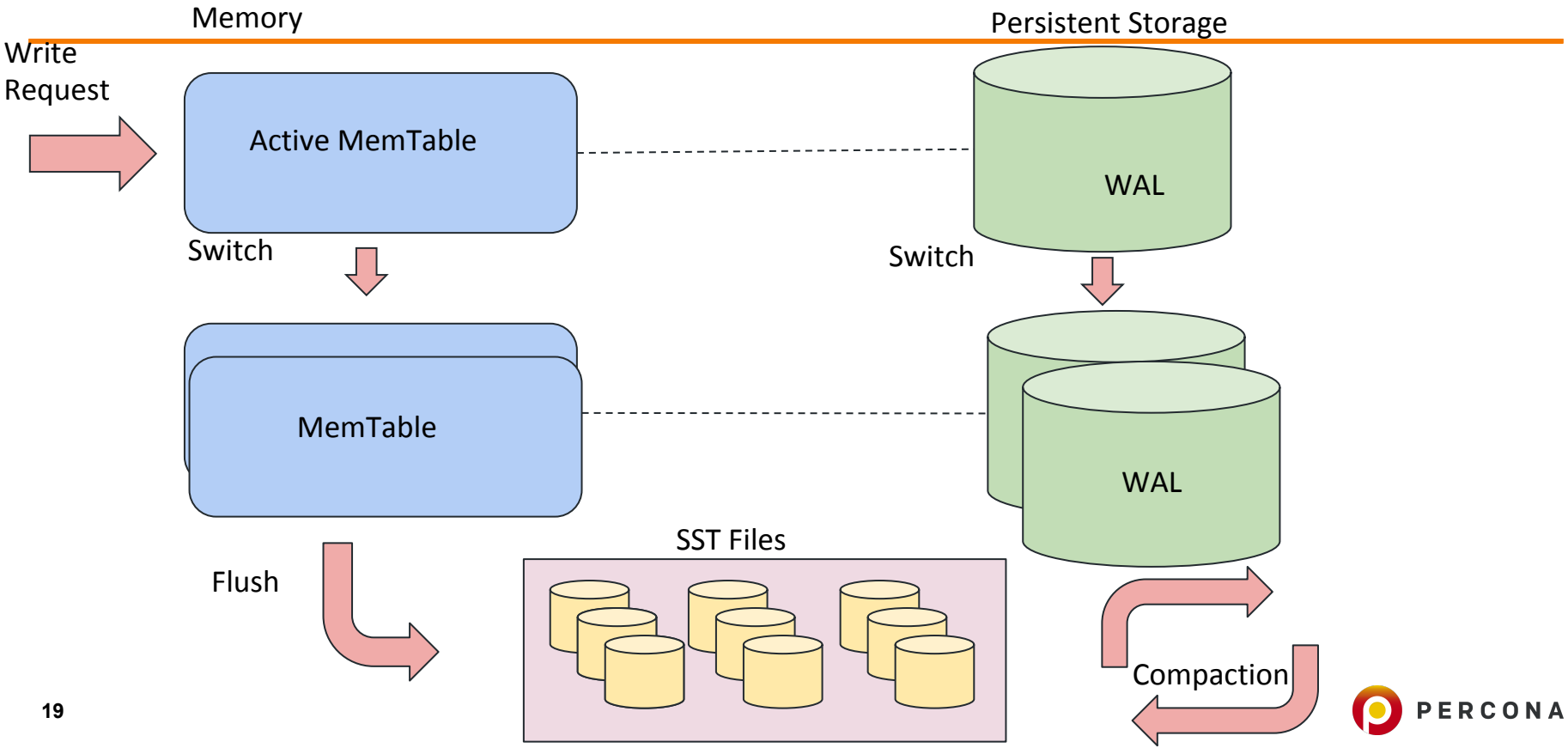
Differences between distributions

- Compression
  - Facebook: none, depends on what you compile with
  - Percona Server: Zlib, ZSTD, LZ4, LZ4HC
  - MariaDB: Snappy, Zlib (+ LZ4, LZ4HC on Ubuntu)
- Data file location
  - Facebook and Percona Server: $datadir/.rocksdb
  - MariaDB: $datadir/#rocksdb
- Gap lock detection
  - Percona Server and Facebook: yes (FB off by default)
  - MariaDB: no

Advanced Internals and Limitations

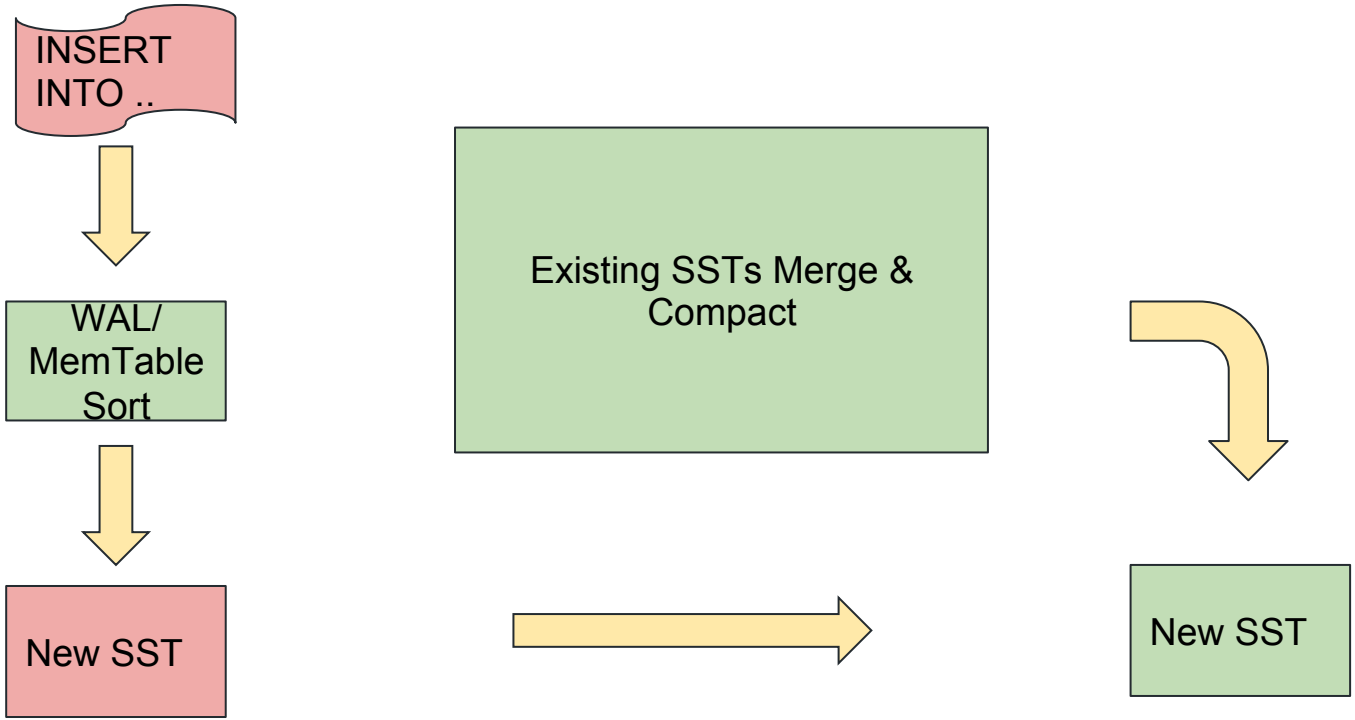
- Mem Table
- WAL (Write Ahead Log)
- Leveled LSM Structure
- Compaction
- Column Family
- … and more

MyRocks Engine Architecture



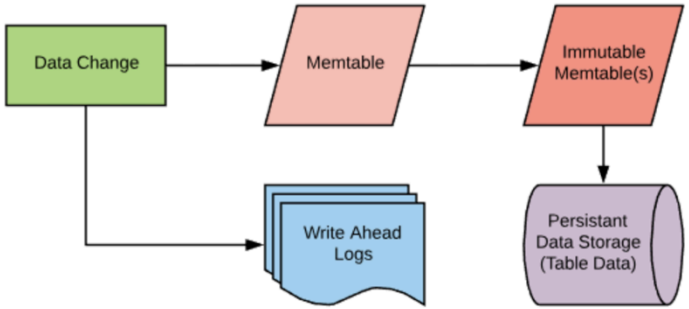
PERCONA

How does LSM handle writes?



MemTable(s)

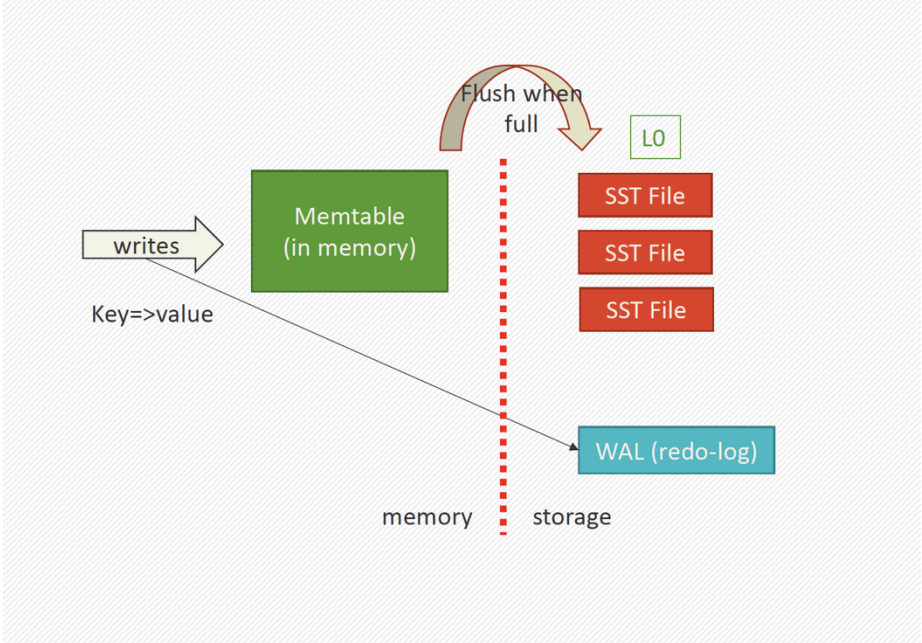
- **Store writes in MyRocks**
  - Associated with each column family
  - Changes go to WAL
  - Limited to 64Mb



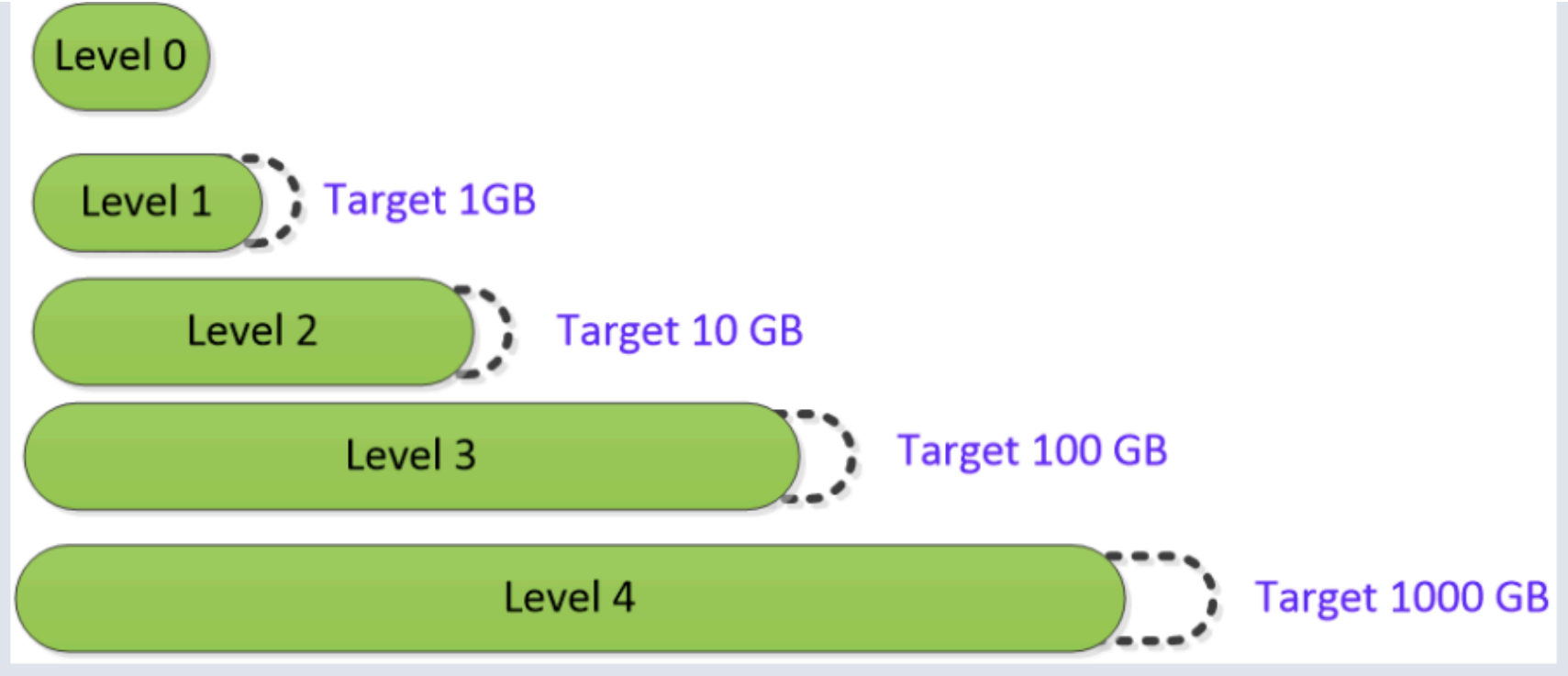
Ref:
https://blog.pythian.com/exposing-myrocks-internals-via-system-variables-part-1-data-writing/

WAL (Write Ahead Log)

- Immediate writes
- Act as redo-log



LSM Leveled Compaction

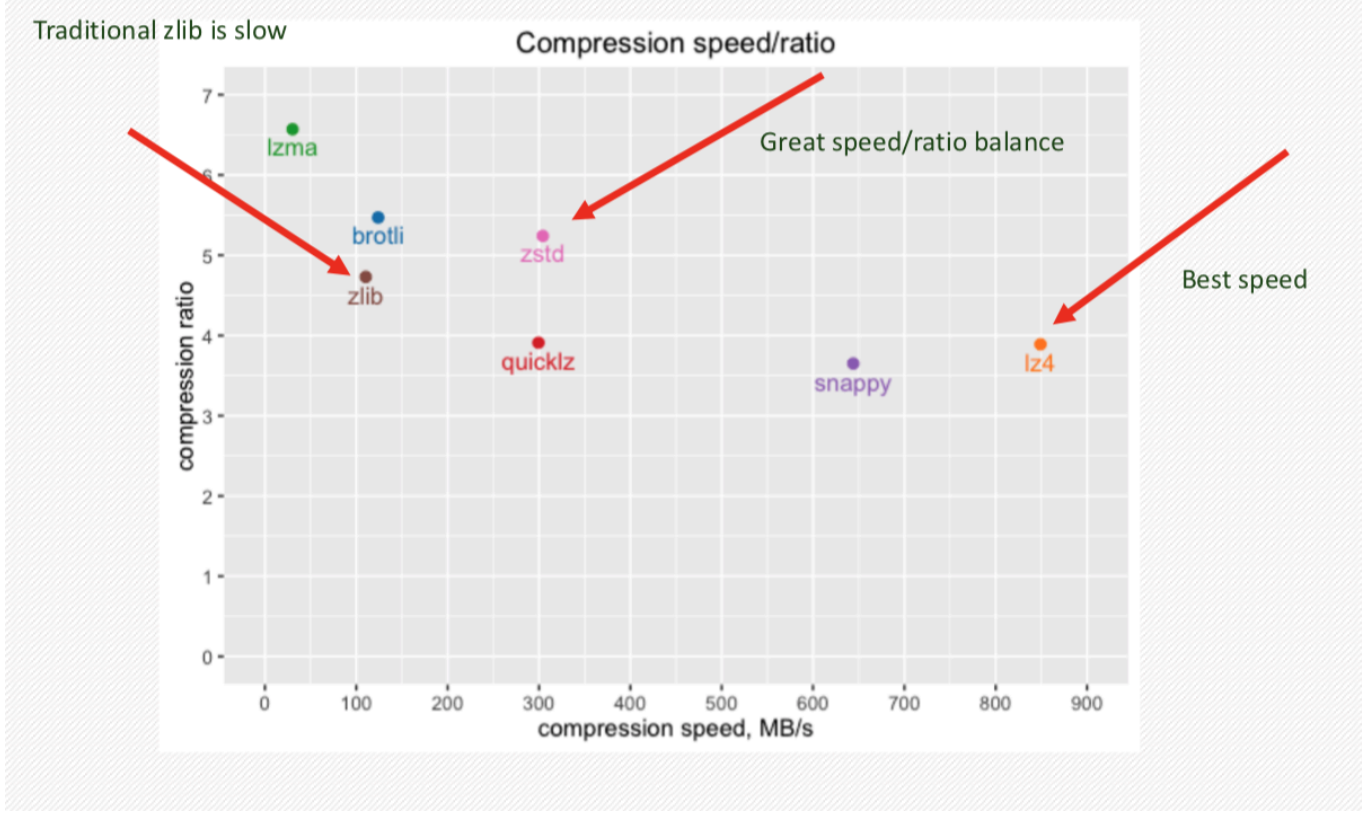


Ref: https://www.percona.com/live/17/sites/default/files/slides/MyRocks_Tutorial.pdf

Compaction

- **LSM compaction on Row level is better**
  - Aligned to OS sector (4Kb unit)
  - Negligible OS page alignment overhead
- **Percona Server LZ4 as default algorithm**
  - All levels compressed
  - Zstd available
  - Column families allow per table/index

Compression Results



PERCONA

Column Family

- **Provides query atomicity between different key spaces.**
  - MemTables and SST files
  - Shared transaction logs
- **Index mapping is 1 to N**
- **MyRocks configuration parameters are per CF**
- **Index Comment per CF**

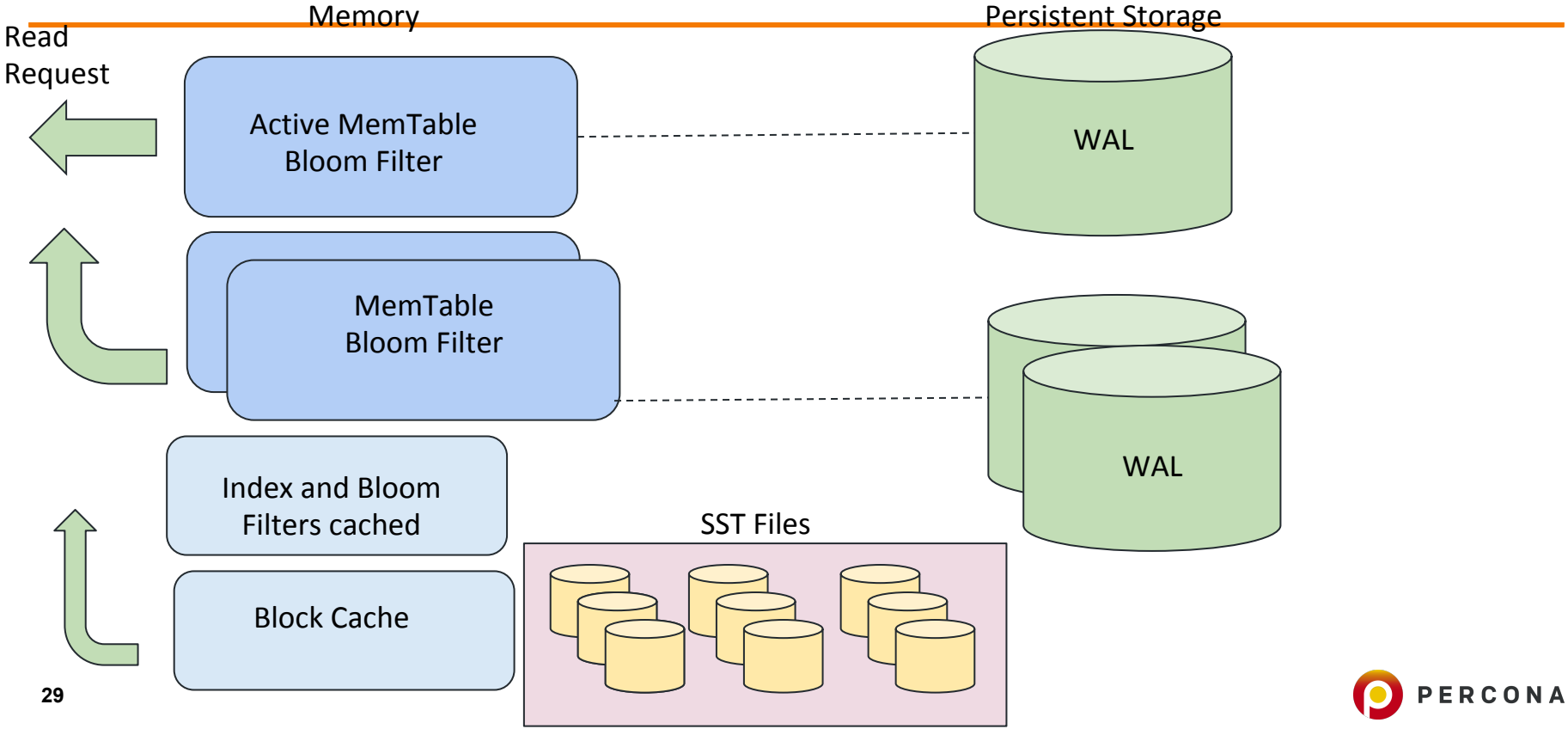
LSM on Disk

- Innodb (Write Amplification on B+Tree)
  - Lower write penalty vs Reduced fragmentation
  - B+Tree Fragmentation over space
  - Compression issues
- Higher read penalty
- Good fit for write heavy workloads

LSM on Flash

- Pros
  - Smaller space with compression
  - Lower write amplification
- Cons
  - Higher read penalty
- Good fit for write heavy workloads

MyRocks Engine Architecture



PERCONA

Data Structure & Query Optimizer

- Supports Primary and Secondary Keys
  - PK is clustered, single step lookup
  - FK not supported
- Tablespaces don’t exist
- Online DDL not possible
- Fast on scanning forward , slow on ORDER BY DESC
- Reverse column families can make DESC scan fast

Data Structure & Query Optimizer

- **Optimizer Statistics**
  - Table statistics (rocksdb_table_stats_sampling_pct; the default value is 10%)
  - Index cardinality
  - Records-in-range estimates
  - SHOW ENGINE ROCKSDB STATUS \G
  - Case Sensitive and Binary Collations
    - *CREATE TABLE myrocks ENGINE=ROCKSDB COLLATE latin1_bin*

Data Structure & Query Optimizer

- **Optimizer Statistics**
  - SST files stores index statistics
    - *Idx name, size, # of rows, disk space, deletes*
    - *Distinct # of keys*
  - Calculated during flush/compaction
    - *Ability to force using ANALYZE TABLE syntax (small tables)*
  - Multi Range Read (MRR) is not supported

Data Dictionary

- Column Family ID
- Index ID
- Global Index ID : Column Family ID + Index ID
- Information Schema

Locking & Isolation Levels

- **Row locking**
  - Read-Committed
  - Repeatable-Read
- **Gap Lock - Not Supported**
  - Error on statement for Repeatable-Read
  - Percona Server will detect and error out

Replication

- **RBR binlog_format=ROW**
  - Large binlogs
  - No triggers on slaves
  - Schema incompatibilities
- **SBR causes issues with Gap Locks**
  - Can use on slaves
  - If safe set rocksdb_unsafe_for_binlog=1

Backup and Recovery

- **XtraBackup**
  - Only in 8.0 with xtrabackup 8.0.6+
  - Optimized for Innodb and MyRocks
  - No partial backups for MyRocks
- **Mariabackup**
  - 10.2.16+, 10.3.8+
  - No partial backups for MyRocks

Backup and Recovery

- **myrocks_hotbackup**
  - Original backup tool
  - Doesn't work with 8.0
  - Copies RocksDB checkpoint + WAL
  - MyRocks only, won't do anything for innodb
  - Supports rolling checkpoint
    - *Less WAL to apply on restore till replication*

Backup and Recovery

- **mysqldump**
  - Optimization can be enabled for import
  - rocksdb_bulk_load=1
  - mysqldump in Percona Server detects MyRocks automatically
- **Snapshots**
  - Quite difficult to do right when mixing engines
  - MyRocks: checkpoint + wal

Crash recovery

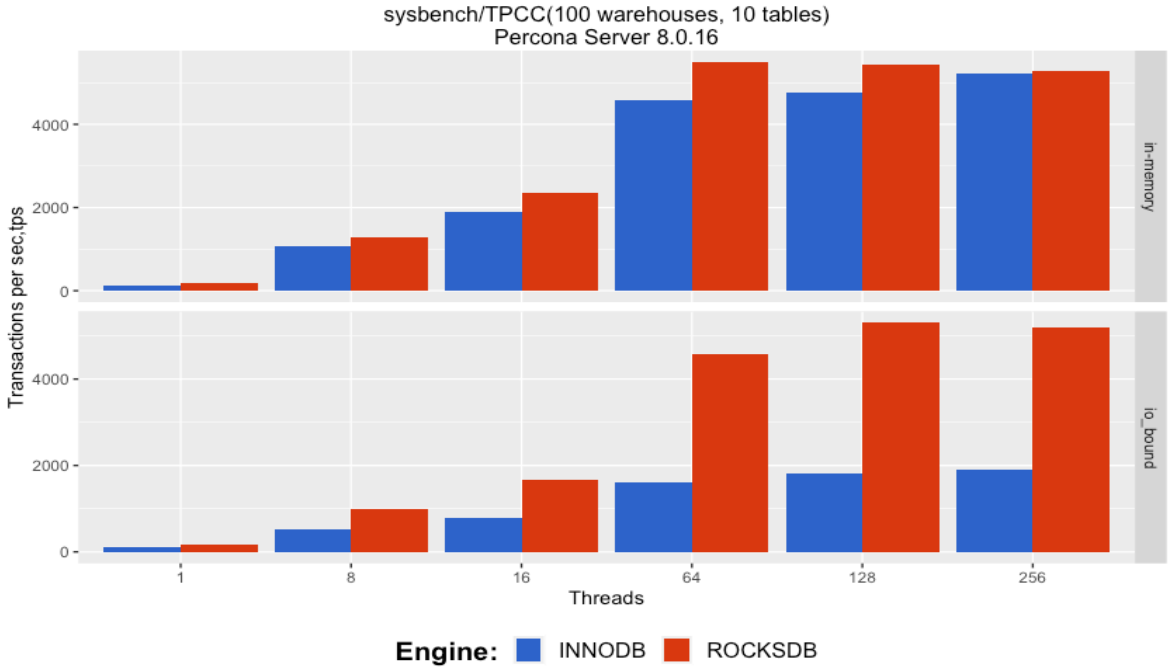
- **Corrupted immutable files: not recoverable**
- **WAL file: recoverable**
  - Variable rocksdb_wal_recovery_mode
    - *1: Fail to start, do not recover*
    - *0: If corrupted last entry: truncate and start*
    - *2: Truncate everything after corrupted entry*
    - *3: Truncate only corrupted entry (unsafe)*

Tool compatibility

Percona tools generally work with MyRocks

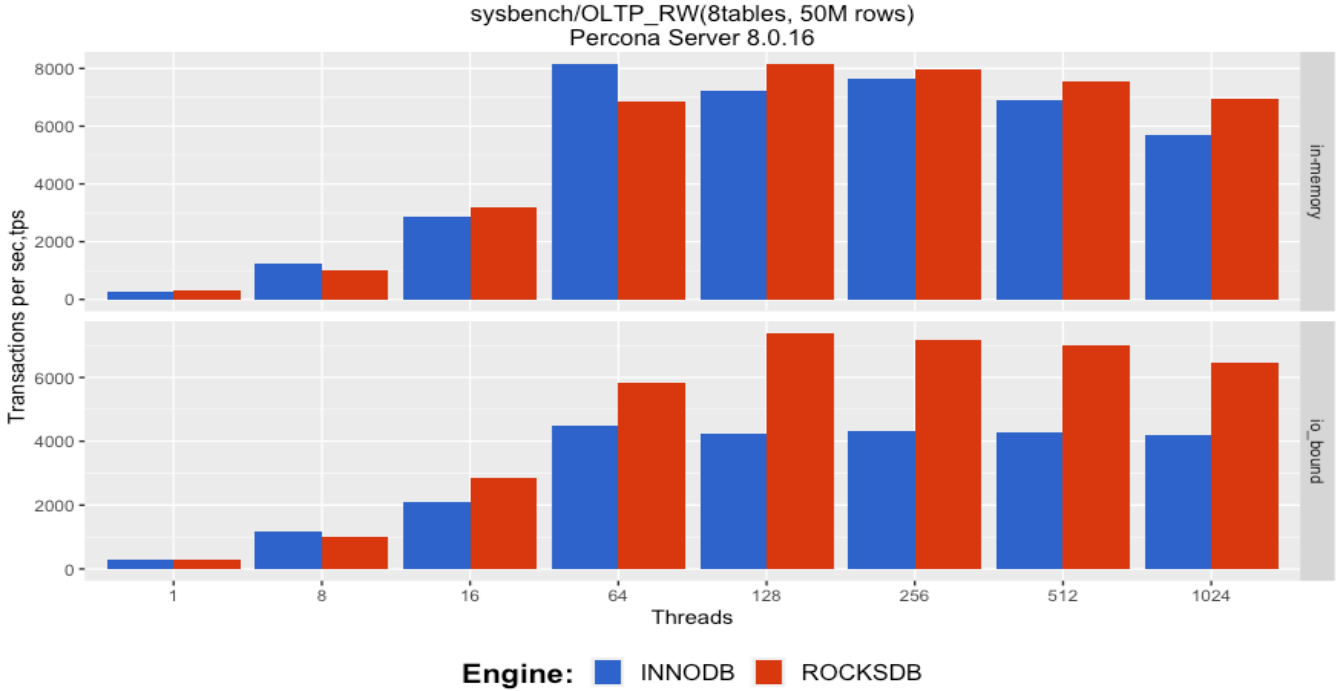
PMM	Supported	Built-in dashboards for MyRocks
xtrabackup	Supported	Since xtrabackup 8.0.6 (MySQL 8.0 only)
pt-online-schema-change	Partial	Only in read committed
pt-table-checksum	Not supported	Only ROW is supported by MyRocks
pt-table-sync	Not supported	Only ROW is supported by MyRocks

Benchmarks



PERCONA

Benchmarks



PERCONA

Tuning suggestions

- **Directory Structure**
  - All files are under .rocksdb directory
  - No file per table option (not even per db)
  - Log file verbosity is high
- **Beware of bulk load is problematic**
  - Set rocksdb_bulk_load=1
  - Set rocksdb_commit_in_the_middle=1

Tuning suggestions

- **Memory Cache Blocks**
  - rocksdb_block_cache_size -`SHOW ENGINE ROCKSDB STATUS`
- **DirectIO (bypass OS cache)**
  - rocksdb_use_direct_reads=ON
  - rocksdb_use_direct_io_for_flush_and_compaction=ON

Tuning suggestions

- **Simulation cache**
  - rocksdb_sim_cache_size
    - *Simulates block cache (for reads)*
    - *Set to larger/smaller value (restart)*
    - *Costs ~2% of that value*
    - *Show engine rocksdb status\G*
      - `rocksdb.sim.block.cache.hit COUNT : 346684`
      - `rocksdb.sim.block.cache.miss COUNT : 86667`

Tuning suggestions

- **Background jobs**
  - rocksdb_max_background_jobs=<num_cpu_cores/4>
  - rocksdb_max_total_wal_size=4G
- **Better compression**
  - rocksdb_block_size=16384

Tuning suggestions

- **Memory limits**
  - rocksdb_db_write_buffer_size
- **Unless using Percona Server 8.0 with optimized defaults**
  - rocksdb_default_cf_options
    - *Use 8.0 defaults, at least enable bloom filters*
    - *block_based_table_factory= {filter_policy=bloomfilter:10:false;};*

Conclusion

- Big data sets over 100Gb
- Multiple indexes
- Write-intensive workloads
- Concurrent reads without range scans
- Cloud efficient and cheaper to run
  - Less IOPS, Memory, Storage
- Write and Read immediately

Special Thanks to...

- Yoshinori Matsunobu @matsunobu
- Vadim Tkachenko @VadimTk
- Sveta Smirnova @svetsmirnova
- Mark Callaghan for doing the extensive research and development.
- Engineering, Experts and Services Teams at Percona

Q&A

Credits & References

https://www.slideshare.net/matsunobu/myrocks-deep-dive
https://blog.pythian.com/exposing-myrocks-internals-via-system-variables-part-1-data-writing/
https://www.percona.com/resources/webinars/how-rock-myrocks
https://mariadb.com/kb/en/library/optimizer-statistics-in-myrocks/
http://smalldatum.blogspot.com/2017/12/myrocks-innodb-and-tokudb-summary.html