Acronis

Dual headquarters
in Switzerland and Singapore

Acronis Cyber Cloud: Percona to MariaDB migration experience

#CyberFit

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Chief Architect

25+ years in cloud software industry. Experienced in the Linux Kernel, Hypervisors, Storages, Databases, Cloud services architecture

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Chief Database Architect

20 years in IT. Experienced in designing and building highly scalable and HA systems, zero downtime migrations, ETL processes

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Agenda

- Acronis Cyber Cloud overview
- Percona-to-MariaDB migration project
- Acronis contribution to OpenSource
  - Contribution to MariaDB
  - Contribution to Percona
  - The acronis-db-bench (DB performance swiss-knife)
- Future Plans / Points of Acronis Interest

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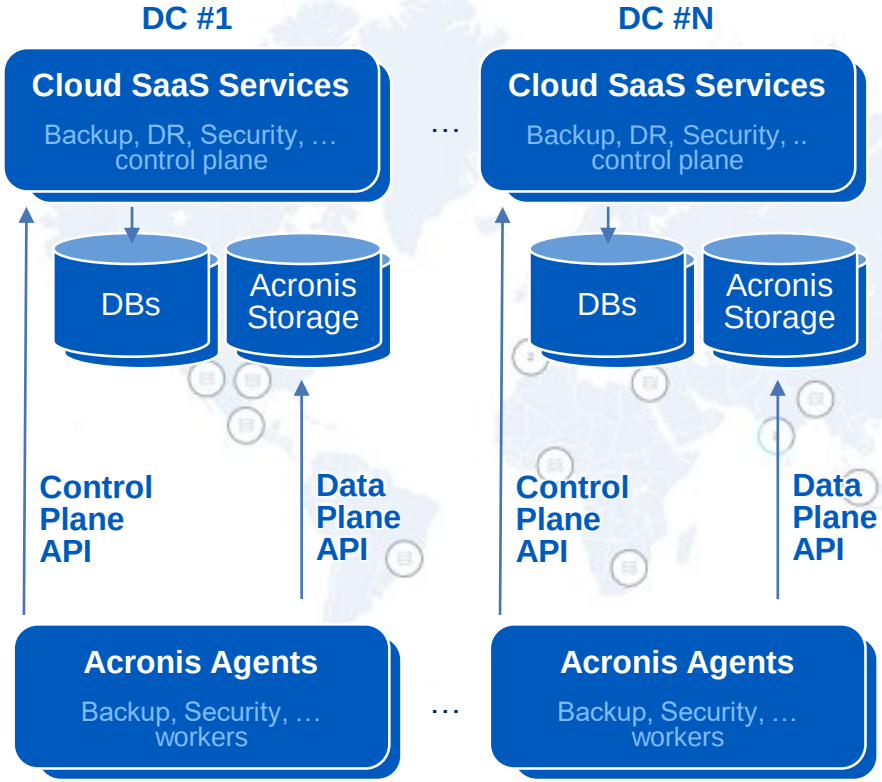
Acronis Cyber Cloud Architecture



Production environment:

- ✓ 50+ data centers
- ✓ 2K DB instances
- ✓ 5K logical DBs
- ✓ 0.35M tables
- ✓ 50TB data in DB
- ✓ 50K connections
- ✓ 10B transactions per day
- ✓ 300K updated rows per second
- ✓ 5K microservices – DB clients (globally)
- ✓ 1M rows per second returned to DB clients
- ✓ Millions of agents

  Agents report their telemetry to SaaS services and so to DBs

Testing environment:

- ✓ 500 test clouds
- ✓ 12K DB instances
- ✓ 30K logical DBs
- ✓ …

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Percona-to-MariaDB Migration Project

Acronis Context, as of 2023:

1. Acronis Cyber Cloud Platform database stack:
    - Percona 5.7 database (EOL Q4'2023)
    - Galera replication
    - HAProxy
    - Percona Monitoring and Management
    - Backup, automation, and deployment scripts
2. Michael “Monty” Widenius joined Acronis ☺
3. NOTE: Acronis run Percona on it’s own and did not use Percona support services

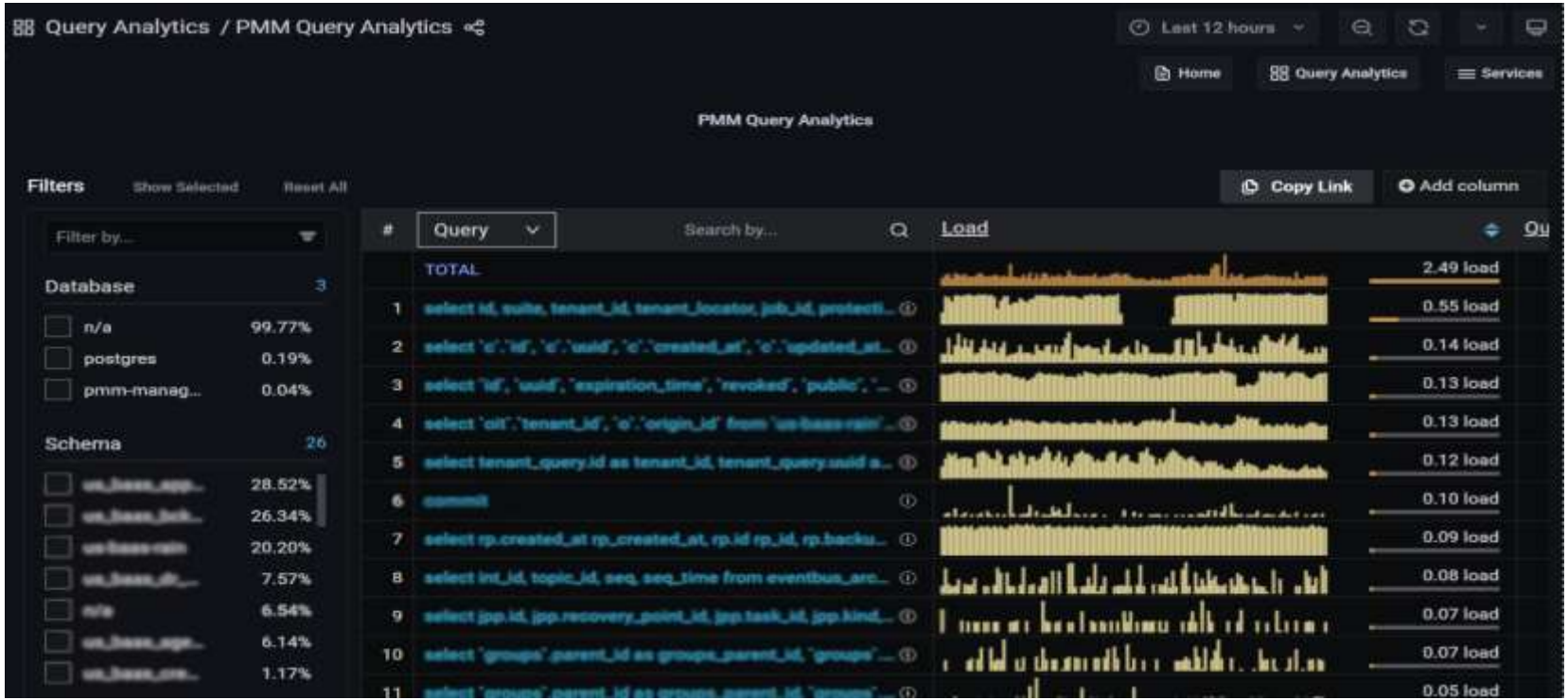
Migration project objectives:

1. To migrate from Percona 5.7 database to the latest stable MariaDB 10.11 with **lowest possible downtime** (< 5min)
2. To **keep the environment** as is: Galera; HA-proxy; Percona Monitoring; Backup, automation and deployment scripts
3. To ensure migration would not introduce unexpected **performance** problems in production
4. To be able to **contribute** to MariaDB and use the features in Production afterwards

Project timeline 2023’Q4 – 2024’Q1

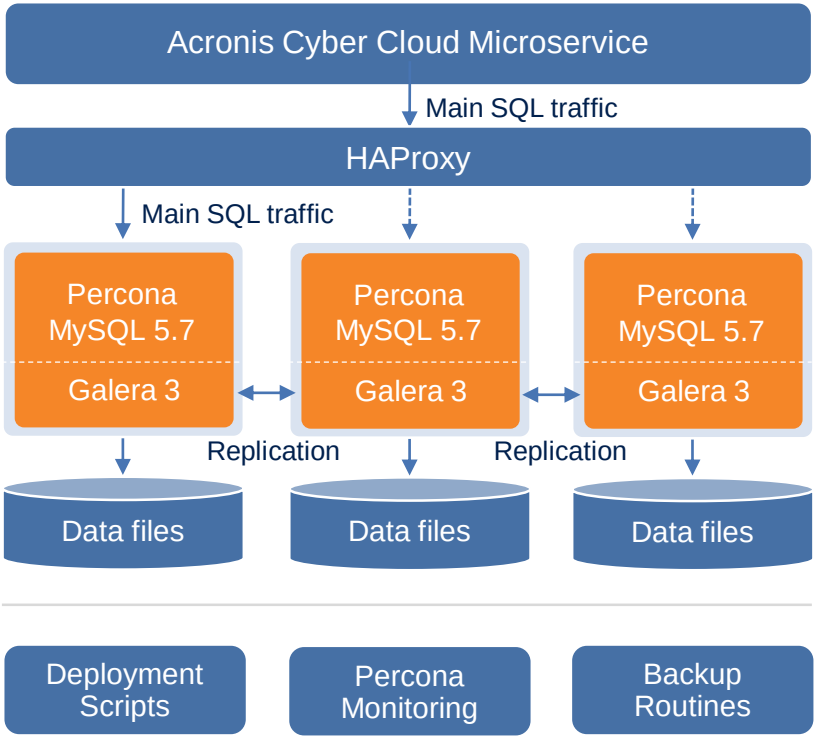
Percona Management and Monitoring (Query Analytics)

Why we ❤ PMM



Percona-to-MariaDB Migration Project

Original Percona cluster:



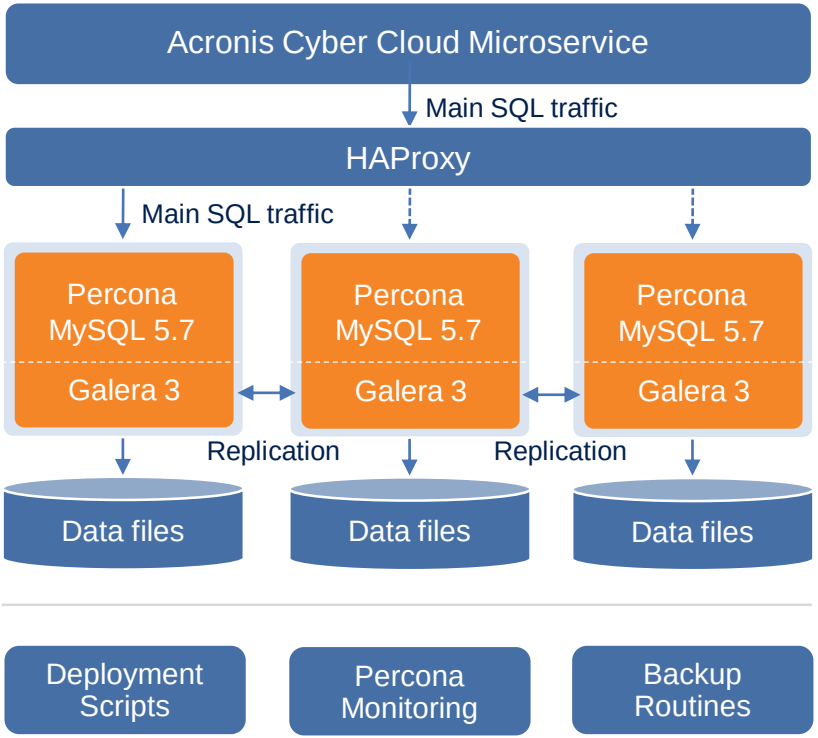
Migration procedure:

1. Stop applications access on HAProxy
2. Backup old Percona configs
3. Set innodb_fast_shutdown = 0
4. Stop mysql
5. Delete Percona packages on all nodes, in reverse ord
6. Delete old configs (/etc/my.cnf and /etc/my.cnf.d)
7. Install new mariadb+galera packages
8. Deploy new mariadb configs in /etc/my.cnf.d/
9. Configure mariadb systemd unit:
   - increase max open files
   - increase systemd startup timeout
10. Start mariadb nodes one-by-one, in direct order
11. Sequentially Run mysql_upgrade on all three nodes
12. Enable applications access on haproxy

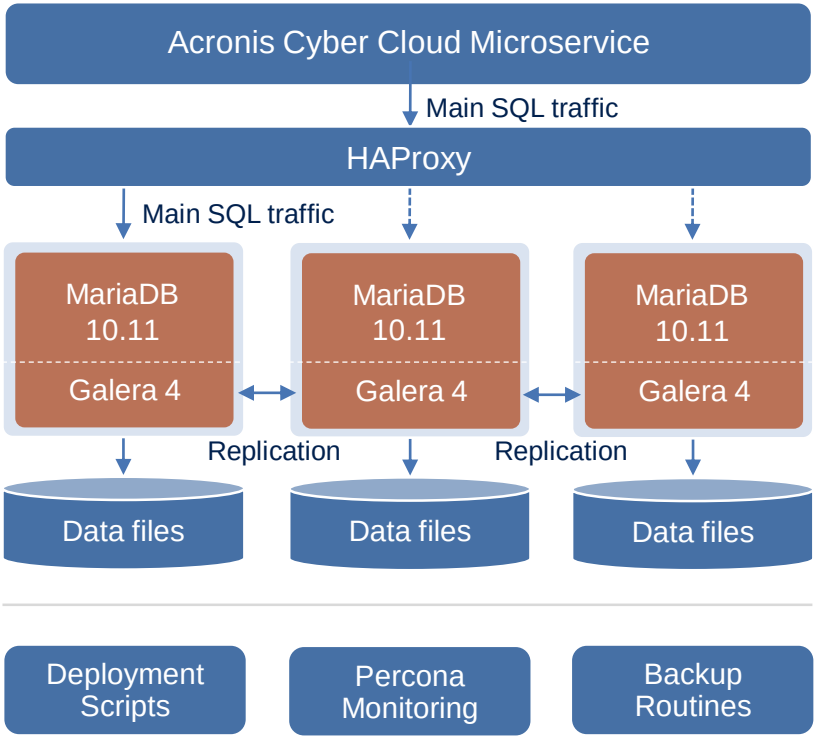
Total downtime is just a few minutes

Percona-to-MariaDB Migration Project

Original Percona cluster:



Target MariaDB cluster:



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Acronis Contribution Into MariaDB (1/3)

Convert MySQL 5.7 partitioned tables (10.6)

1. Stop server, replace MySQL binaries with MariaDB
2. Start server
3. Try to access table

MDEV-23106

```
MariaDB [acronis_db]> select count(*) from temp_table;
ERROR 1932 (42S02): Table 'acronis_db.temp_table' doesn't exist in engine
```

Support for Zulu format (10.11.7)

- ISO 8601, dates like '2023-05-21T14:40:39.046Z'

```
MariaDB [testdb]> insert into example_table (timestamp_column)
                  values ('2023-05-21T14:40:39.046Z');
ERROR 1292 (22007): Incorrect datetime value: '2023-05-21T14:40:39.046Z'
for column `testdb`.`example_table`.`timestamp_column` at row 1
```

Acronis Contribution Into MariaDB (2/3)

Log warnings into sql_error_log (10.11.7)

```
sql_error_log_warnings = ON
```

MDEV-7389

```
.. [] ERROR 1146: Table 'testdb.test1' doesn't exist : insert ignore into test1 values (1,now())
.. [] WARNING 1062: Duplicate entry '1' for key 'PRIMARY' : insert ignore into test values (1,now())
.. [] ERROR 1062: Duplicate entry '1' for key 'PRIMARY' : insert into test values (1,now())
.. [] WARNING 1292: Truncated incorrect INTEGER value: 'abc' : SELECT CAST('abc' AS SIGNED)
.. [] WARNING 1365: Division by 0 : SELECT 1 / 0
```

More statistics in slow log (11.7)

- **Pages_accessed, Pages_read**, Pages_updated
- **Pages_read_time, Engine_time**
- Tmp_tables, Tmp_disk_tables, **Tmp_tables_sizes**
- Full_scan, Full_join, Tmp_tables, Tmp_table_on_disk
- Filesort, Filesort_on_disk, Merge_passes, Priority_qu

```
# Time: 240130  9:40:53
# User@Host: root[root] @ localhost []
# Thread_id: 68  Schema: testdb  QC_hit: No
# Query_time: 3.136546  Lock_time: 0.000217  Rows_sent: 1  Rows_examined: 1000002
# Rows_affected: 0  Bytes_sent: 123
# Pages_accessed: 2140  Pages_read: 97  Pages_updated: 0  Old_rows_read: 0
# Pages_read_time: 12.0190  Engine_time: 795.1505
# Tmp_tables: 1  Tmp_disk_tables: 0  Tmp_table_sizes: 253984
# Full_scan: Yes  Full_join: No  Tmp_table: Yes  Tmp_table_on_disk: No
# Filesort: Yes  Filesort_on_disk: No  Merge_passes: 0  Priority_queue: No
use testdb;
SET timestamp=1706607653;
SELECT DATE_FORMAT(ctime, '%Y-%m-%d %H:00:00') as hour,
       COUNT(*) as row_count
FROM test
GROUP BY hour
HAVING row_count > 10
ORDER BY row_count DESC;
```

Acronis Contribution Into MariaDB (3/3)

Ignore log_slow_rate_limit for slow queries (11.7)

```
log_slow_rate_limit=10
```

log each 10th occurrence of the query

```
log_slow_always_query_time=0.1
```

log unconditionally queries slower than 100ms

Extended statistics for userstat module (11.7)

- `information_schema.table_statistics: ROWS_INSERTED, ROWS_UPDATED, ROWS_DELETED, KEY_READ_HITS, KEY_READ_MISSES`
- `information_schema.client_statistics: KEY_READ_HITS, KEY_READ_MISSES`
- `information_schema.user_statistics: KEY_READ_HITS, KEY_READ_MISSES`
- `information_schema.index_statistics: QUERIES`

MDEV-33151

Limits on binlog size (11.7)

```
binlog_space_limit
```

MDEV-31404

limiting disk space used by binlogs

```
max_binlog_total_size
```

considers if binlogs are needed by replica node

Temp usage quotas (11.7)

```
max_tmp_space_usage
```

per user

```
max_total_tmp_space_usage
```

for all users

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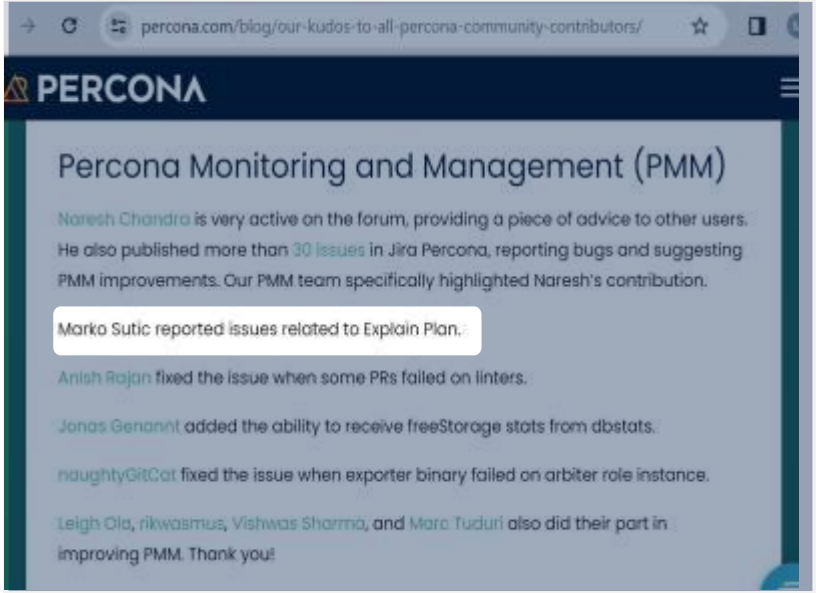
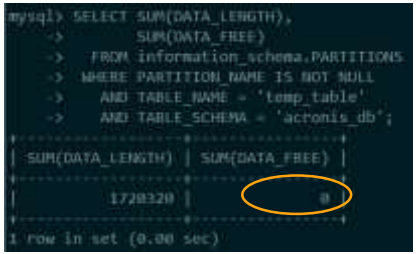
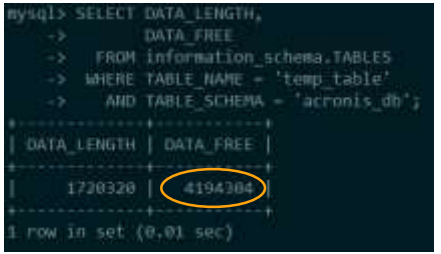
Acronis Contribution Into Percona

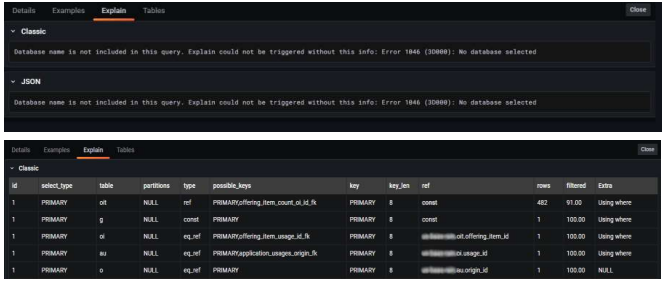


- Not consistent DATA_FREE between IS.TABLES and IS.PARTITIONS https://forums.percona.com/t/possible-bug-in-data-free-reporting-for-partitioned-tables/26745/ → PS-9015





- New statistics for MariaDB: PMM-12886
- Issues with Explain Plan PMM-12151



Acronis Contribution Into Percona

Before:

After:

id	select_type	table	partitions	type	possible_keys	key	key_len	ref	rows	filtered	Extra
1	PRIMARY	oit	NULL	ref	PRIMARY,offering_item_count_oi_id_fk	PRIMARY	8	const	482	91.00	Using where
1	PRIMARY	g	NULL	const	PRIMARY	PRIMARY	8	const	1	100.00	Using where
1	PRIMARY	oi	NULL	eq_ref	PRIMARY,offering_item_usage_id_fk	PRIMARY	8	[redacted].oit.offering_item_id	1	100.00	Using where
1	PRIMARY	au	NULL	eq_ref	PRIMARY,application_usages_origin_fk	PRIMARY	8	[redacted].oi.usage_id	1	100.00	Using where
1	PRIMARY	o	NULL	eq_ref	PRIMARY	PRIMARY	8	[redacted].au.origin_id	1	100.00	NULL

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Open Sourced Benchmark With Multi-tenant-like SQL

Acronis Context:

1. Acronis Cyber Cloud instance consists of **150+** microservices
2. Each service stores all the customers & services **data in single (own) database**
3. Such model requires multi-tenant and multi-service **access check** logic to be implemented directly in SQL
4. These SQL queries could be complicated and require specific optimization techniques, DB tuning or use of no-SQL

The acronis-db-bench idea:

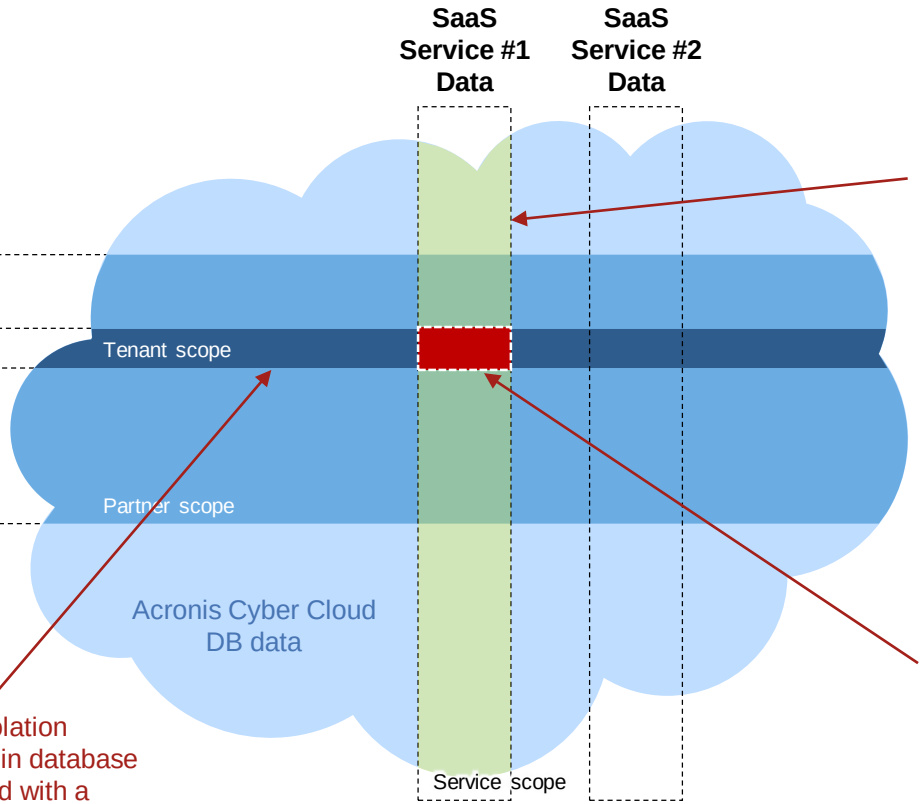
1. To collect all the typical SQL query patterns used by Acronis **multi-tenant** services in single benchmark
2. To develop a benchmark which can test **simple-to-complex** scenarios – SELECT, INSERT, UPDATE, etc
3. Can be used to compare different DB configurations or solutions (Percona, MariaDB, PostgreSQL, Cassandra, etc)
4. To make it **open source** to get feedback, submit performance tickets to community or verify optimisations

Sources available @ https://github.com/acronis/perfkit/ - written in go-lang, ~**10K LOC**

Acronis Multi-Tenancy and Multi-Service Access Che

Acronis Cyber Cloud hierarchical multi-tenancy model:

- Distributor 1
  - Partner 1.1
    - Folder 1.1.1
      - Customer 1.1.1.1
        - Customer 1.1.1.2
    - Folder 1.1.2
      - Customer 1.1.2.1
    - Customer 1.1.3
- Distributor 2
  - Partner 2.1
    - Customer 2.1.1
    - Customer 2.1.2



(2) **Services** isolation requires objects in database to be associated with a **service ID**

Service #1 data visible to Customer 1.1.1.1

(1) Tenants isolation requires object in database to be associated with a **tenant ID**

The acronis-db-bench - testing methodology

1. Use several type of **tables** (simple-to-complex)
   - Synthetic '**light**' table – 2 columns, 0 indexes
   - Synthetic '**medium**' table – 5 columns, 1 index
   - Synthetic '**heavy**' table – 40 columns, 20 indexes
   - A bunch of **realistic** tables (with multi-tenancy support)

2. Pre-defined set of queries **flavours** (INSERT, SELECT, UPDATE, etc) gradually increases the complexity, like:
   - BEGIN; INSERT; INSERT ; ... ; COMMIT
   - INSERT INTO () VALUES (…, …)
   - INSERT INTO () VALUES (…, …) // with prepared statement
   - COPY ()

   - SELECT 1
   - SELECT … WHERE {data filter}
   - SELECT … WHERE {data filter} AND {tenant filter}
   - SELECT … WHERE {data filter} AND {tenant filter} AND {service filter}
   - …

3. Supported **patterns**:
   - INSERT, UPDATE, SELECT queries
   - JSON insert / search
   - Large blobs data INSERT / SELECT
   - Sequence generation simulation
   - Custom query from command line

4. Benchmark **parameters**:
   - Test duration
   - Number of queries
   - Concurrency
   - Customizable cardinality
   - Optional logging / EXPLAIN
   - Raw SQL vs DBR query builder
   - Different DB vendors support:
     - Percona / MariaDB / MySQL
     - PostgreSQL
     - SQLite
     - NoSQL – Cassandra, ClickHouse

The acronis-db-bench – cmdline example

Single quick test run example: insert-light vs insert-heavy

```
$ acronis-db-bench --driver mysql --dsn $DSN -t insert-light -l 100000 -c 16
================================================================================================================
======
Acronis Database Benchmark: version v1.0.0
Connected to 'mysql' database: 10.11.4-MariaDB (Source distribution)
================================================================================================================
=====

mysql database settings checks:
 - innodb_buffer_pool_size (aka primary DB cache)..... 12884901888    OK
 - innodb_log_file_size (aka InnoDB redo log size)..... 2147483648     OK
 - max_connections (aka max allowed number of DB connections)..... 2048          OK
 - query_cache_type (aka query cache policy)..... OFF           OK
 - performance_schema (aka performance-related server metrics)..... ON            OK

test: insert-light: rows-before-test: 120171: time: 5.7 sec: workers: 16: loops: 100000: batch: 1: rate: 17457 rows/sec
```

```
$ acronis-db-bench --driver mysql --dsn $DSN -t insert-heavy -l 100000 -c 16
================================================================================================================
======
Acronis Database Benchmark: version v1.0.0
Connected to 'mysql' database: 10.11.4-MariaDB (Source distribution)
================================================================================================================
=====

...

test: insert-heavy: rows-before-test: 60: time: 9.8 sec: workers: 16: loops: 100000: batch: 1: rate: 10246 rows/sec
```

The acronis-db-bench – Integration with the Perftrac

Integration with the Perftracker (https://github.com/perfguru87/perftracker)

The acronis-db-bench – explore your databases

- Compare **simple table** performance vs **complex** ones
- Compare **simple queries** vs **comple**x ones
- Compare single **worker** vs N workers
- Compare single query vs N queries in **transaction**
- Compare DB **engines** (InnoDB vs Aria)
- Compare DB **vendors** (MariaDB vs PostgreSQL)
- Compare DB **versions** (10.11 vs 11.4)
- Compare **different hardware**
- Compare single DB **instance** vs **cluster**
- Compare default DB **config** vs **tuned**
- Compare **enough-memory** vs **memory-shortage**
- Compare standalone **DB** vs **DB-in-kubernetes**
- Compare your **on-prem DB** vs **AWS-hosted**
- Compare **tables/indexes** disk consumption space on different storage/DB engines
- …

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Future Plans / Points of Acronis Interest

1. **Non-blocking backup in Community Server**
   MDEV-26644 (10.11.8)

2. **Extended error messages**
   Adding table, column and index names to error messages (10.11)

3. **Extended temp usage monitoring and quotas**
   - TEMPORARY TABLE relations (11.7)

4. **Better monitoring capabilities**
   - More metrics (11.7)
   - Visualizing in Percona Management and Monitoring (11.7)

5. **Catalogs**
   HW resources isolation (11.7)

6. **Built-in analog of pt-osc, gh-ost**
   Zero downtime migrations (11.7)

7. **Avoid stall in Galera during huge table drop**

8. **Create foreign keys without downtime**

9. **Performance**
   MDEV-6096 (Parallel query execution), multi-tenant-like queries

10. **No SQL**
    Vector database for AI models, indexable JSON

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Q&A

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