QINGCLOUD | RadonDB

开源分布式数据库 RadonDB
技术揭秘

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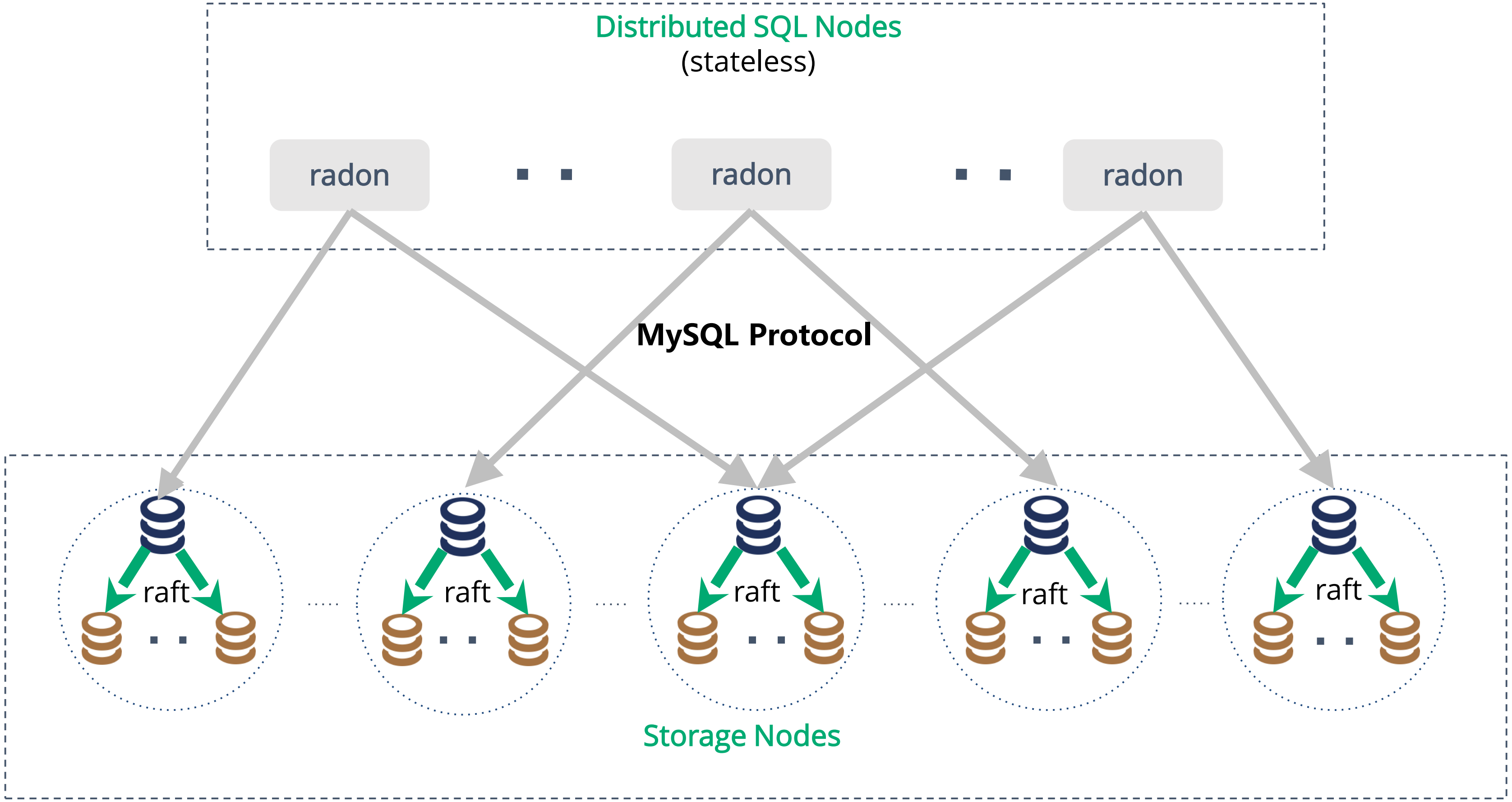
目录

- ▶ RadonDB架构
- ▶ Radon介绍
- ▶ Xenon介绍
- ▶ 其他功能介绍

RadonDB

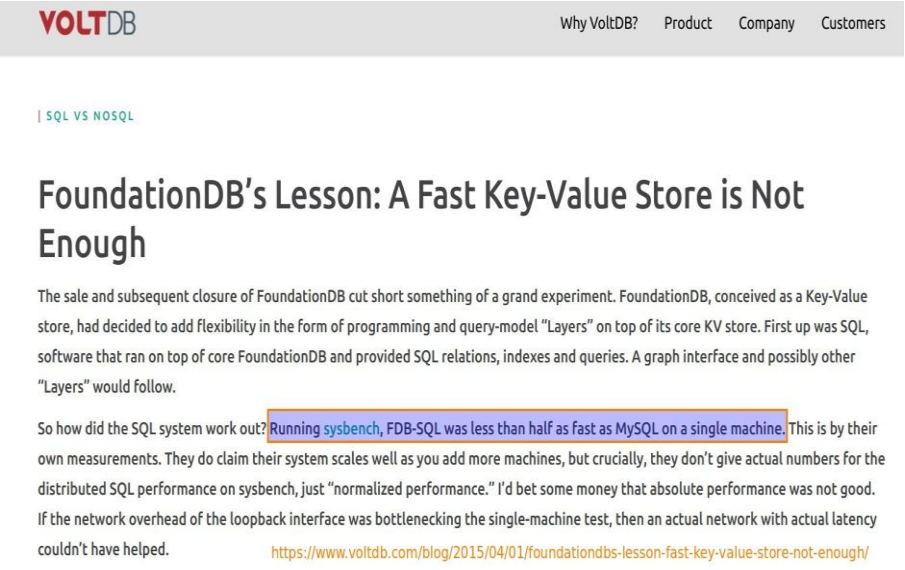
- Radon: 氡，惰性气体
- 官网:http://radondb.io
- 开源:https://github.com/radondb
- RadonDB = radon + xenon

Architecture



存储和计算节点的选择

- 为什么不是KV? MySQL!
- 稳定可靠、多索引写原子保证
- 计算下推，数据就近计算原则
- 不仅存储还有计算能力
- SQL 与 Storage 数据传输最小化
- MySQL 8.0更加强大...



VOLTDB　Why VoltDB?　Product　Company　Customers

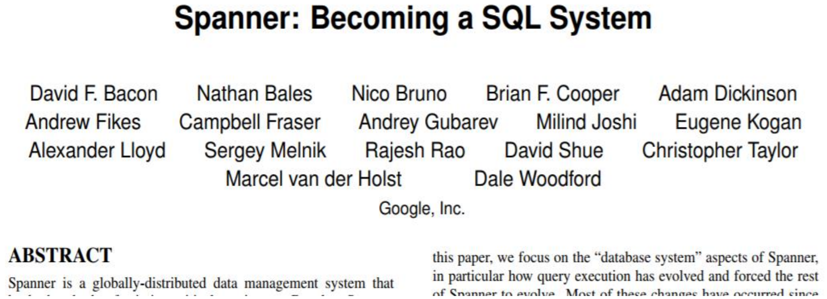
| SQL VS NOSQL

FoundationDB's Lesson: A Fast Key-Value Store is Not Enough

The sale and subsequent closure of FoundationDB cut short something of a grand experiment. FoundationDB, conceived as a Key-Value store, had decided to add flexibility in the form of programming and query-model "Layers" on top of its core KV store. First up was SQL, software that ran on top of core FoundationDB and provided SQL relations, indexes and queries. A graph interface and possibly other "Layers" would follow.

So how did the SQL system work out? Running sysbench, FDB-SQL was less than half as fast as MySQL on a single machine. This is by their own measurements. They do claim their system scales well as you add more machines, but crucially, they don't give actual numbers for the distributed SQL performance on sysbench, just "normalized performance." I'd bet some money that absolute performance was not good. If the network overhead of the loopback interface was bottlenecking the single-machine test, then an actual network with actual latency couldn't have helped.

https://www.voltdb.com/blog/2015/04/01/foundationdbs-lesson-fast-key-value-store-not-enough/



Spanner: Becoming a SQL System

David F. Bacon　Nathan Bales　Nico Bruno　Brian F. Cooper　Adam Dickinson
Andrew Fikes　Campbell Fraser　Andrey Gubarev　Milind Joshi　Eugene Kogan
Alexander Lloyd　Sergey Melnik　Rajesh Rao　David Shue　Christopher Taylor
Marcel van der Holst　Dale Woodford
Google, Inc.

ABSTRACT

Spanner is a globally-distributed data management system that

this paper, we focus on the "database system" aspects of Spanner, in particular how query execution has evolved and forced the rest of Spanner to evolve. Most of these changes have occurred since

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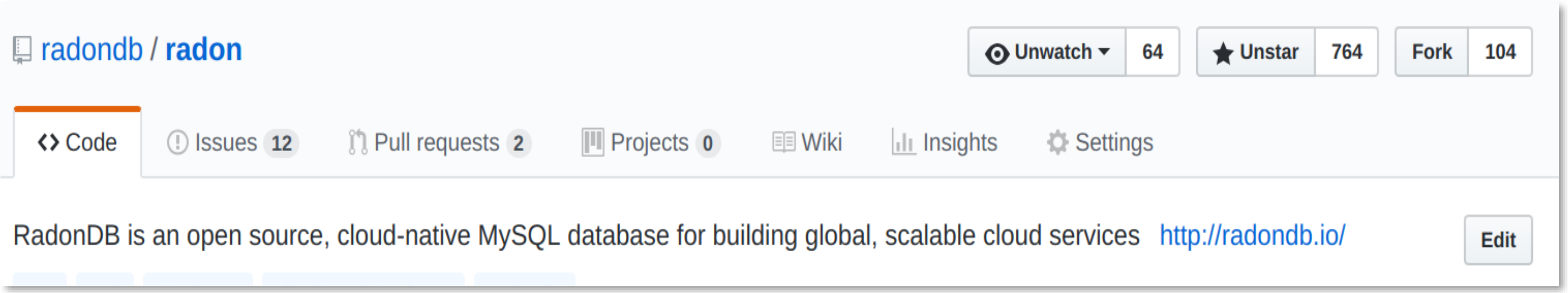
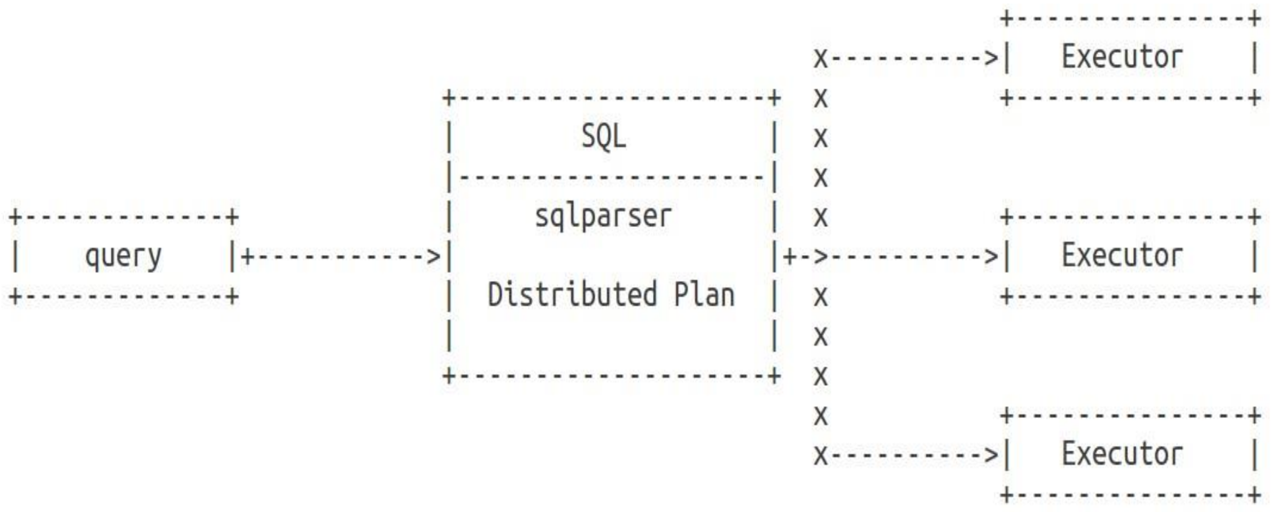
Radon



RadonDB is an open source, cloud-native MySQL database for building global, scalable cloud services http://radondb.io/

Distributed SQL

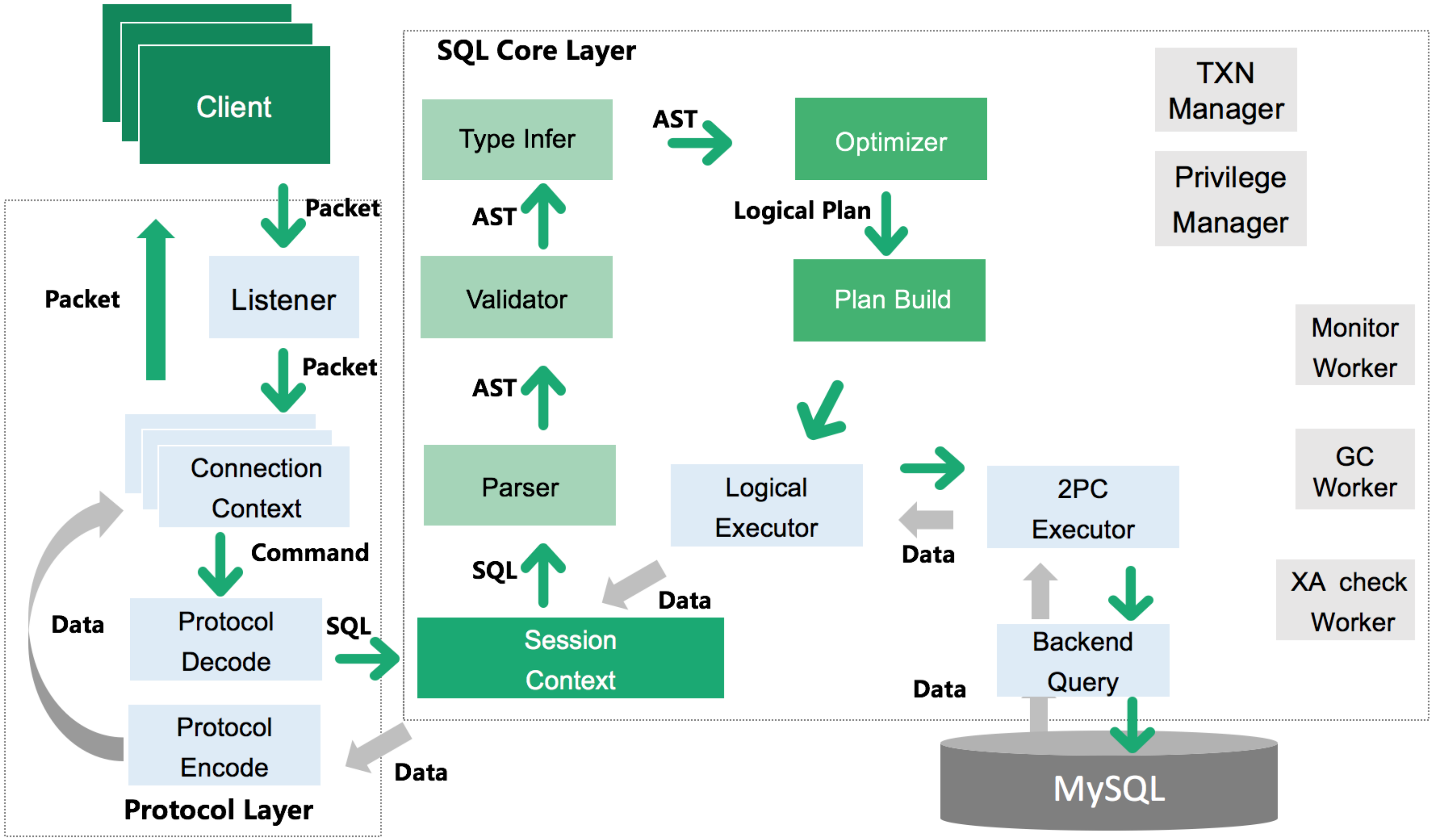
- ▶ 生成分布式执行计划
- ▶ 执行器并行执行
- ▶ orderby/limit/groupby/aggr ...
- ▶ 主从模式



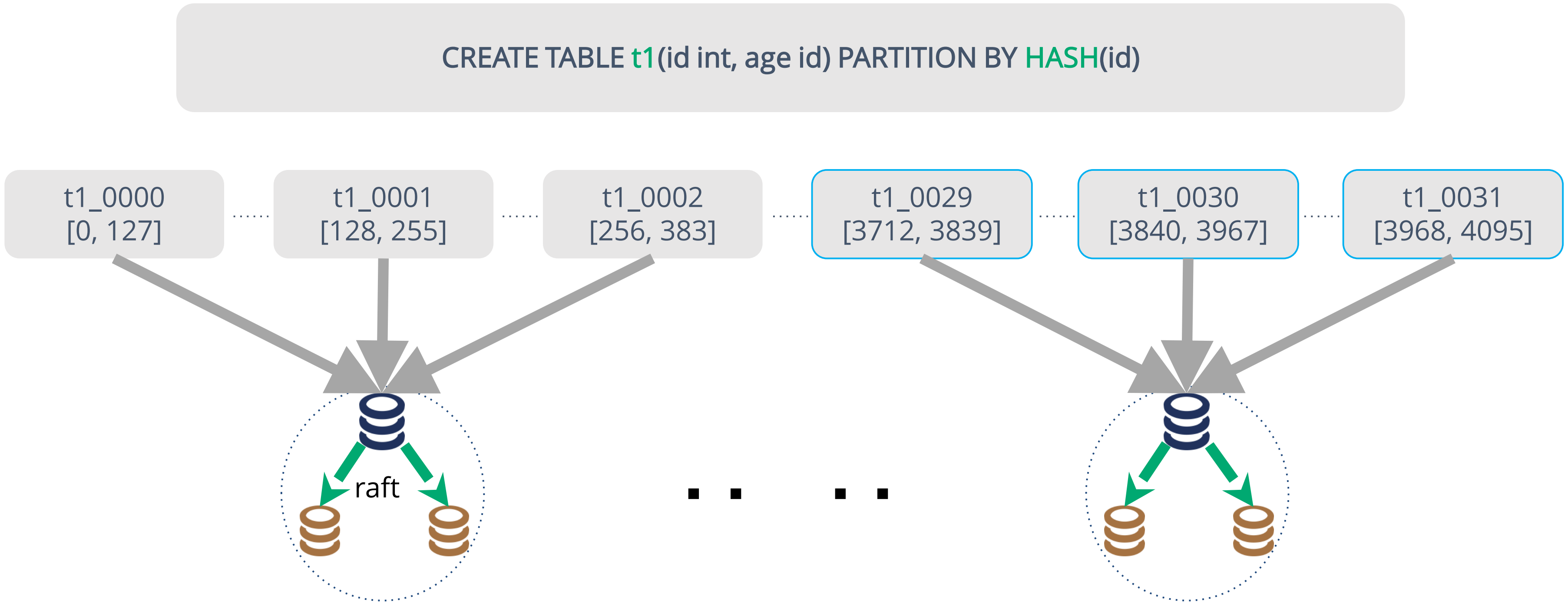
```
                                                                +----------------+
                                                    x----------->|   Executor     |
                            +---------------------+ x           +----------------+
                            |         SQL         | x
                            |---------------------| x
+-------------+             |      sqlparser      | x           +----------------+
|    query    |+----------->|                     |+->--------->|   Executor     |
+-------------+             |  Distributed Plan   | x           +----------------+
                            |                     | x
                            +---------------------+ x
                                                    x           +----------------+
                                                    x----------->|   Executor     |
                                                                +----------------+
```

分布式SQL剖析

- 语法解析
- 执行计划
- 并发执行
- 事务封装



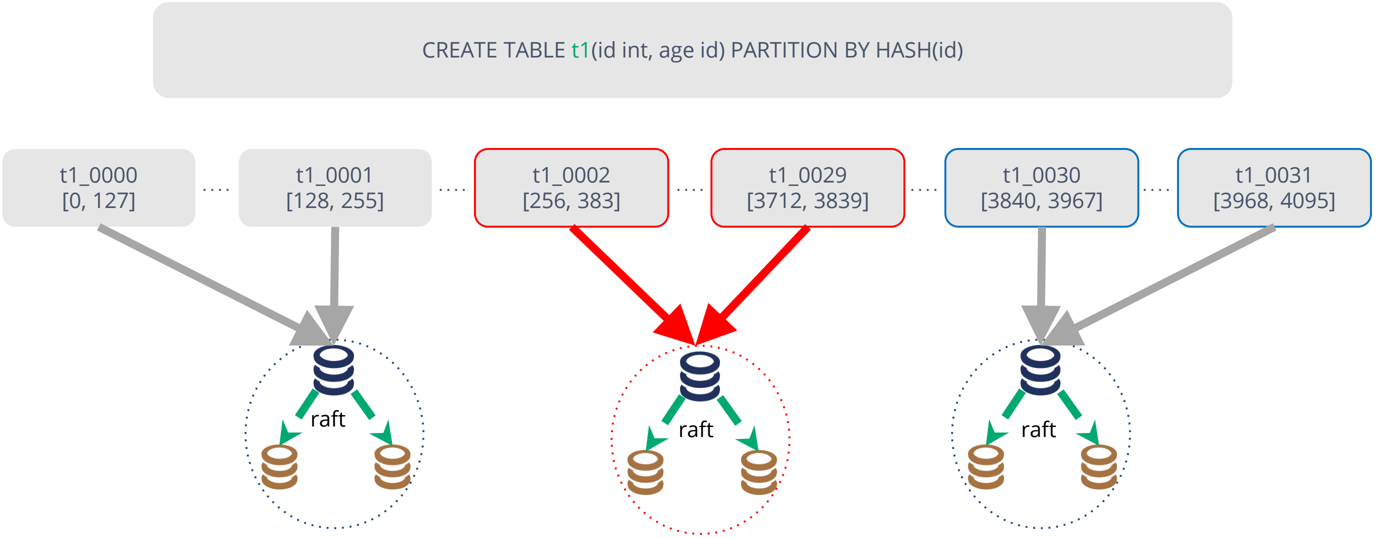
数据分布



- ▶整张表共 4096 slots
- ▶每个小表 128 slots
- ▶小表均匀分散在 node节点

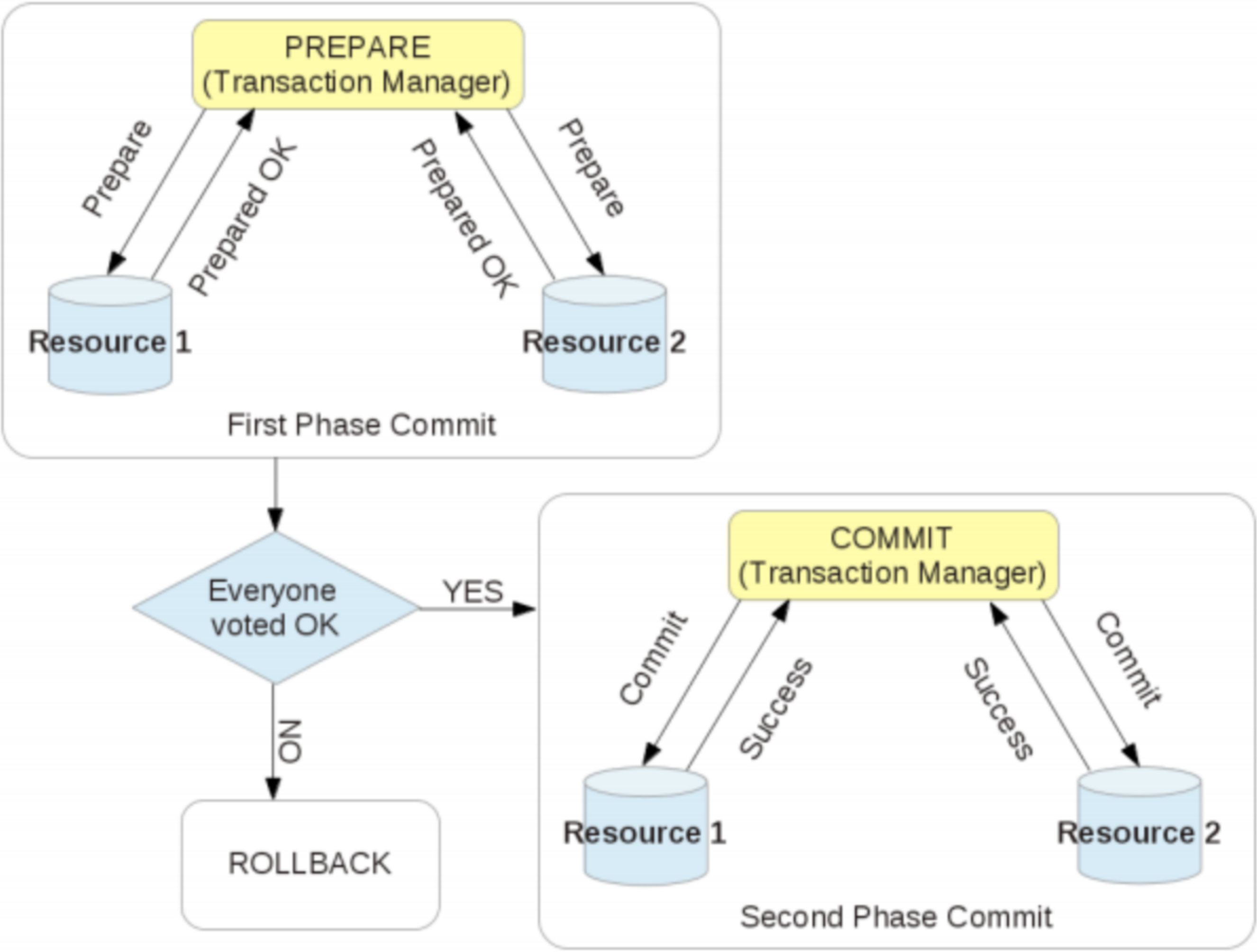
扩容

- 小表可动态漂移
- 先全量后增量
- 较大/热度高者优先
- 资源分配最优化



Distributed Transaction

- 两阶段提交算法
- 事务管理器：Radon
- 资源管理器：MySQL
- 分布式事务对用户透明

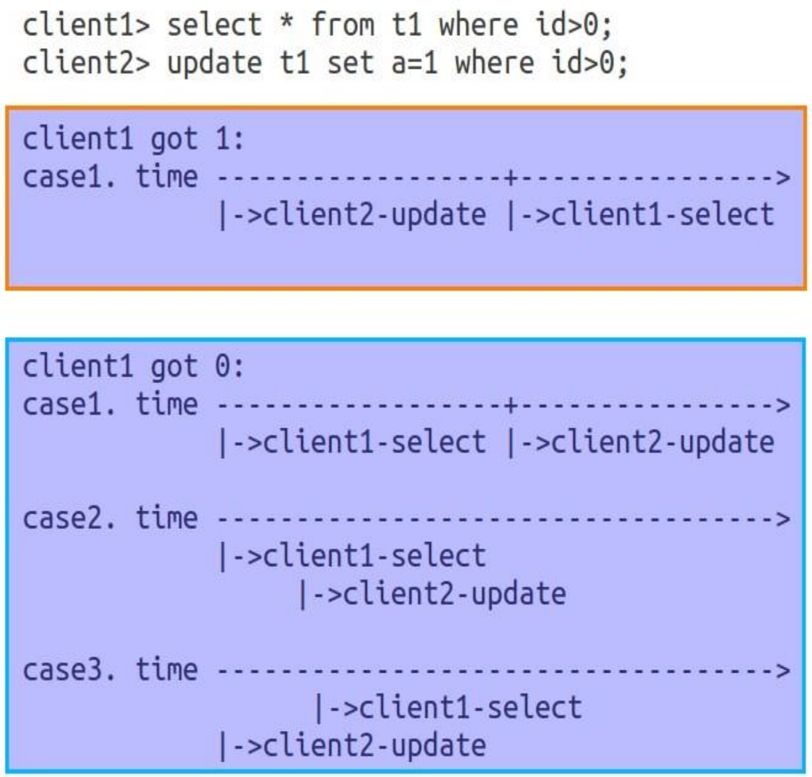


针对各种异常处理

- prepare失败/超时
  - TM发送rollback到所有RM
- 提交事务之前，某个RM返回操作错误
  - TM发送rollback到所有RM
- TM crash
  - 多种阶段不同处理，报警人工干预
- RM crash
  - 有记录xa log，最终生效
- 日志巡检等措施

分布式事务隔离级别

- 默认快照SI隔离级别
  - 所有修改只在提交时才对外可见
  - 未提交不可见
  - 部分提交不可见
- 最高可达到serializable



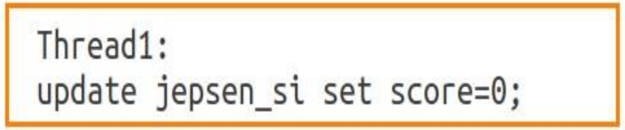
```
client1> select * from t1 where id>0;
client2> update t1 set a=1 where id>0;
```

```
client1 got 1:
case1. time ------------------+----------------->
            |->client2-update |->client1-select
```

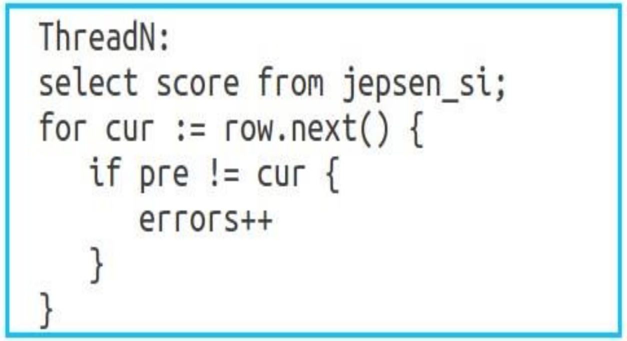
```
client1 got 0:
case1. time ------------------+----------------->
            |->client1-select |->client2-update

case2. time ------------------------------------>
            |->client1-select
                 |->client2-update

case3. time ------------------------------------>
                  |->client1-select
            |->client2-update
```

隔离级别验证

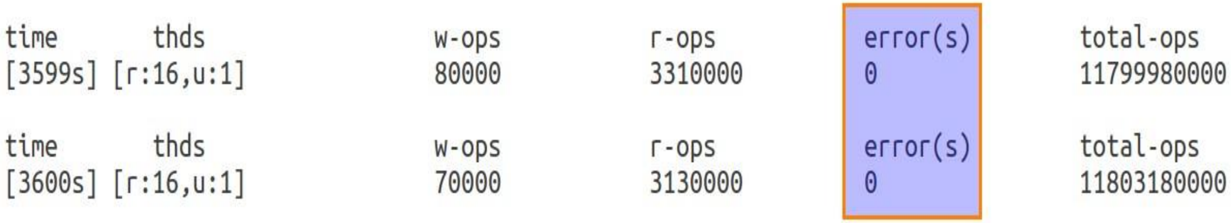
- ▶ xelabs/go-jepsen
- ▶ 1个更新线程，16个扫表线程
- ▶ 100多亿次操作和检测
- ▶ 各种异常情况的模拟验证



```
Thread1:
update jepsen_si set score=0;
```



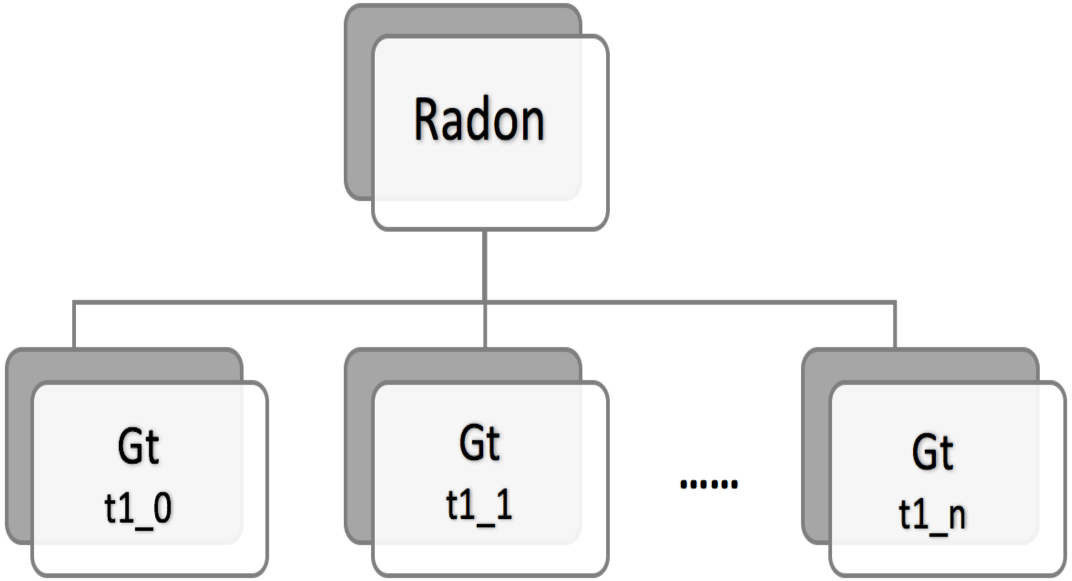
```
ThreadN:
select score from jepsen_si;
for cur := row.next() {
    if pre != cur {
        errors++
    }
}
```



```
time     thds                w-ops     r-ops      error(s)   total-ops
[3599s]  [r:16,u:1]          80000     3310000    0          11799980000

time     thds                w-ops     r-ops      error(s)   total-ops
[3600s]  [r:16,u:1]          70000     3130000    0          11803180000
```

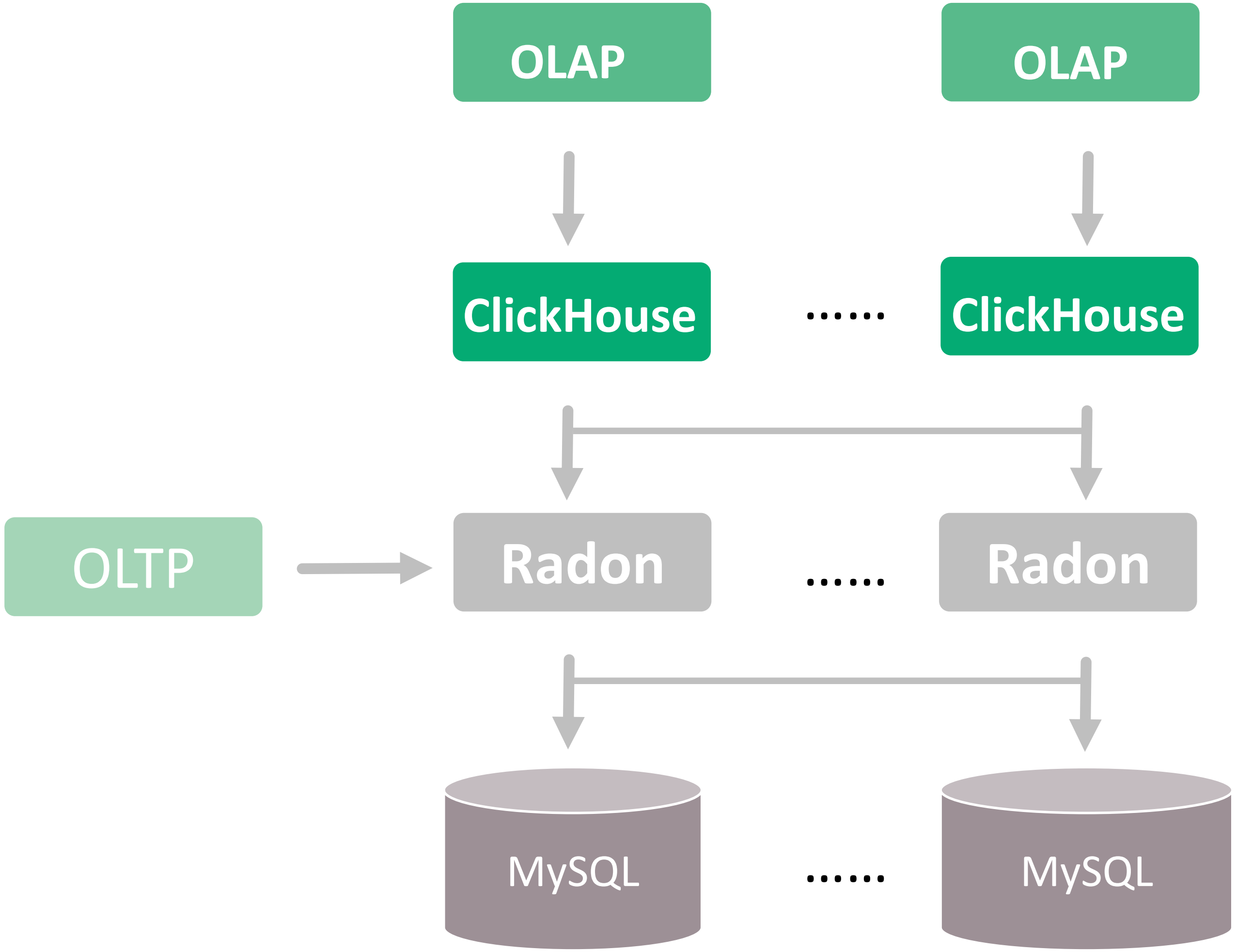
支持全局表join

- 实际数据库场景中，经常需要一些字典表：数据量小、变更频率低，可创建为全局表
- 全局表之间、全局表与分区表间join操作可根据路由下推存储节点执行，执行效率高，避免了跨库Join，执行结果在SQL节点汇总

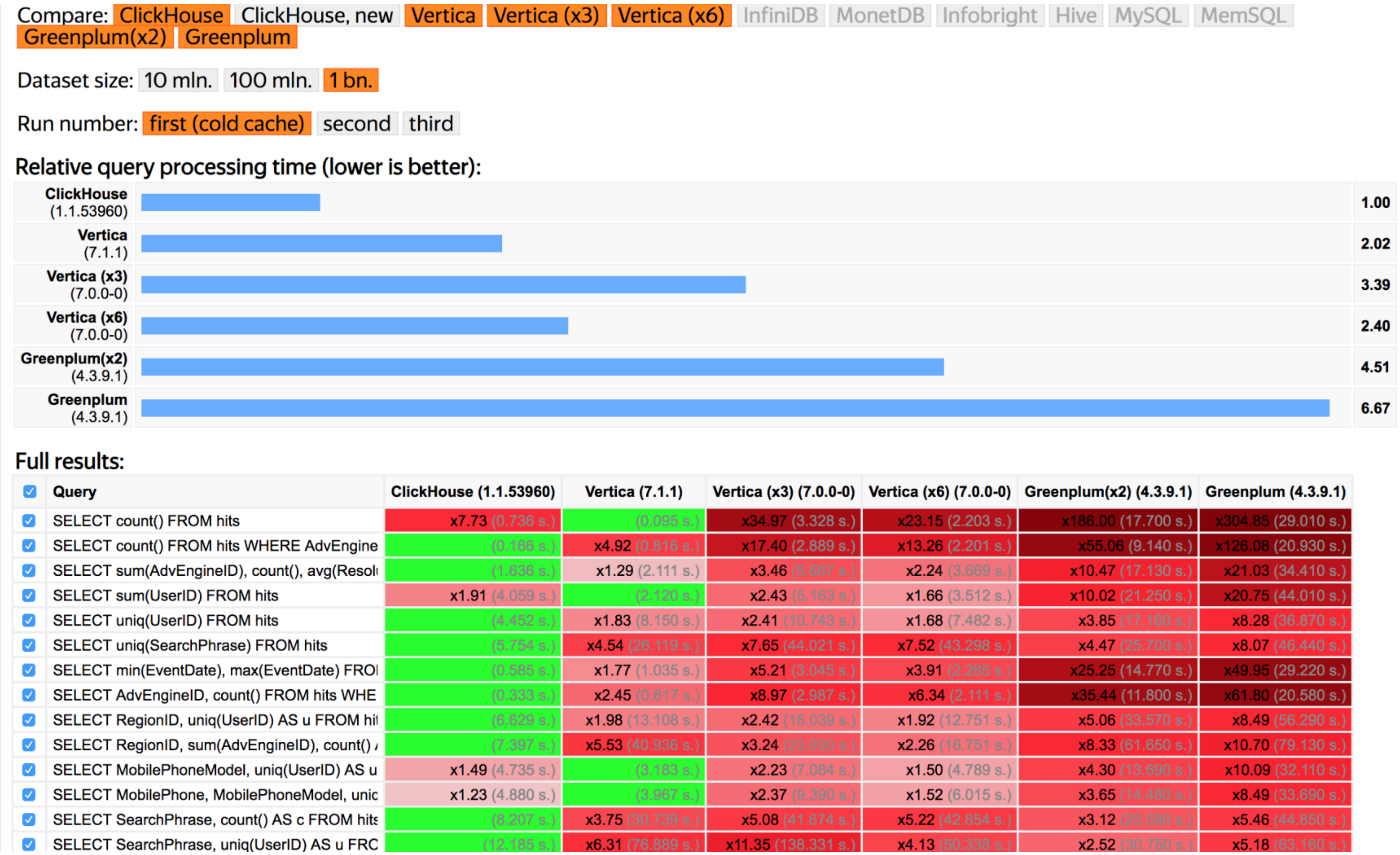


OLAP = RadonDB+ClickHouse

- 分析性相关计算和复杂查询
- 向量化执行引擎和多重优化
- 未来和ClickHouse更深度融合



What is ClickHouse?



Compare: ClickHouse ClickHouse, new Vertica Vertica (x3) Vertica (x6) InfiniDB MonetDB Infobright Hive MySQL MemSQL Greenplum(x2) Greenplum

Dataset size: 10 mln. 100 mln. 1 bn.

Run number: first (cold cache) second third

Relative query processing time (lower is better):

ClickHouse (1.1.53960)	1.00
Vertica (7.1.1)	2.02
Vertica (x3) (7.0.0-0)	3.39
Vertica (x6) (7.0.0-0)	2.40
Greenplum(x2) (4.3.9.1)	4.51
Greenplum (4.3.9.1)	6.67

Full results:

☑	Query	ClickHouse (1.1.53960)	Vertica (7.1.1)	Vertica (x3) (7.0.0-0)	Vertica (x6) (7.0.0-0)	Greenplum(x2) (4.3.9.1)	Greenplum (4.3.9.1)
☑	SELECT count() FROM hits	x7.73 (0.736 s.)	(0.095 s.)	x34.97 (3.328 s.)	x23.15 (2.203 s.)	x186.00 (17.700 s.)	x304.85 (29.010 s.)
☑	SELECT count() FROM hits WHERE AdvEngine	(0.166 s.)	x4.92 (0.816 s.)	x17.40 (2.889 s.)	x13.26 (2.201 s.)	x55.06 (9.140 s.)	x126.08 (20.930 s.)
☑	SELECT sum(AdvEngineID), count(), avg(Resol	(1.636 s.)	x1.29 (2.111 s.)	x3.46 (5.667 s.)	x2.24 (3.669 s.)	x10.47 (17.130 s.)	x21.03 (34.410 s.)
☑	SELECT sum(UserID) FROM hits	x1.91 (4.059 s.)	(2.120 s.)	x2.43 (5.163 s.)	x1.66 (3.512 s.)	x10.02 (21.250 s.)	x20.75 (44.010 s.)
☑	SELECT uniq(UserID) FROM hits	(4.452 s.)	x1.83 (8.150 s.)	x2.41 (10.743 s.)	x1.68 (7.482 s.)	x3.85 (17.160 s.)	x8.28 (36.870 s.)
☑	SELECT uniq(SearchPhrase) FROM hits	(5.754 s.)	x4.54 (26.119 s.)	x7.65 (44.021 s.)	x7.52 (43.298 s.)	x4.47 (25.700 s.)	x8.07 (46.440 s.)
☑	SELECT min(EventDate), max(EventDate) FROI	(0.585 s.)	x1.77 (1.035 s.)	x5.21 (3.045 s.)	x3.91 (2.285 s.)	x25.25 (14.770 s.)	x49.95 (29.220 s.)
☑	SELECT AdvEngineID, count() FROM hits WHE	(0.333 s.)	x2.45 (0.817 s.)	x8.97 (2.987 s.)	x6.34 (2.111 s.)	x35.44 (11.800 s.)	x61.80 (20.580 s.)
☑	SELECT RegionID, uniq(UserID) AS u FROM hi	(6.629 s.)	x1.98 (13.108 s.)	x2.42 (16.039 s.)	x1.92 (12.751 s.)	x5.06 (33.570 s.)	x8.49 (56.290 s.)
☑	SELECT RegionID, sum(AdvEngineID), count() /	(7.397 s.)	x5.53 (40.936 s.)	x3.24 (23.930 s.)	x2.26 (16.751 s.)	x8.33 (61.650 s.)	x10.70 (79.130 s.)
☑	SELECT MobilePhoneModel, uniq(UserID) AS u	x1.49 (4.735 s.)	(3.183 s.)	x2.23 (7.084 s.)	x1.50 (4.789 s.)	x4.30 (13.690 s.)	x10.09 (32.110 s.)
☑	SELECT MobilePhone, MobilePhoneModel, unic	x1.23 (4.880 s.)	(3.967 s.)	x2.37 (9.390 s.)	x1.52 (6.015 s.)	x3.65 (14.480 s.)	x8.49 (33.690 s.)
☑	SELECT SearchPhrase, count() AS c FROM hits	(8.207 s.)	x3.75 (30.739 s.)	x5.08 (41.674 s.)	x5.22 (42.854 s.)	x3.12 (25.590 s.)	x5.46 (44.850 s.)
☑	SELECT SearchPhrase, uniq(UserID) AS u FRC	(12.185 s.)	x6.31 (76.889 s.)	x11.35 (138.331 s.)	x4.13 (50.338 s.)	x2.52 (30.750 s.)	x5.18 (63.160 s.)

https://clickhouse.yandex/benchmark.html

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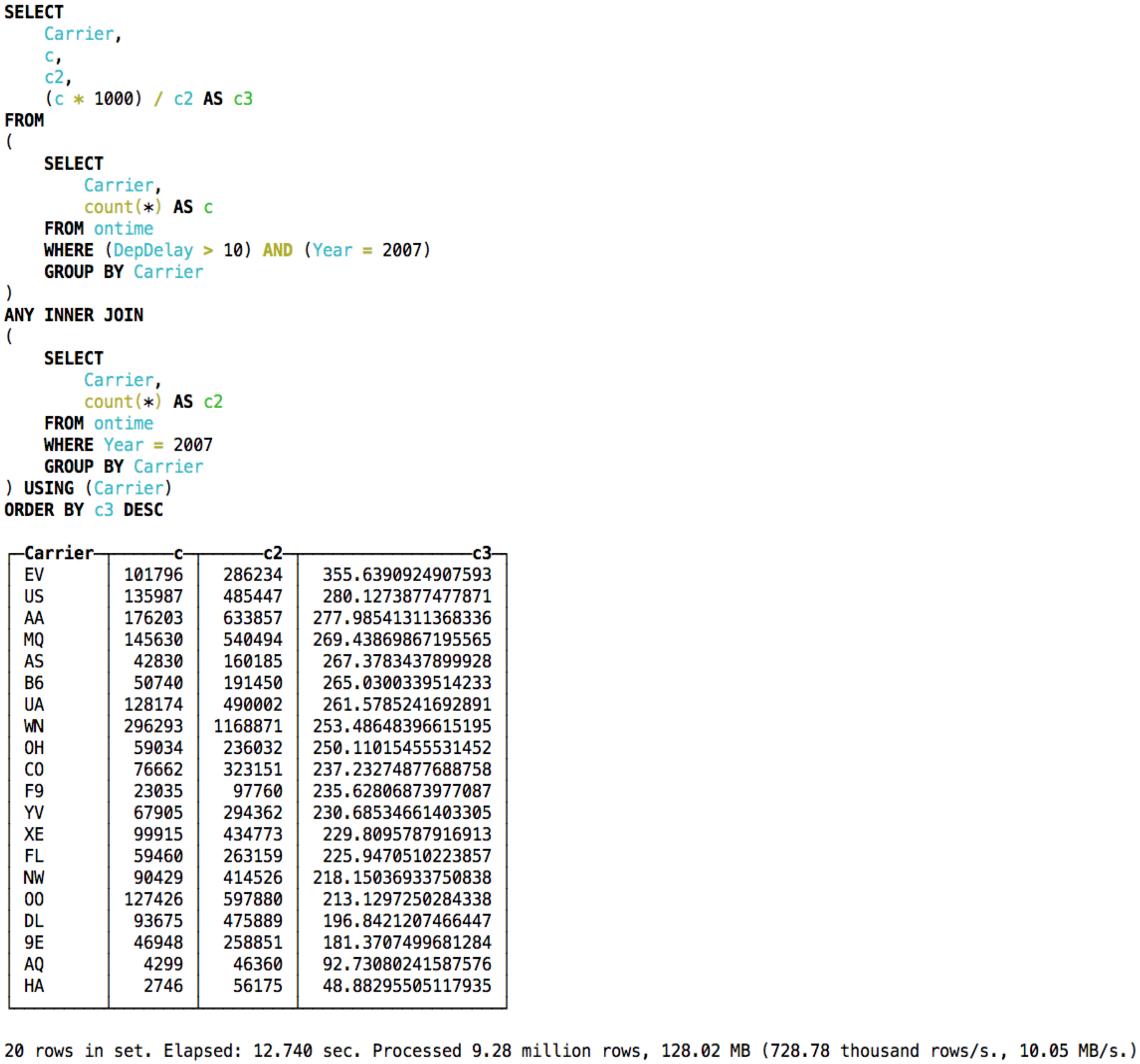


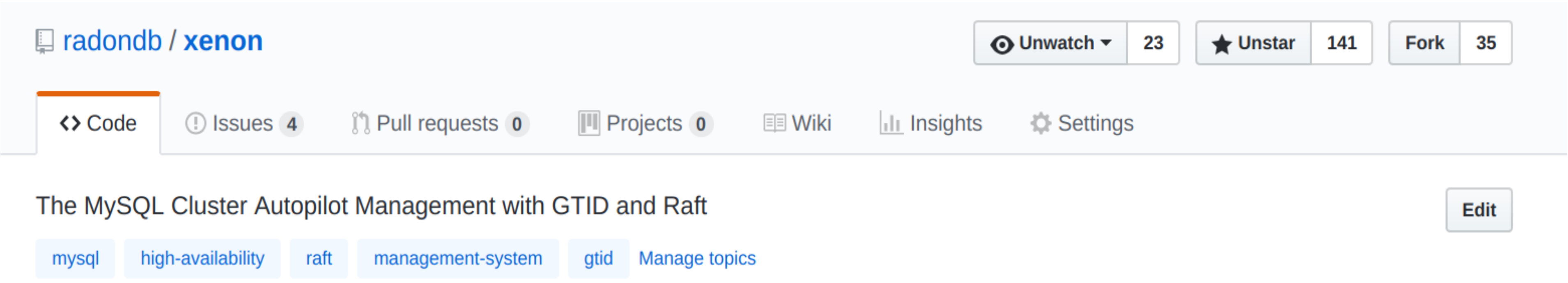
```
SELECT
    Carrier,
    c,
    c2,
    (c * 1000) / c2 AS c3
FROM
(
    SELECT
        Carrier,
        count(*) AS c
    FROM ontime
    WHERE (DepDelay > 10) AND (Year = 2007)
    GROUP BY Carrier
)
ANY INNER JOIN
(
    SELECT
        Carrier,
        count(*) AS c2
    FROM ontime
    WHERE Year = 2007
    GROUP BY Carrier
) USING (Carrier)
ORDER BY c3 DESC

┌─Carrier─┬──────c─┬──────c2─┬───────────────c3─┐
│ EV      │ 101796 │  286234 │ 355.6390924907593 │
│ US      │ 135987 │  485447 │ 280.1273877477871 │
│ AA      │ 176203 │  633857 │ 277.98541311368336 │
│ MQ      │ 145630 │  540494 │ 269.43869867195565 │
│ AS      │  42830 │  160185 │ 267.3783437899928 │
│ B6      │  50740 │  191450 │ 265.0300339514233 │
│ UA      │ 128174 │  490002 │ 261.5785241692891 │
│ WN      │ 296293 │ 1168871 │ 253.48648396615195 │
│ OH      │  59034 │  236032 │ 250.11015455531452 │
│ CO      │  76662 │  323151 │ 237.23274877688758 │
│ F9      │  23035 │   97760 │ 235.62806873977087 │
│ YV      │  67905 │  294362 │ 230.68534661403305 │
│ XE      │  99915 │  434773 │ 229.8095787916913 │
│ FL      │  59460 │  263159 │ 225.9470510223857 │
│ NW      │  90429 │  414526 │ 218.15036933750838 │
│ OO      │ 127426 │  597880 │ 213.1297250284338 │
│ DL      │  93675 │  475889 │ 196.8421207466447 │
│ 9E      │  46948 │  258851 │ 181.3707499681284 │
│ AQ      │   4299 │   46360 │ 92.73080241587576 │
│ HA      │   2746 │   56175 │ 48.88295505117935 │
└─────────┴────────┴─────────┴──────────────────┘

20 rows in set. Elapsed: 12.740 sec. Processed 9.28 million rows, 128.02 MB (728.78 thousand rows/s., 10.05 MB/s.)
```

4核8G 1.5亿数据， 109列，美国航空飞行数据

xenon

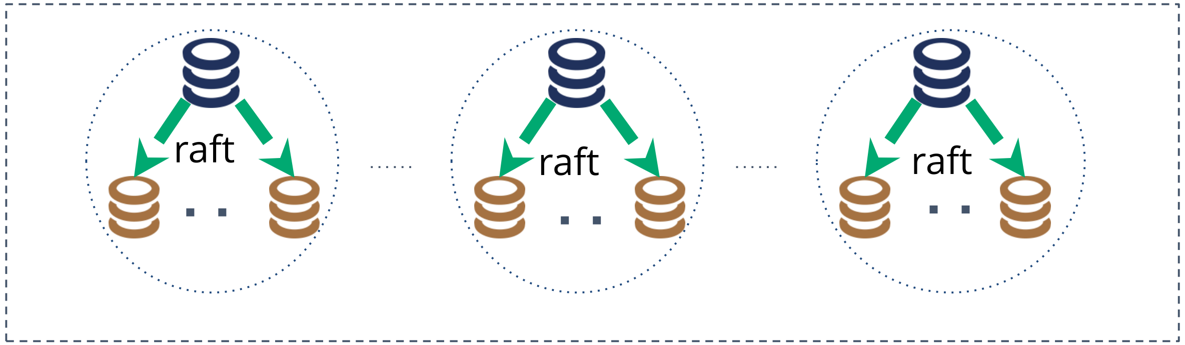

radondb / xenon

The MySQL Cluster Autopilot Management with GTID and Raft

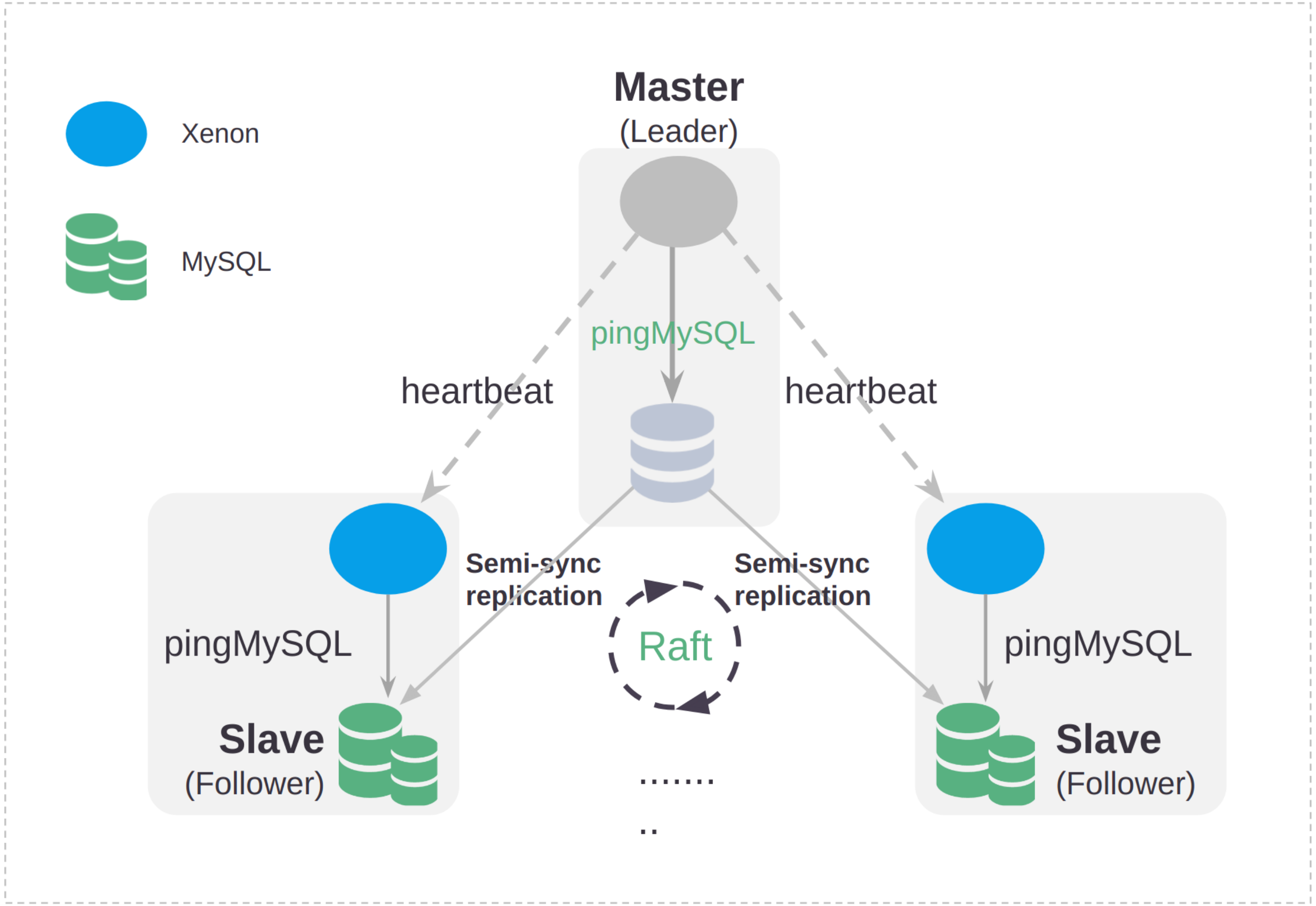
Storage Nodes

- 存储层由多个 node 组成
- 每个node 由多副本组成
- 每个副本为一个 **MySQL**
- 不仅存储还有计算能力

Storage Nodes

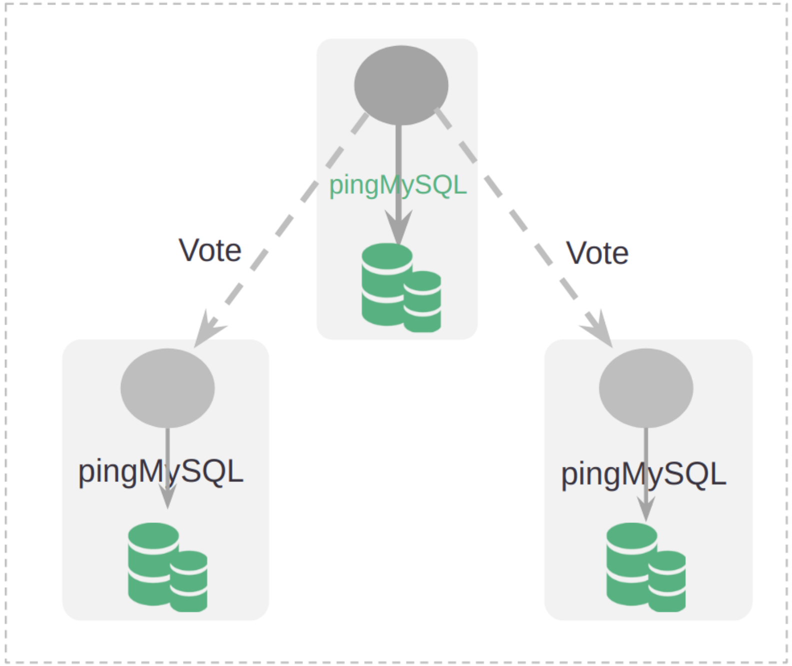


Xenon架构

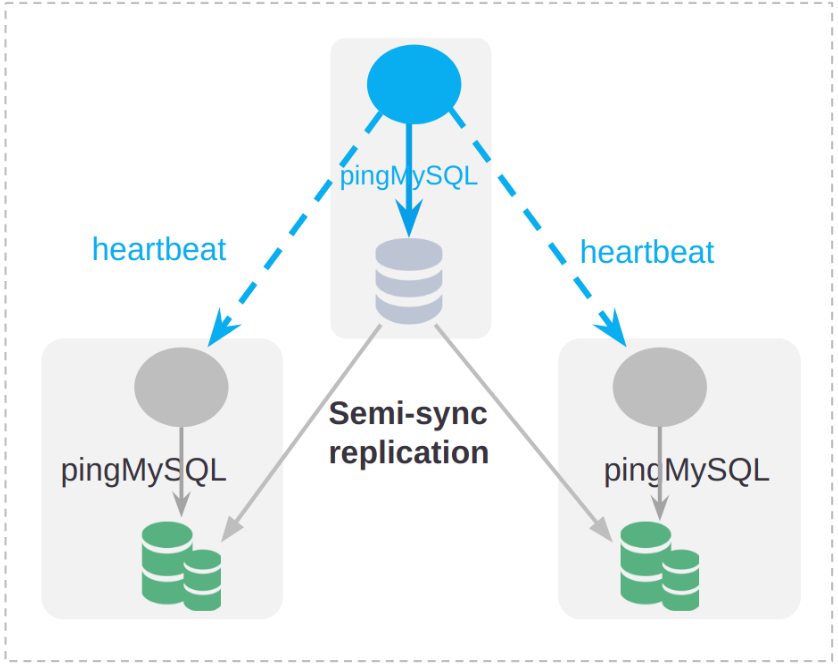


Xenon
MySQL
Master
(Leader)
pingMySQL
heartbeat
heartbeat
Semi-sync
replication
Semi-sync
replication
Raft
pingMySQL
pingMySQL
Slave
(Follower)
Slave
(Follower)
....
..

初始状态

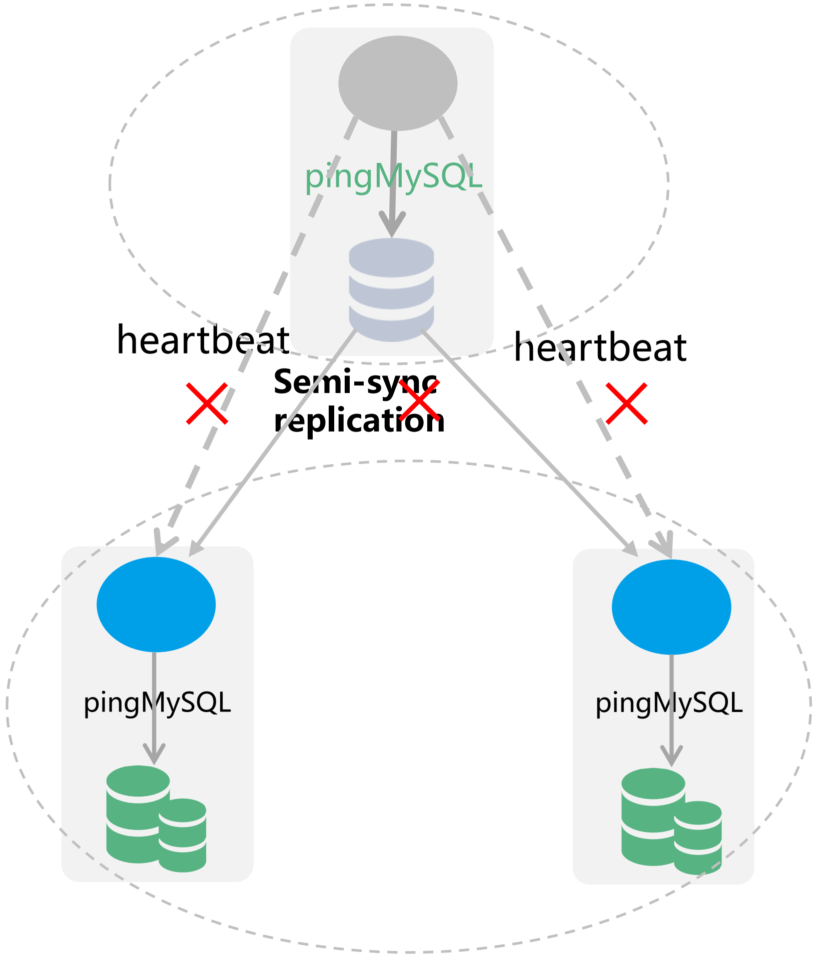


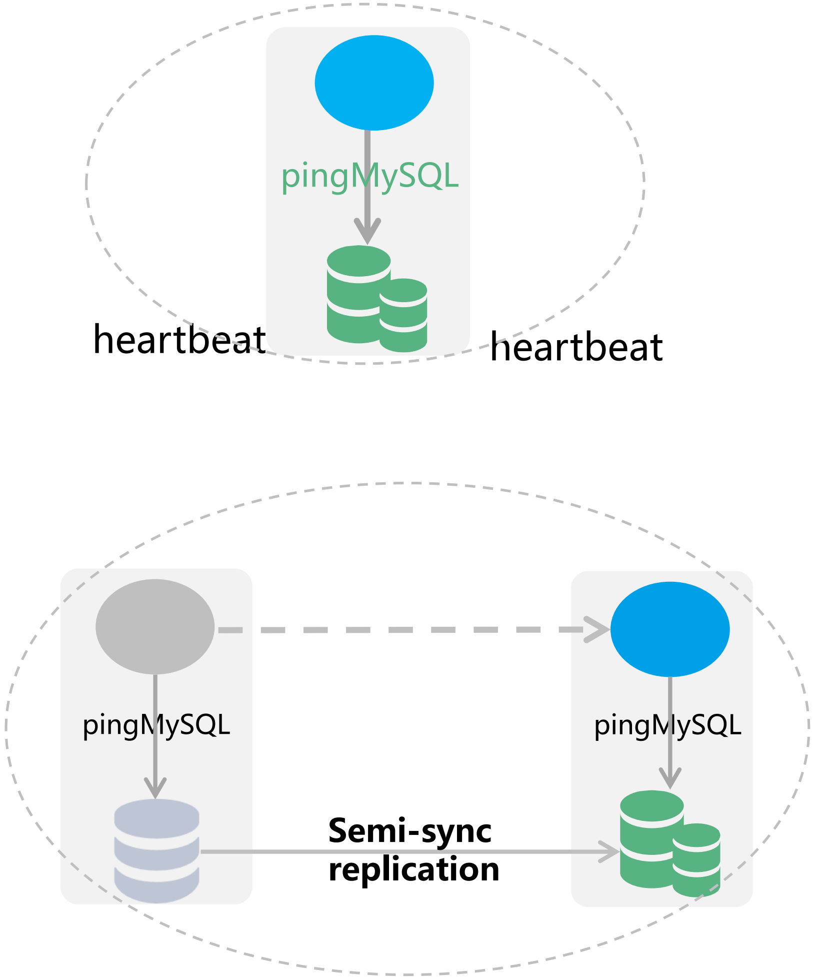
发起选举



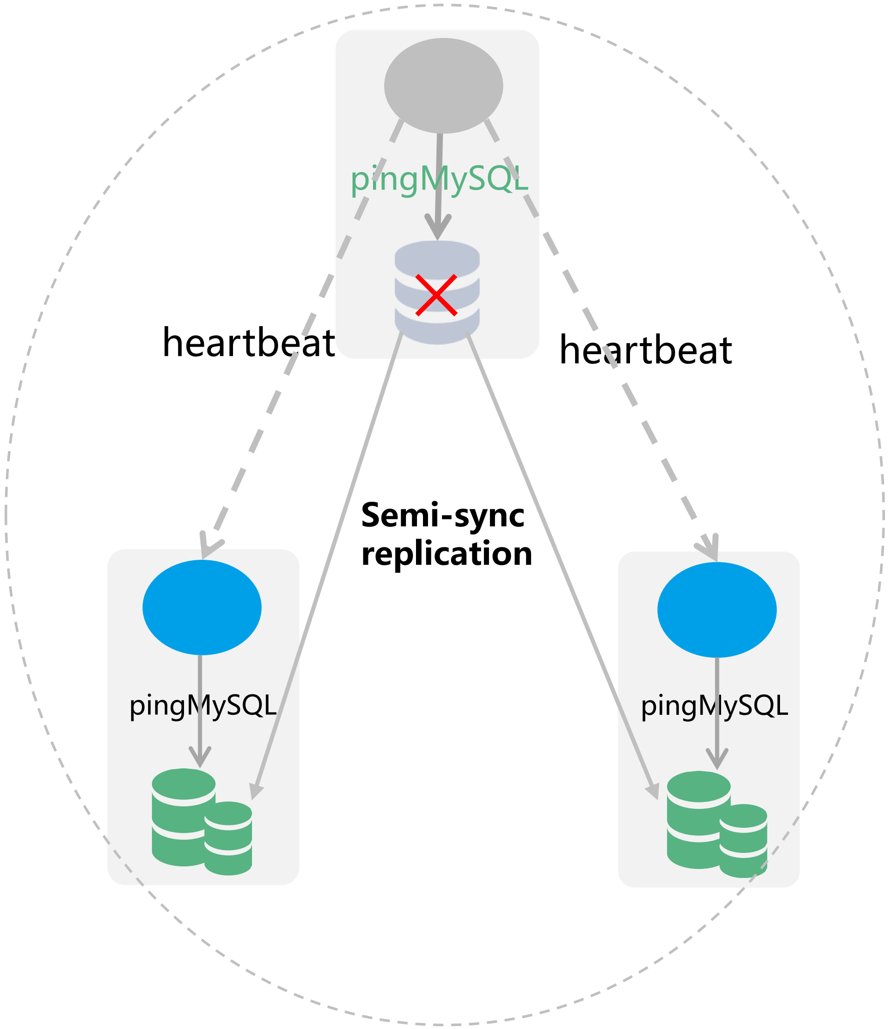
当选为Leader

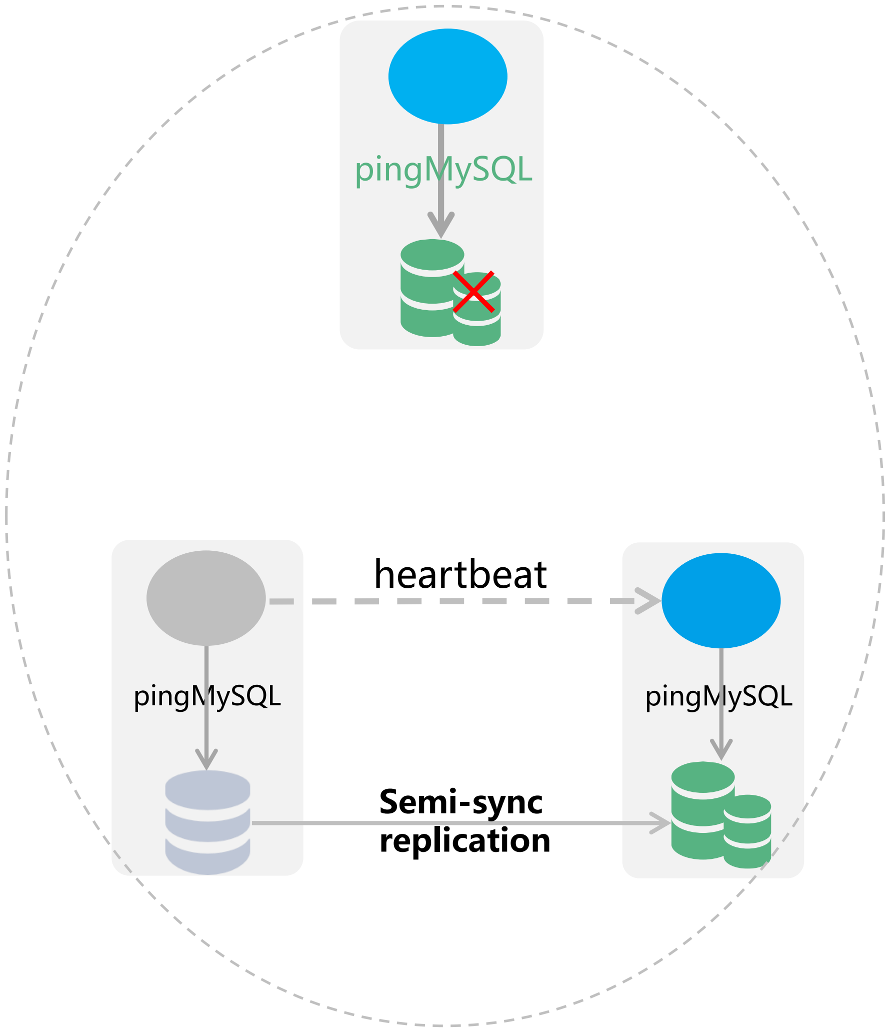
网络隔离


pingMySQL
heartbeat
heartbeat
Semi-sync
replication
pingMySQL
pingMySQL


pingMySQL
heartbeat
heartbeat
pingMySQL
pingMySQL
Semi-sync
replication

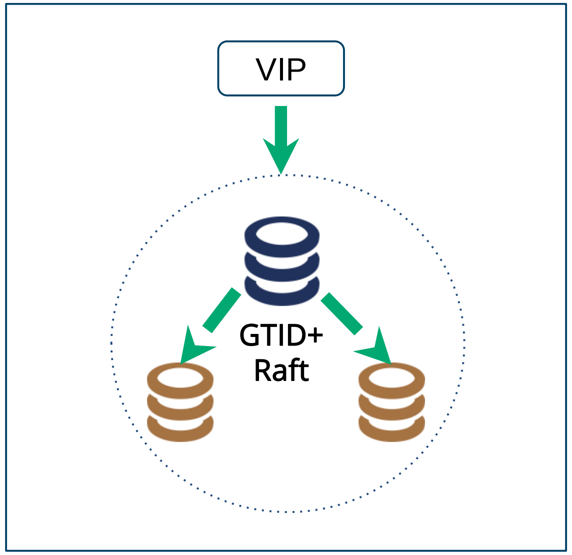
Leader 故障

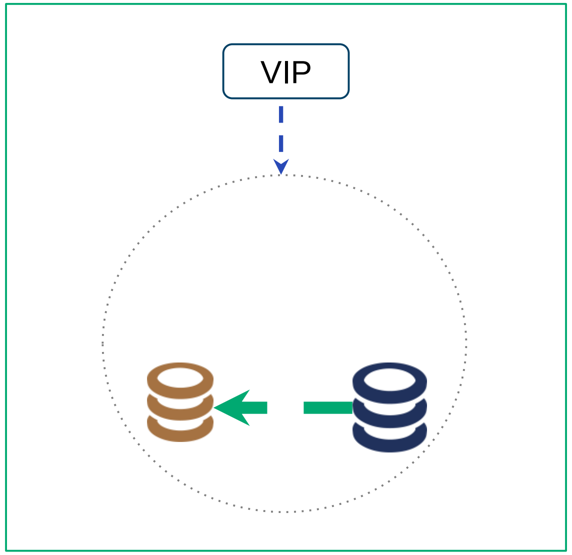

pingMySQL
heartbeat
heartbeat
Semi-sync
replication
pingMySQL
pingMySQL


pingMySQL
heartbeat
pingMySQL
pingMySQL
Semi-sync
replication

高可用

- GTID 作为 Raft Log Index
- Raft 协议选主、Log 并行复制
- 主副本故障秒级切换即可服务
- 强 Semi-Sync 确保事务不丢失
- 单副本故障可快速流式重建
- 无中心化，可跨机房部署





Raft + MySQL = Raft 选主 + GTID 并行复制 + 强 Semi-Sync

数据强一致、切换零丢失

性能

sysbench: 16表，512线程，随机写，5000万条数据

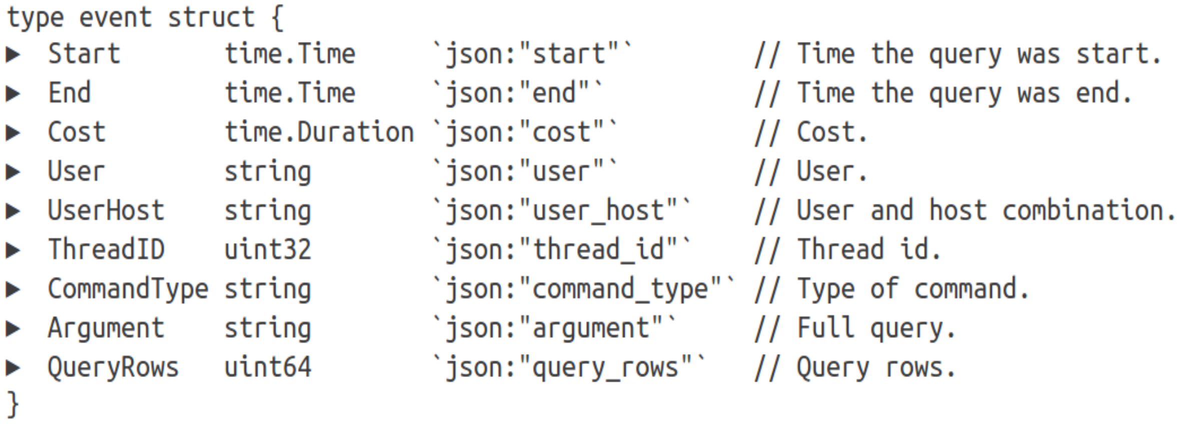
	Transaction Per Second(TPS)	Response Time(avg)	规格

RadonDB
(1SQL节点，4 存储节点)
	26,589	**20ms**	4 存储节点(16C64G超高性能主机)
			sync_binlog=1
			innodb_flush_log_at_trx_commit=1

单机 MySQL
(QingCloud RDB)
	9,346	73ms	RDB(16C64G超高性能主机)
			sync_binlog=1
			innodb_flush_log_at_trx_commit=1

审计日志

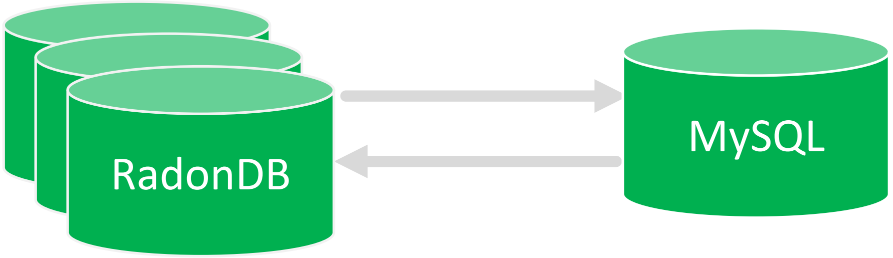
- 支持多种审计模式
- 可定位慢查询等



```
type event struct {
▶  Start       time.Time     `json:"start"`       // Time the query was start.
▶  End         time.Time     `json:"end"`         // Time the query was end.
▶  Cost        time.Duration `json:"cost"`        // Cost.
▶  User        string        `json:"user"`        // User.
▶  UserHost    string        `json:"user_host"`   // User and host combination.
▶  ThreadID    uint32        `json:"thread_id"`   // Thread id.
▶  CommandType string        `json:"command_type"`// Type of command.
▶  Argument    string        `json:"argument"`    // Full query.
▶  QueryRows   uint64        `json:"query_rows"`  // Query rows.
}
```

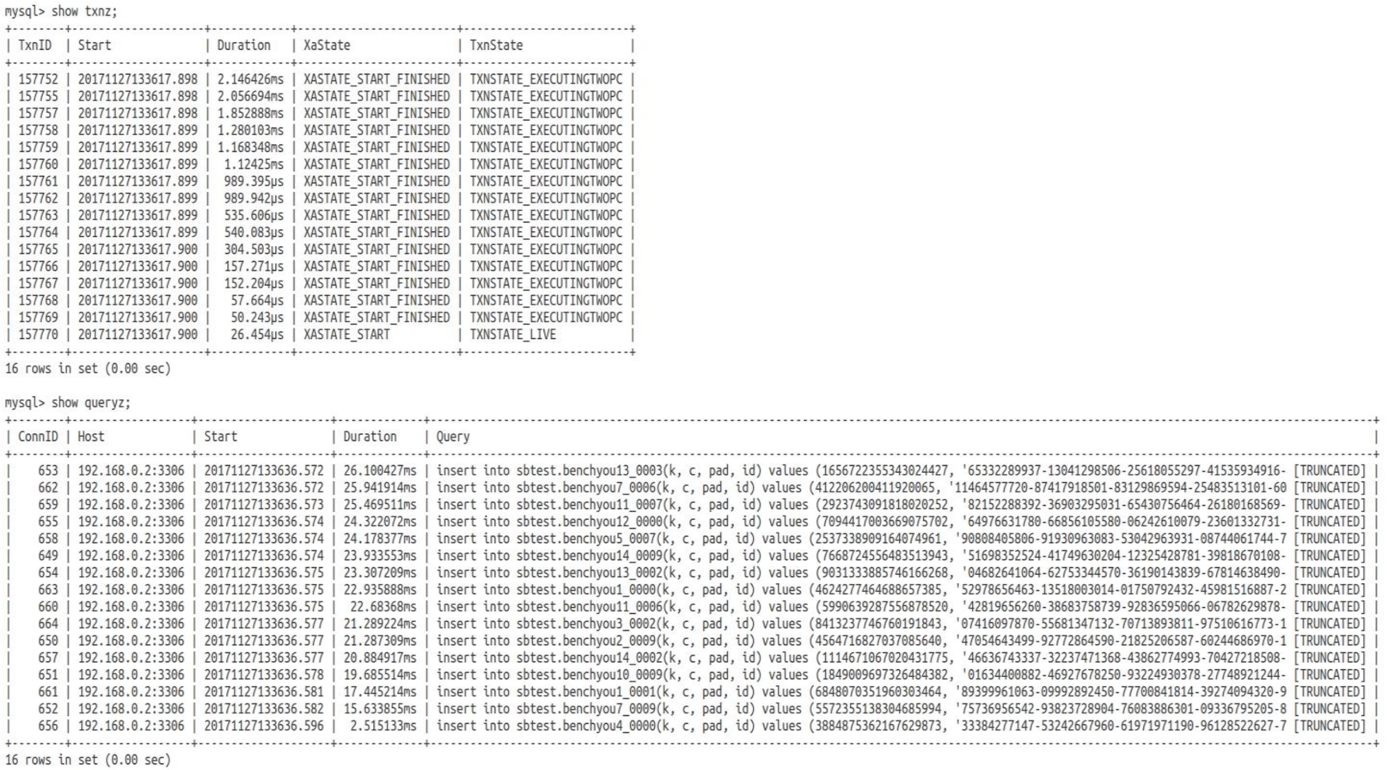
Backup & restore

- xelabs/go-mydumper
- 批量并行流式导出
- 批量并行导入
- 在线数据同步工具



监控信息

- 全链路监控
- mysql> show processlist;
- mysql> show txnz;
- mysql> show queryz;

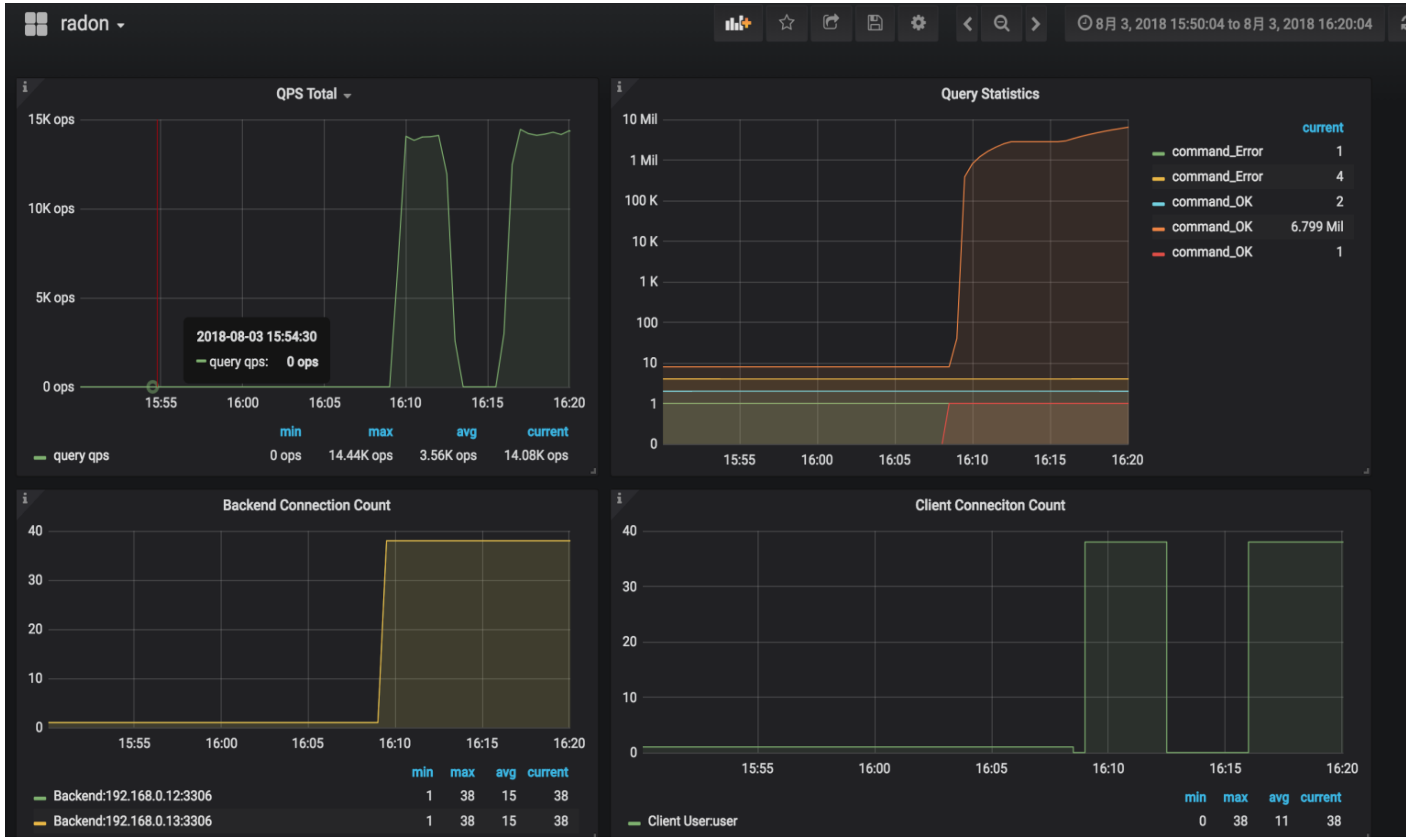


```
mysql> show txnz;
+--------+--------------------+------------+------------------------+-------------------------+
| TxnID  | Start              | Duration   | XaState                | TxnState                |
+--------+--------------------+------------+------------------------+-------------------------+
| 157752 | 20171127133617.898 | 2.146426ms | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157755 | 20171127133617.898 | 2.056694ms | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157757 | 20171127133617.898 | 1.852888ms | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157758 | 20171127133617.899 | 1.280103ms | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157759 | 20171127133617.899 | 1.168348ms | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157760 | 20171127133617.899 |  1.12425ms | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157761 | 20171127133617.899 |  989.395μs | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157762 | 20171127133617.899 |  989.942μs | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157763 | 20171127133617.899 |  535.606μs | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157764 | 20171127133617.899 |  540.083μs | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157765 | 20171127133617.900 |  304.503μs | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157766 | 20171127133617.900 |  157.271μs | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157767 | 20171127133617.900 |  152.204μs | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157768 | 20171127133617.900 |   57.664μs | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157769 | 20171127133617.900 |   50.243μs | XASTATE_START_FINISHED | TXNSTATE_EXECUTINGTWOPC |
| 157770 | 20171127133617.900 |   26.454μs | XASTATE_START          | TXNSTATE_LIVE           |
+--------+--------------------+------------+------------------------+-------------------------+
16 rows in set (0.00 sec)

mysql> show queryz;
+--------+------------------+--------------------+-------------+----------------------------------------------------------------------------------------------------------------------------------------------+
| ConnID | Host             | Start              | Duration    | Query                                                                                                                                        |
+--------+------------------+--------------------+-------------+----------------------------------------------------------------------------------------------------------------------------------------------+
|    653 | 192.168.0.2:3306 | 20171127133636.572 | 26.100427ms | insert into sbtest.benchyou13_0003(k, c, pad, id) values (1656722355343024427, '65332289937-13041298506-25618055297-41535934916- [TRUNCATED] |
|    662 | 192.168.0.2:3306 | 20171127133636.572 | 25.941914ms | insert into sbtest.benchyou7_0006(k, c, pad, id) values (412206200411920065, '11464577720-87417918501-83129869594-25483513101-60 [TRUNCATED] |
|    659 | 192.168.0.2:3306 | 20171127133636.573 | 25.469511ms | insert into sbtest.benchyou11_0007(k, c, pad, id) values (2923743091818020252, '82152288392-36903295031-65430756464-26180168569- [TRUNCATED] |
|    655 | 192.168.0.2:3306 | 20171127133636.574 | 24.322072ms | insert into sbtest.benchyou12_0000(k, c, pad, id) values (7094417003669075702, '64976631780-66856105580-06242610079-23601332731- [TRUNCATED] |
|    658 | 192.168.0.2:3306 | 20171127133636.574 | 24.178377ms | insert into sbtest.benchyou5_0007(k, c, pad, id) values (2537338909164074961, '90808405806-91930963083-53042963931-08744061744-7 [TRUNCATED] |
|    649 | 192.168.0.2:3306 | 20171127133636.574 | 23.933553ms | insert into sbtest.benchyou14_0009(k, c, pad, id) values (7668724556483513943, '51698352524-41749630204-12325428781-39818670108- [TRUNCATED] |
|    654 | 192.168.0.2:3306 | 20171127133636.575 | 23.307209ms | insert into sbtest.benchyou13_0002(k, c, pad, id) values (9031333885746166268, '04682641064-62753344570-36190143839-67814638490- [TRUNCATED] |
|    663 | 192.168.0.2:3306 | 20171127133636.575 | 22.935888ms | insert into sbtest.benchyou1_0000(k, c, pad, id) values (4624277464688657385, '52978656463-13518003014-01750792432-45981516887-2 [TRUNCATED] |
|    660 | 192.168.0.2:3306 | 20171127133636.575 |  22.68368ms | insert into sbtest.benchyou11_0006(k, c, pad, id) values (5990639287556878520, '42819656260-38683758739-92836595066-06782629878- [TRUNCATED] |
|    664 | 192.168.0.2:3306 | 20171127133636.577 | 21.289224ms | insert into sbtest.benchyou3_0002(k, c, pad, id) values (8413237746760191843, '07416097870-55681347132-70713893811-97510616773-1 [TRUNCATED] |
|    650 | 192.168.0.2:3306 | 20171127133636.577 | 21.287309ms | insert into sbtest.benchyou2_0009(k, c, pad, id) values (4564716827037085640, '47054643499-92772864590-21825206587-60244686970-1 [TRUNCATED] |
|    657 | 192.168.0.2:3306 | 20171127133636.577 | 20.884917ms | insert into sbtest.benchyou14_0002(k, c, pad, id) values (1114671067020431775, '46636743337-32237471368-43862774993-70427218508- [TRUNCATED] |
|    651 | 192.168.0.2:3306 | 20171127133636.578 | 19.685514ms | insert into sbtest.benchyou10_0009(k, c, pad, id) values (1849009697326484382, '01634400882-46927678250-93224930378-27748921244- [TRUNCATED] |
|    661 | 192.168.0.2:3306 | 20171127133636.581 | 17.445214ms | insert into sbtest.benchyou1_0001(k, c, pad, id) values (6848070351960303464, '89399961063-09992892450-77700841814-39274094320-9 [TRUNCATED] |
|    652 | 192.168.0.2:3306 | 20171127133636.582 | 15.633855ms | insert into sbtest.benchyou7_0009(k, c, pad, id) values (5572355138304685994, '75736956542-93823728904-76083886301-09336795205-8 [TRUNCATED] |
|    656 | 192.168.0.2:3306 | 20171127133636.596 |  2.515133ms | insert into sbtest.benchyou4_0000(k, c, pad, id) values (3884875362167629873, '33384277147-53242667960-61971971190-96128522627-7 [TRUNCATED] |
+--------+------------------+--------------------+-------------+----------------------------------------------------------------------------------------------------------------------------------------------+
16 rows in set (0.00 sec)
```

监控图形化展示

- Radon代码程序中定制需要的Metric
- 开源时序数据库Prometheus作为监控和性能指标信息存储方案
- 使用Grafana作为可视化组件进行展示



	min	max	avg	current
query qps	0 ops	14.44K ops	3.56K ops	14.08K ops

	current
command_Error	1
command_Error	4
command_OK	2
command_OK	6.799 Mil
command_OK	1

	min	max	avg	current
Backend:192.168.0.12:3306	1	38	15	38
Backend:192.168.0.13:3306	1	38	15	38

	min	max	avg	current
Client User:user	0	38	11	38

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radondb.io

代码地址
https://github.com/radondb

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