MySQL Group Replication 深度剖析及实践

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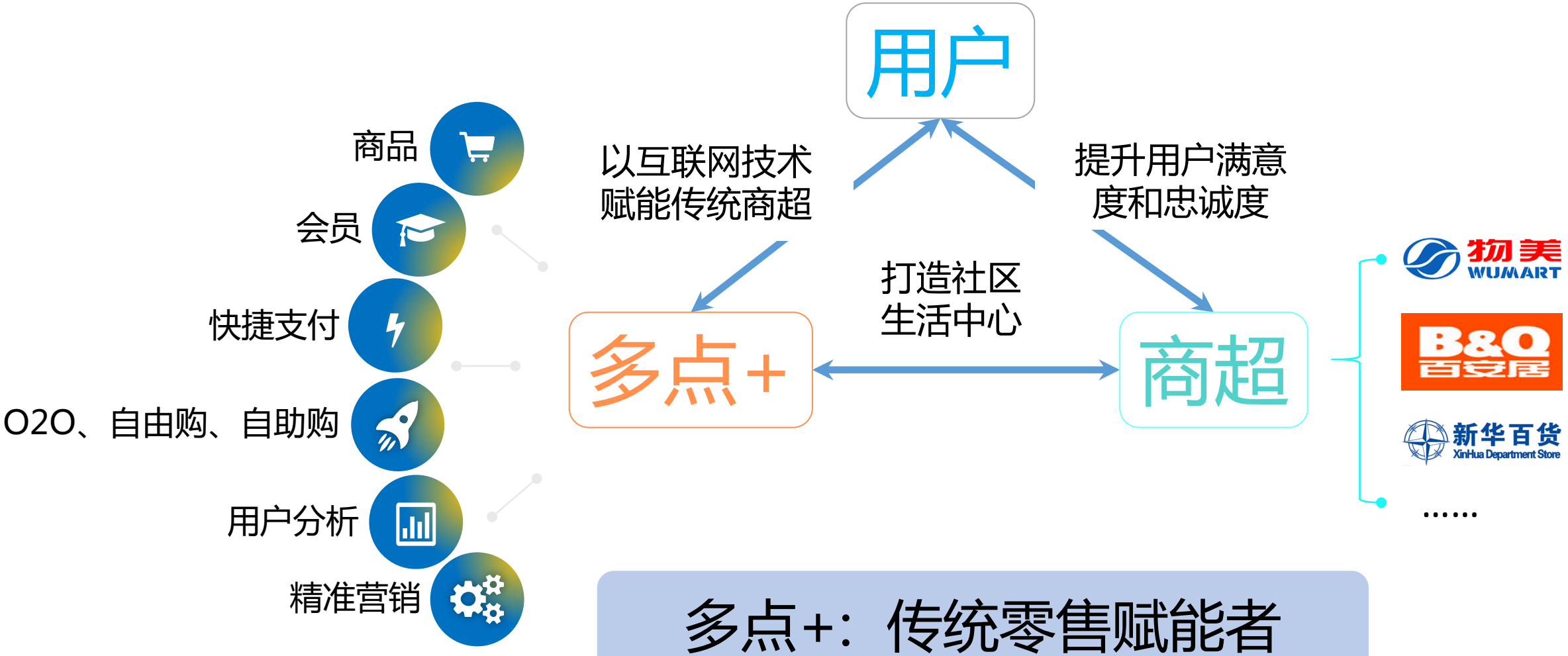
2018-08-11

About me

- 『前』阿里MySQL内核研发
  - Thread pool / Statement timeout
  - SELECT … FROM UPDATE / Thread running ctl
  - TokuDB / Galera Cluster
- 多点数据库负责人
  - MySQL、PG、Redis、MongoDB
  - 自动化运维平台

多点 dmall.com

About 多点Dmall



多点+：传统零售赋能者

主要内容

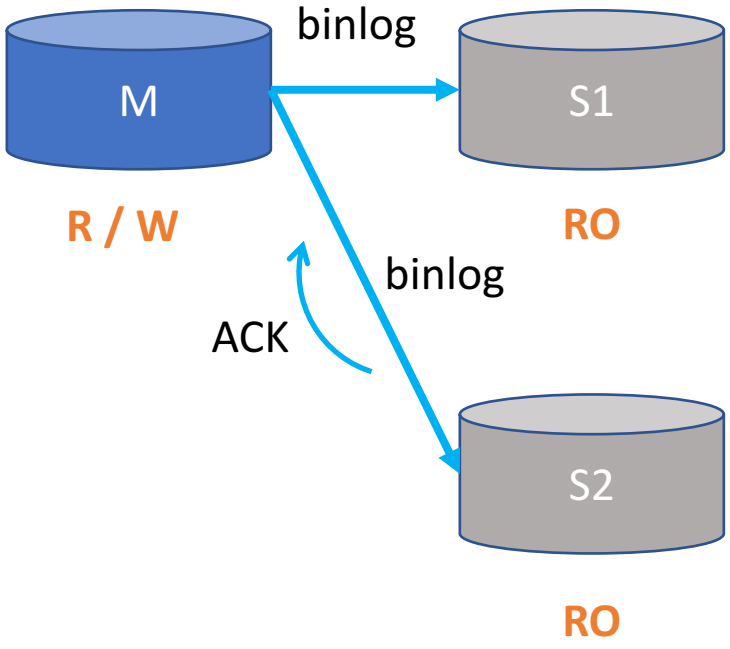
- MGR特性
- 集群整体架构
- 集群数据同步、冲突检测、流控
- 集群性能分析
- 适用场景及实践
- Q & A

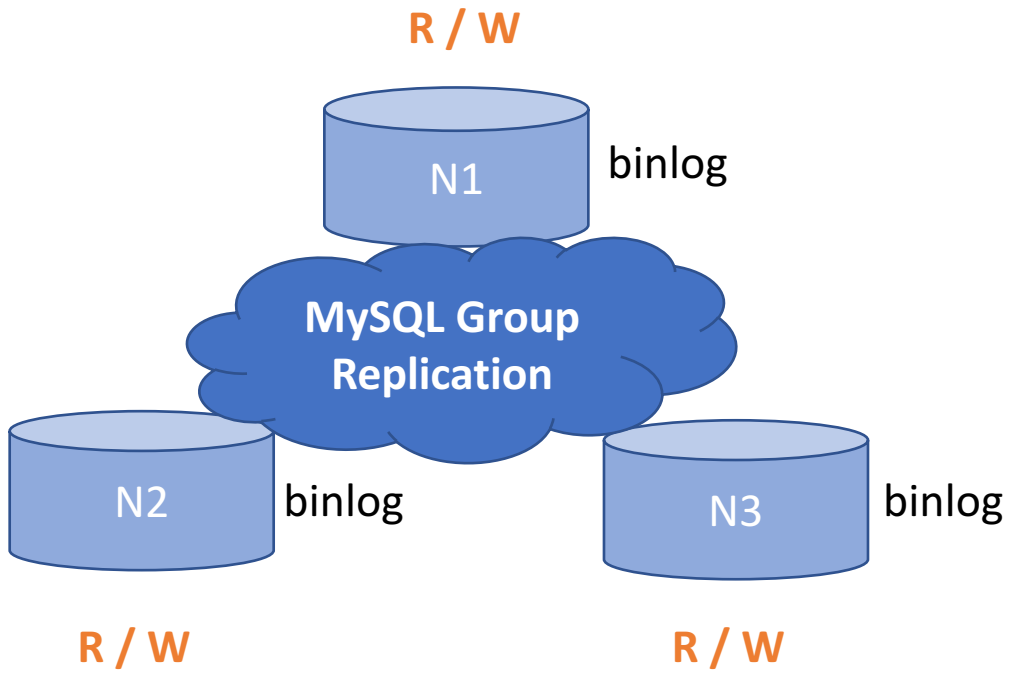
MGR特性

高可用	准同步复制	多节点写	分布式集群
• 自动failover • 不丢数据	• 大多数节点ACK • 最终一致 • 延迟控制	• 自动冲突检测 • Single Primary	• Share Nothing • Paxos • As a plugin

MGR集群架构

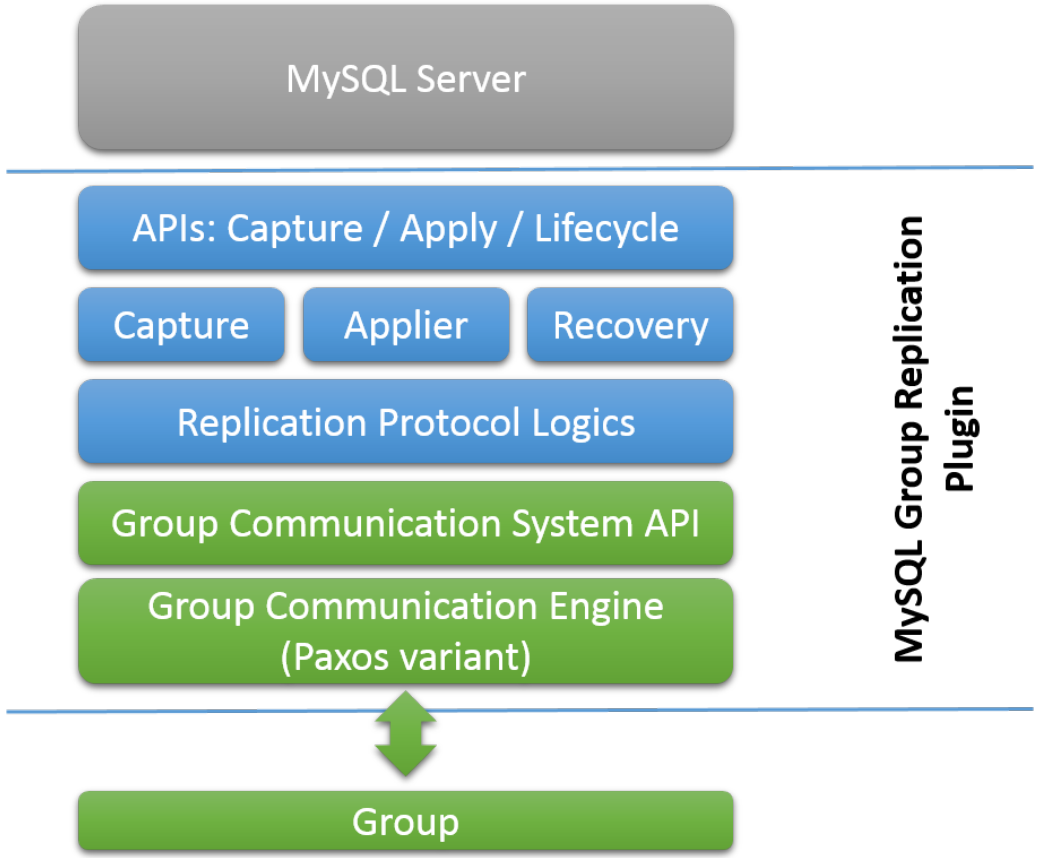
- 原生异步复制/半同步复制 VS. MGR

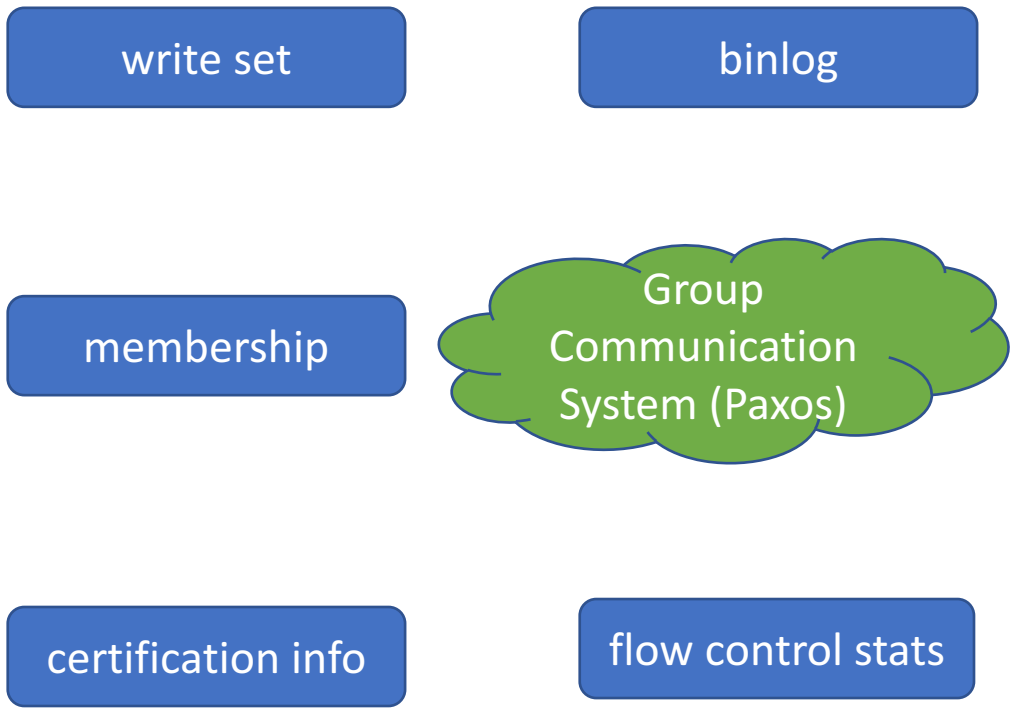




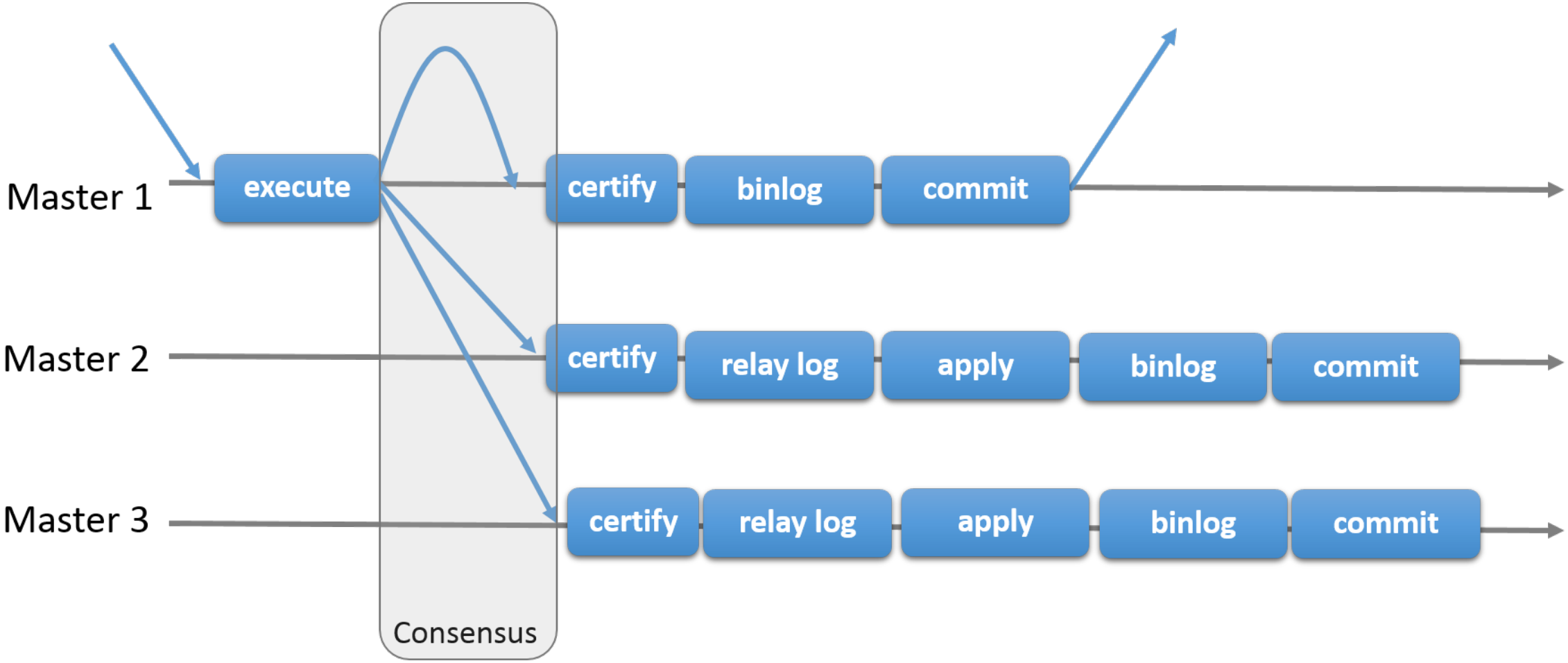
MGR集群架构

- Group Communication System （**GCS**）





MGR集群同步 / replication



MGR集群同步 / replication

数据一致性保证

- State Machine
  - 分布式系统中，各节点执行相同的数据变更序列，状态最终一致
  - **Paxos协议**

- Certification
  - 各节点独立执行冲突检测，并执行后续动作，不需要其他节点ACK
  - **数据变更中包含事务上下文信息**，各节点冲突检测结果一致

MGR集群同步 / replication

- Write set
  - 事务更新涉及的 Primary key / Unique key 集合
- Transaction context log event
  - *std::list<const char*> write_set;*

```
-- sql/handler.cc
int handler::ha_write_row / ha_update_row / ha_delete_row
int binlog_log_row
   -- sql/rpl_write_set_handler.cc
   void add_pke
     static void generate_hash_pke
     thd->get_transaction()->get_transaction_write_set_ctx()->add_write_set(hash);
```

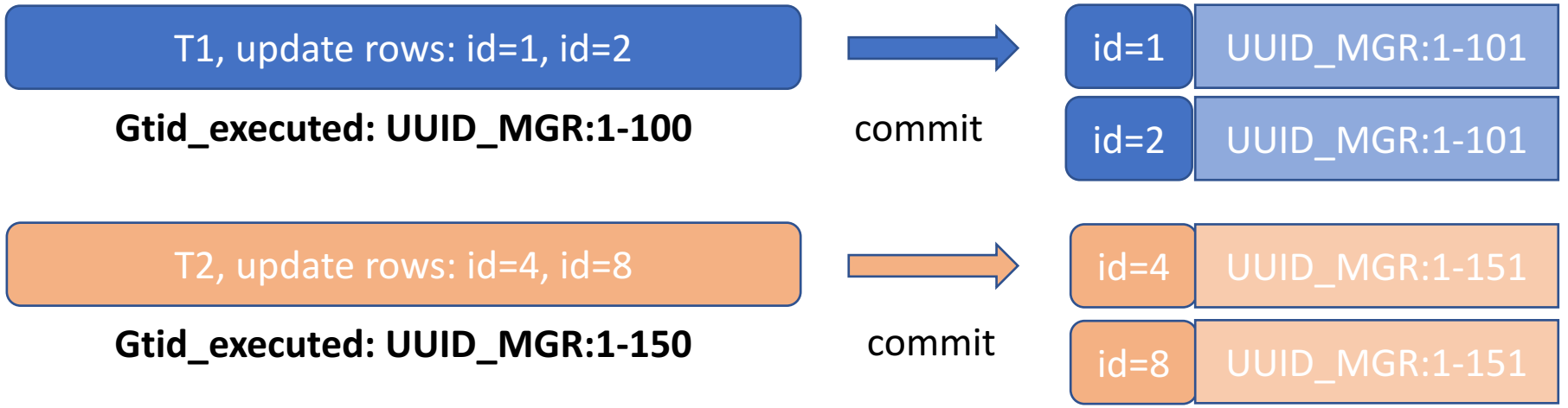
MGR集群同步 / replication

```
-- rapid/plugin/group_replication/src/observer_trans.cc
int group_replication_trans_before_commit(Trans_param *param)

  Transaction_write_set* write_set= get_transaction_write_set(param->thread_id);
  add_write_set(tcle, write_set);
  tcle->write(cache);              // 1. Write transaction context to group replication cache.
  gle->write(cache);               // 2. Write Gtid log event to group replication cache.
  transaction_msg.append_cache(cache);              // 3. Copy group replication cache to buffer.
  transaction_msg.append_cache(cache_log);          // 4. Copy binlog cache content to buffer.

  certification_latch->registerTicket(param->thread_id);
  applier_module->get_flow_control_module()->do_wait();// 5. Flow control step
  gcs_module->send_message(transaction_msg);              // 6. Broadcast Transaction Message
  certification_latch->waitTicket(param->thread_id);      // 7. Waiting for certifier's notify
```

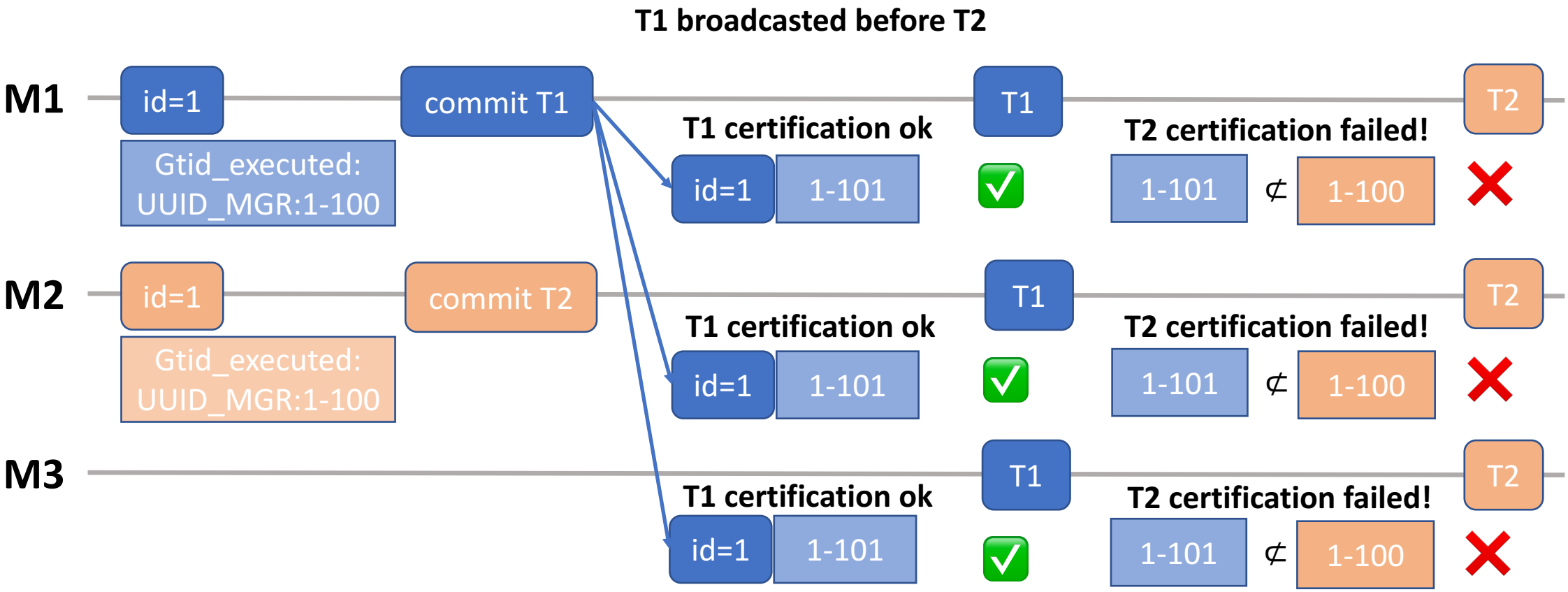
MGR集群冲突检测 / certification

- Certificatio info
  - 已通过冲突检测的write set及其**快照版本**
    - ***typedef std::map<std::string, Gtid_set_ref*> Certification_info;***
  - certification通过条件：

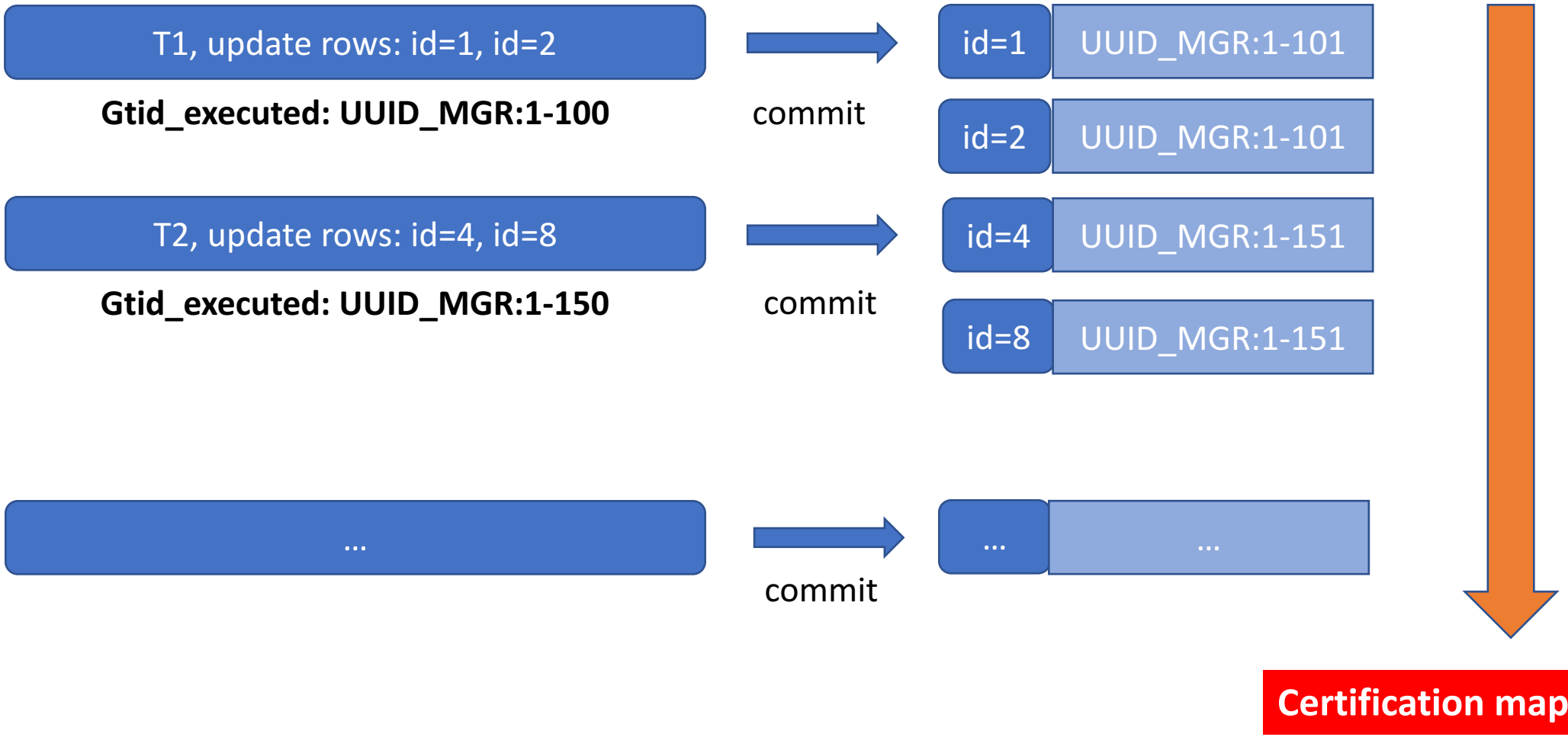
certification info snapshot version ⊂ **transaction write set snapshot version**



MGR集群冲突检测 / certification

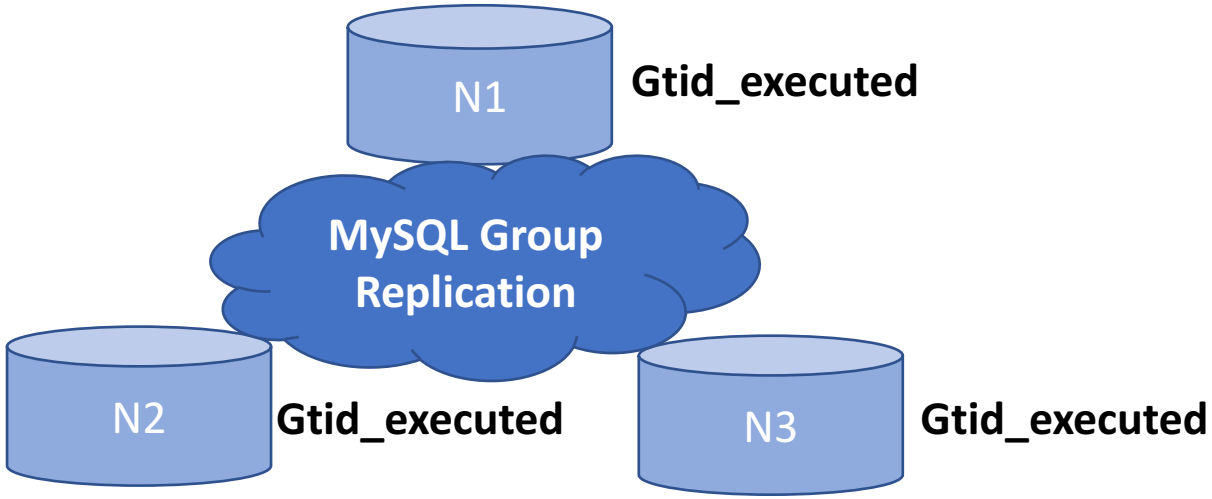


MGR集群流控 / certification



MGR集群流控 / certification

- 节点之间定期交换事务执行信息
  - Gtid_executed
  - 每60s



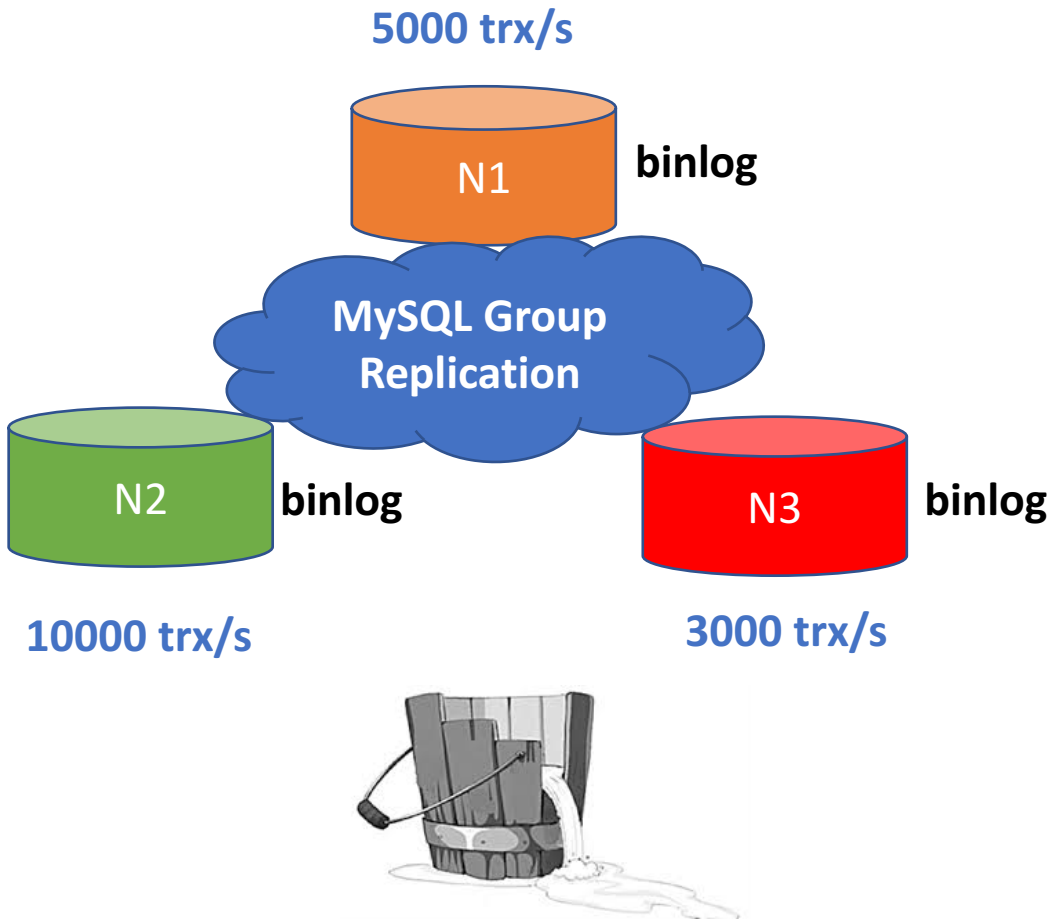
- Certification map GC
  - Minimal Gtid_executed of all nodes
  - Purge:

certification info snapshot version ⊂ **Minimal gtid_executed**

MGR集群流控 / flow control

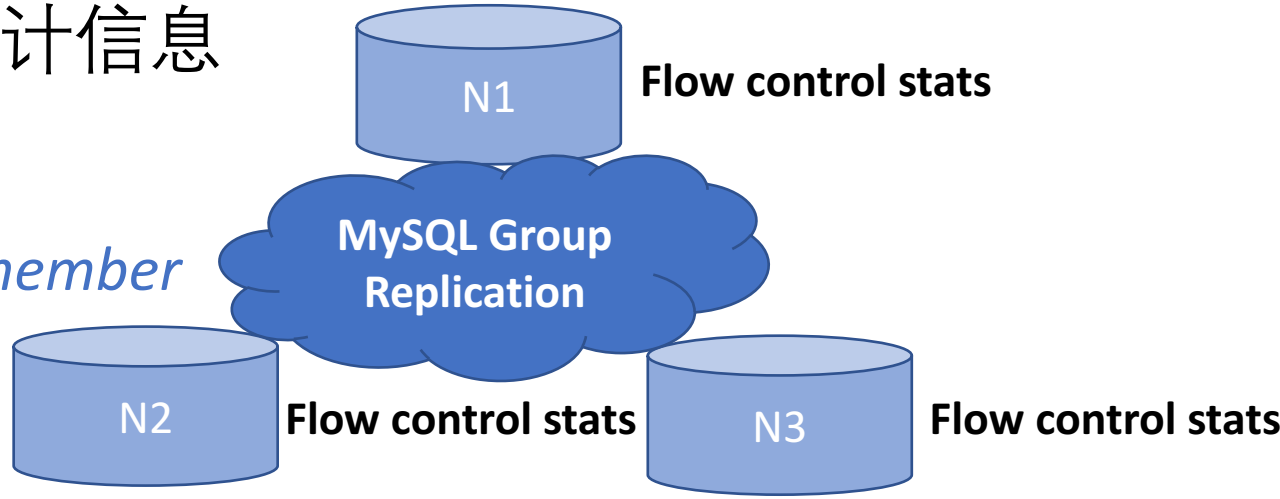
- 各节点性能不完全一致
- 各节点异步 certification / apply

- Flow control
  - 保证集群延迟可控
  - 读写分离场景
  - 集群性能：木桶原理



MGR集群流控 / flow control

- 节点之间定期交换flow control统计信息
  - *certifier queue size*
  - *replication applier queue size*
  - *total # of remote trx applied in the member*
  - *total # of trx certified*
  - *total # of local transactions*



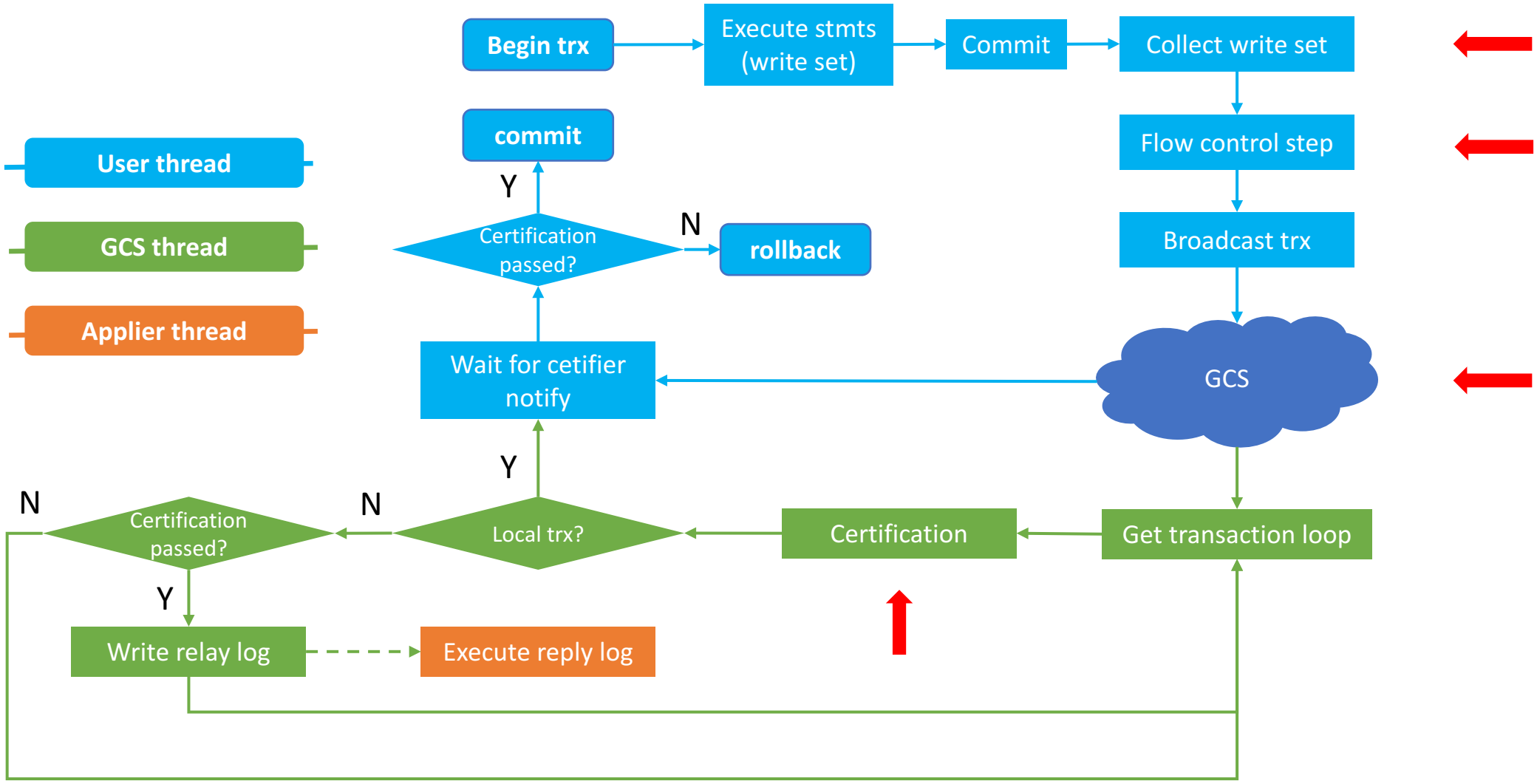
- 计算出最慢的节点处理能力 (N trx/s)

- 节点事务配额：Quota = **0.9** * (N / # of write nodes)

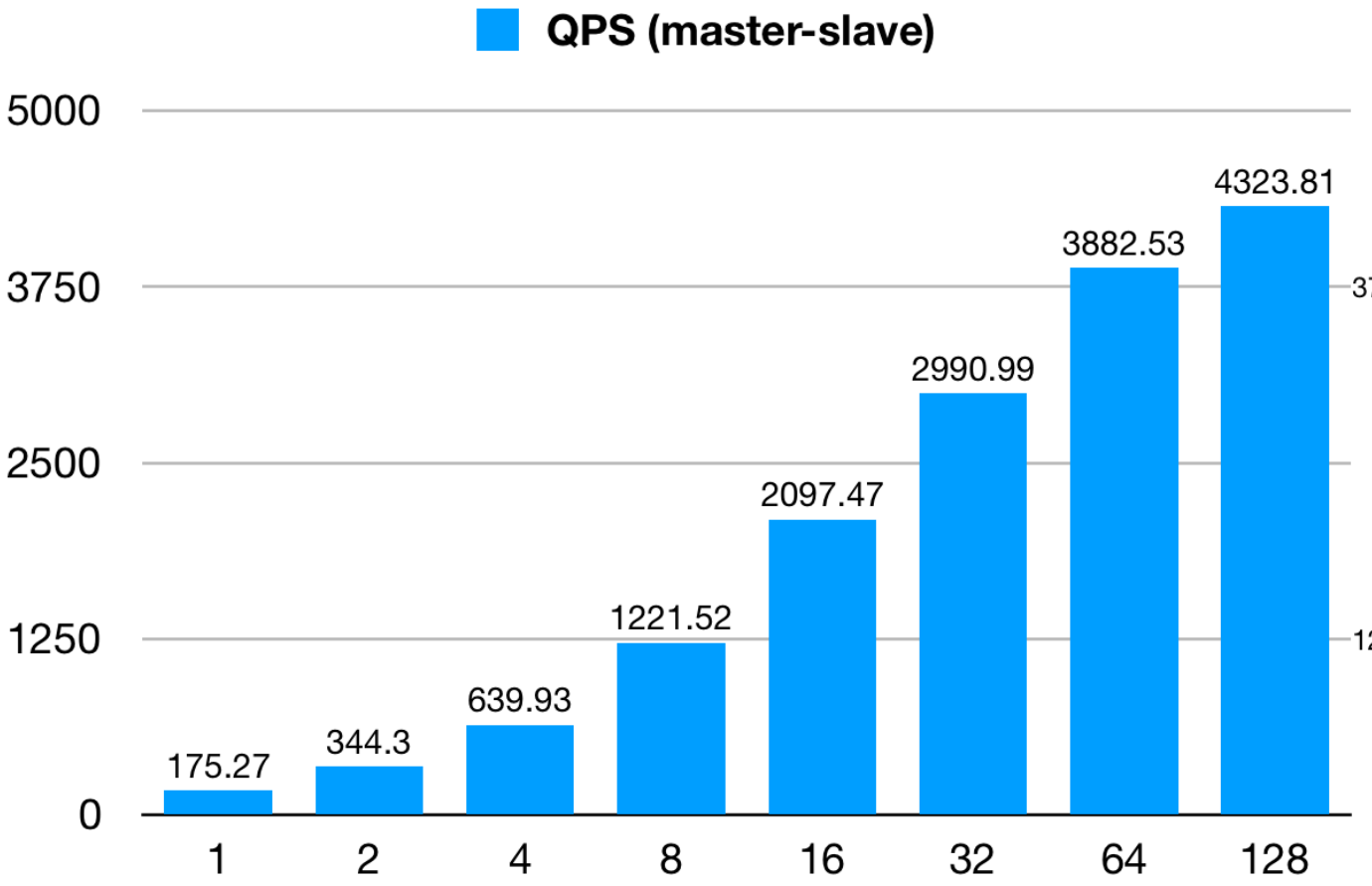
MGR集群流控 / flow control

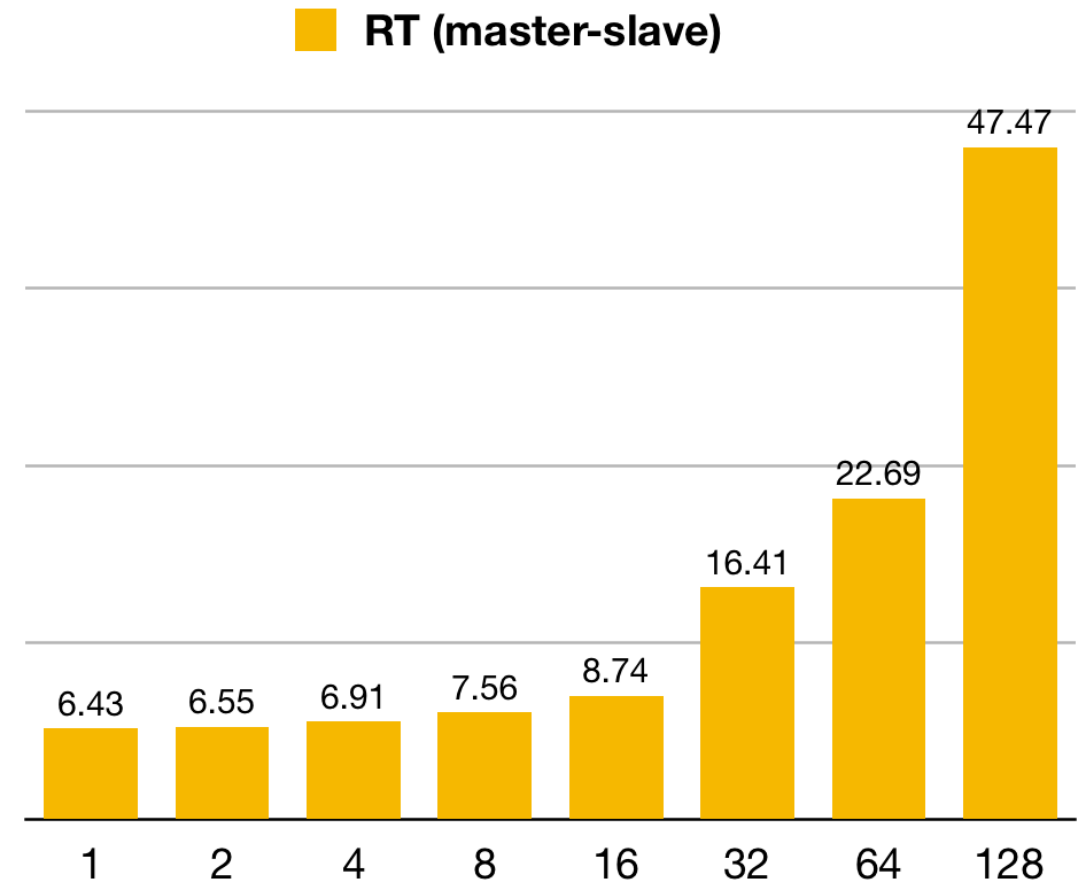
- group_replication_flow_control_mode
  - QUOTA / DISABLED
- group_replication_flow_control_certifier_threshold
  - default: 25000
- group_replication_flow_control_applier_threshold
  - default: 25000
- group_replication_flow_control_hold_percent
  - default: 10

MGR集群性能分析

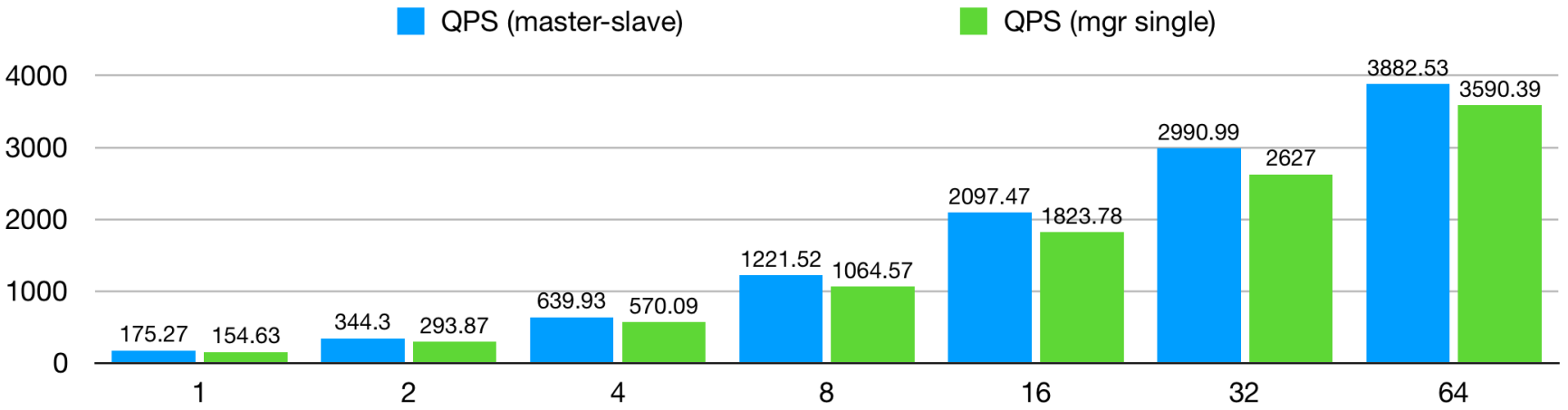

Begin trx
Execute stmts (write set)
Commit
Collect write set
Flow control step
Broadcast trx
GCS
Get transaction loop
Certification
Local trx?
Certification passed?
Write relay log
Execute reply log
Wait for cetifier notify
Certification passed?
rollback
commit
Y
N
User thread
GCS thread
Applier thread

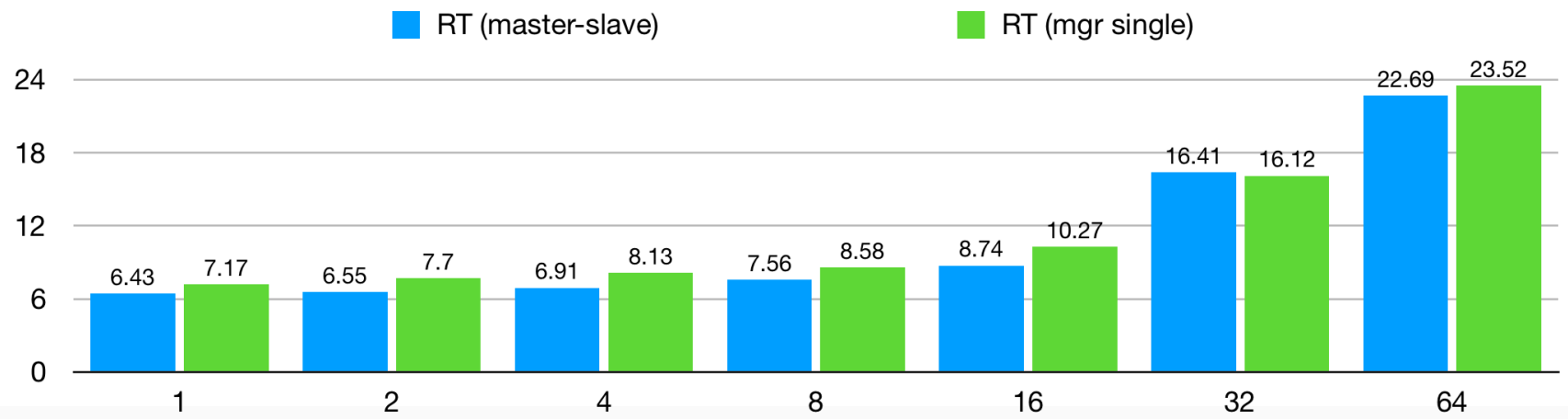
MGR集群性能分析


QPS (master-slave)
5000
3750
2500
1250
0
175.27
344.3
639.93
1221.52
2097.47
2990.99
3882.53
4323.81
1
2
4
8
16
32
64
128

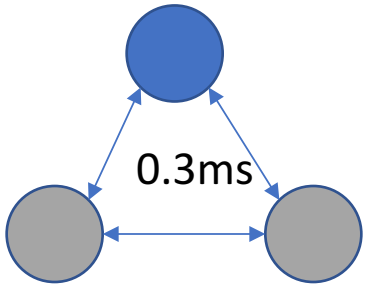

RT (master-slave)
50
37.5
25
12.5
0
6.43
6.55
6.91
7.56
8.74
16.41
22.69
47.47
1
2
4
8
16
32
64
128

MGR集群性能分析

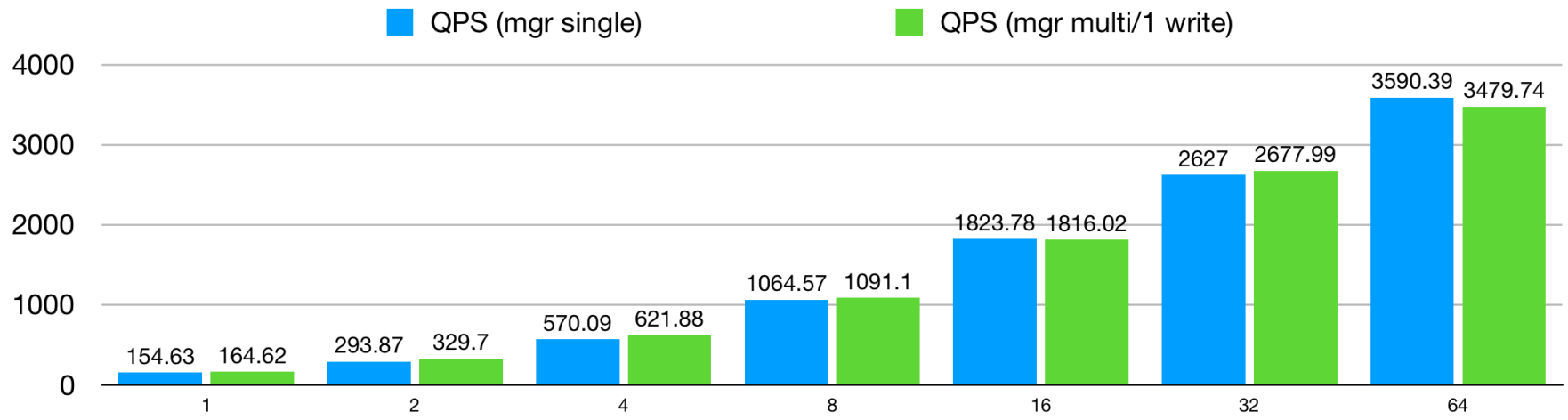


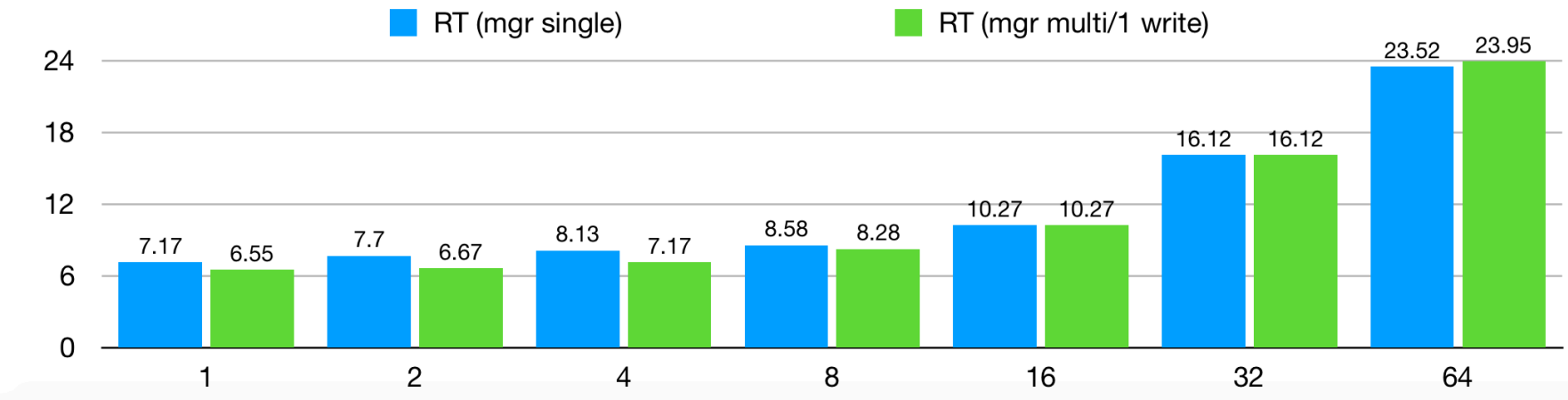


92%

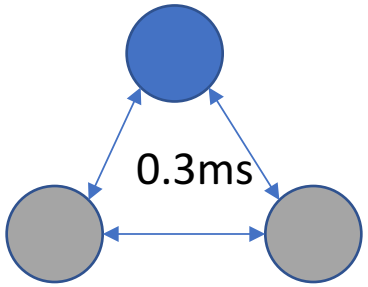


MGR集群性能分析

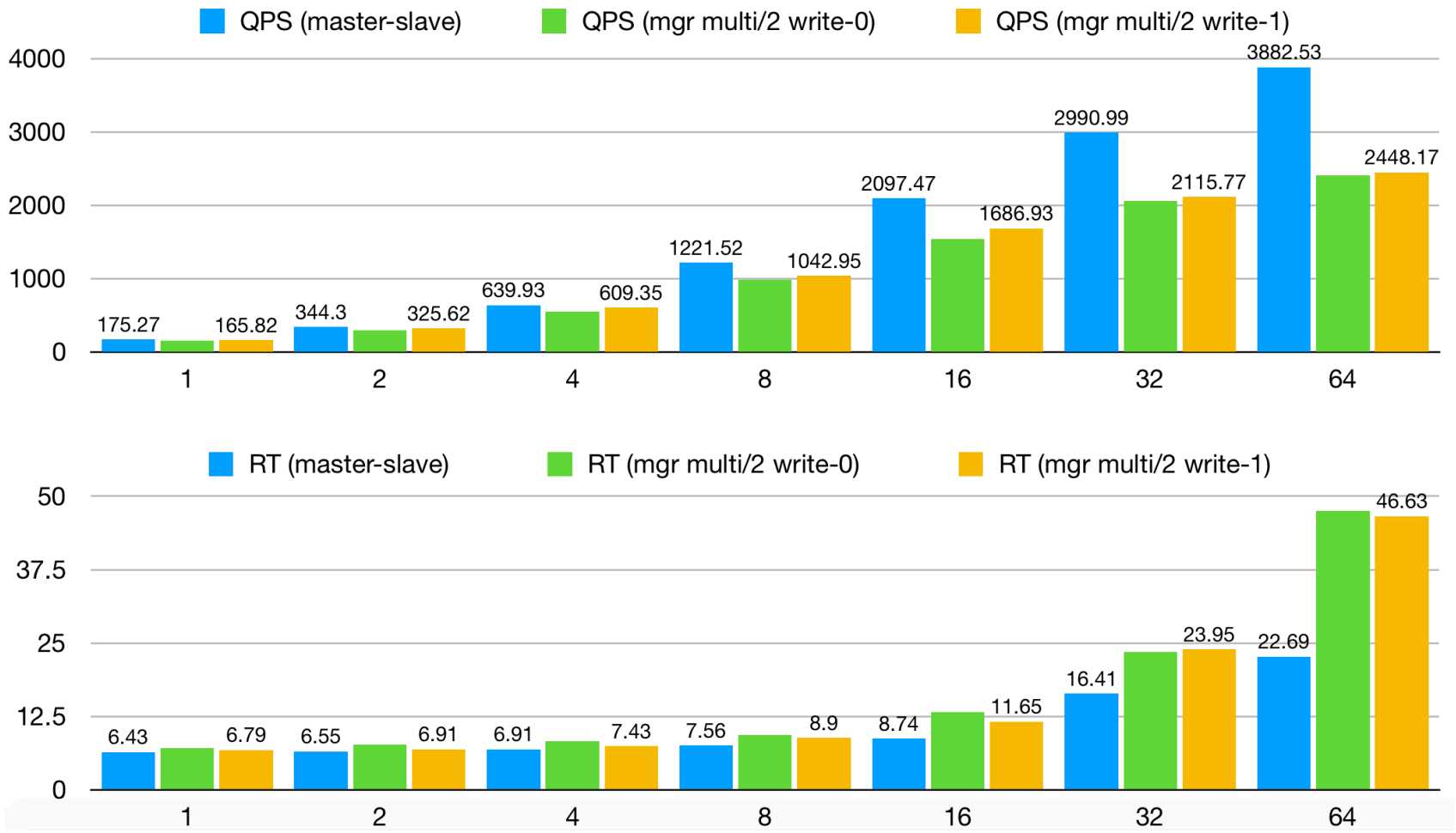




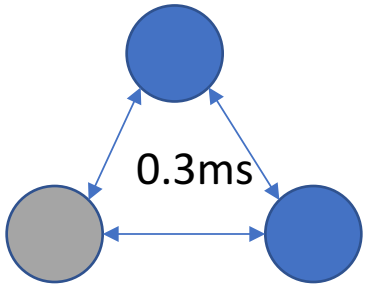
97%



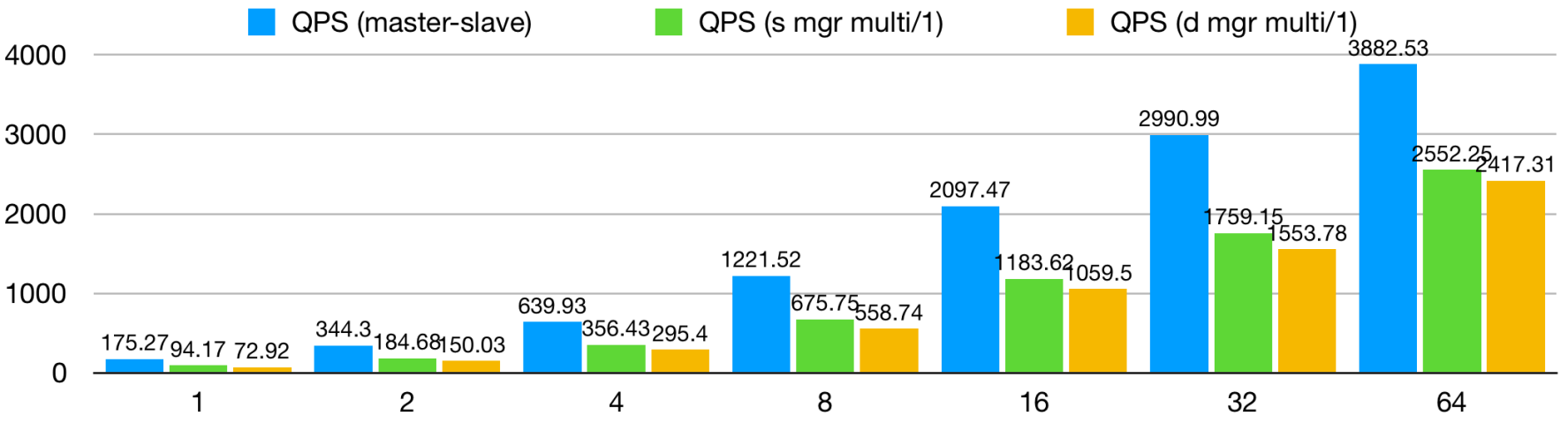
MGR集群性能分析

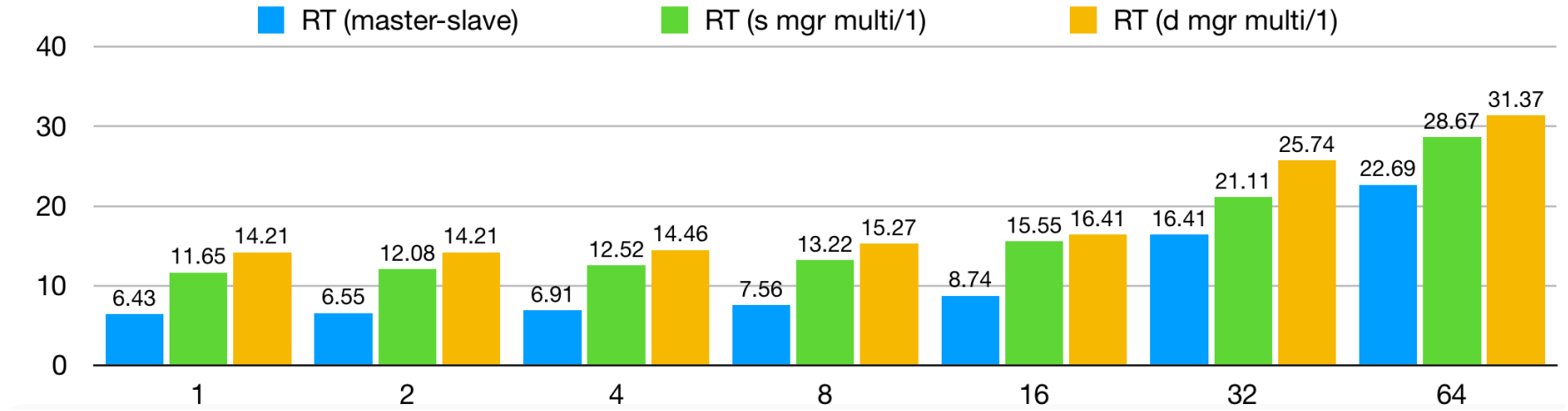


100%

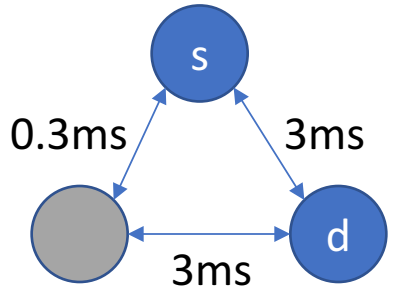


MGR集群性能分析





66%



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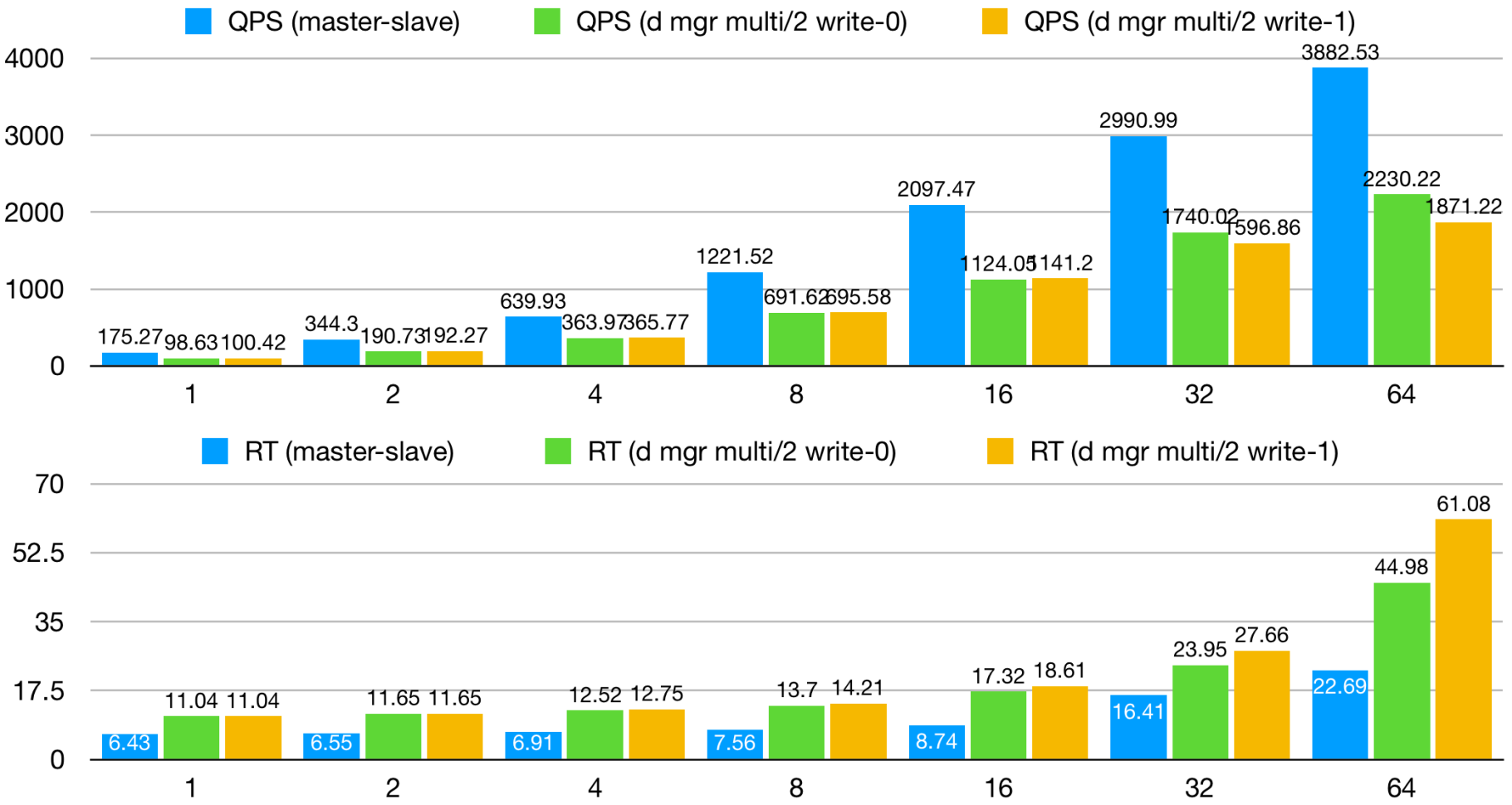

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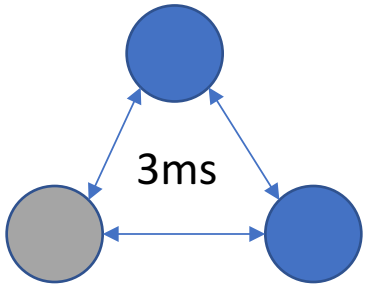


MGR集群性能分析

- Sysbench OLTP标准压测（CPU、内存都未到达瓶颈）
  - data: 15G，BP: 32G，24CPU/48G

- 局域网内（RTT < 0.5ms）
  - MGR性能单节点写入能达到原生异步复制90%
  - Certification对性能影响非常小，测试中为5%内
  - 多节点写，集群QPS吞吐可以达到原生异步复制，RT增大

- 同城异地网络（RTT < 5ms）
  - 受RTT影响，MGR性能单节点写入能达到原生异步复制67%+
  - 多节点写，集群QPS吞吐可以达到原生异步复制，RT增大

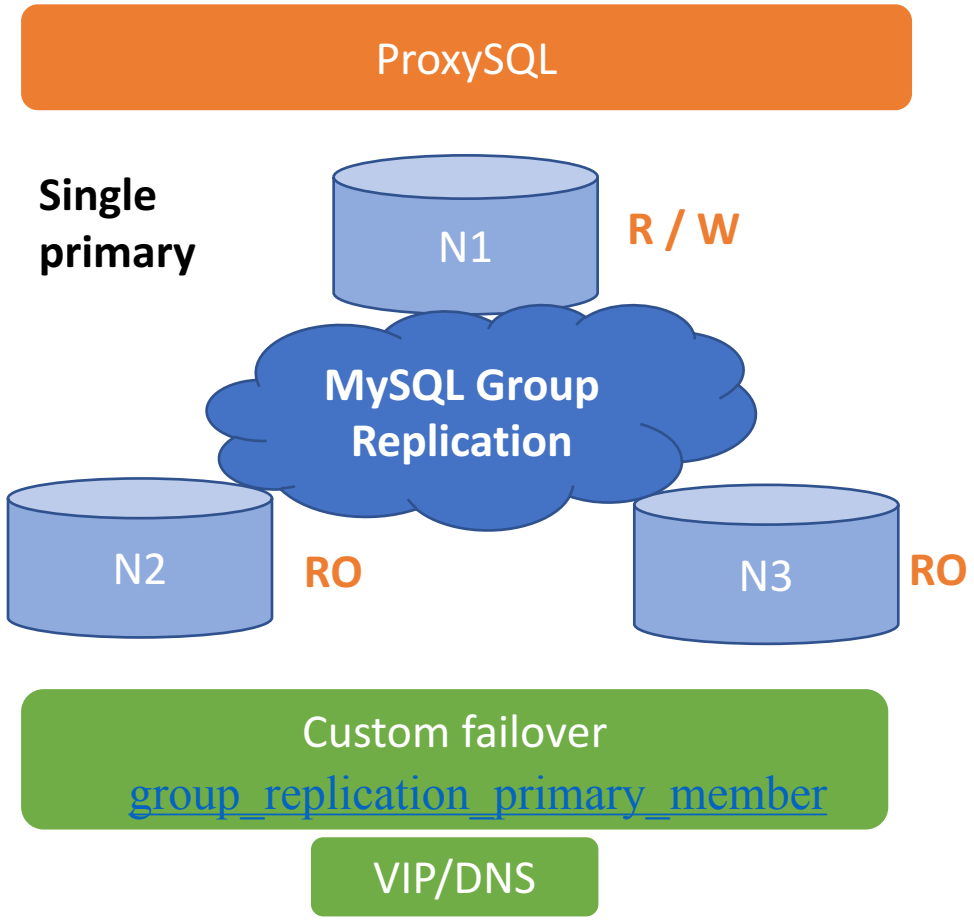
MGR适用场景 / 实践

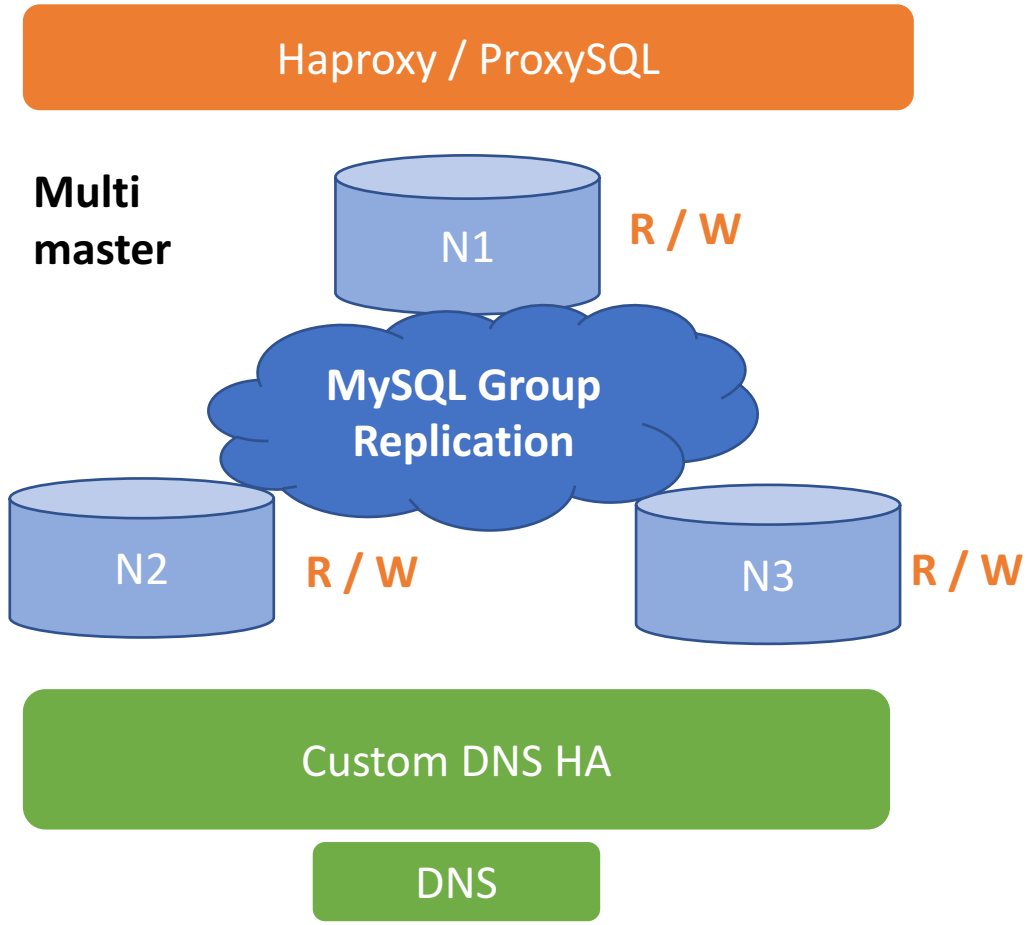
- 集群部署网络环境
  - 局域网 / 同城网络
  - 异地网络（RTT > 30ms）？

- 限制：
  - InnoDB / ROW / GTID
  - 事务隔离级别：READ COMMITTED
  - group_replication_transaction_size_limit
  - Multi master模式：同一个表DDL / DML落到相同节点
    - https://bugs.mysql.com/bug.php?id=89058

- **性能可能下降30%以上** ==> **数据安全+高可用**

MGR适用场景 / 实践






```
performance_schema.replication_group_members.Member_state = ONLINE
```

MGR适用场景 / 实践

```
mysql> SHOW GLOBAL STATUS LIKE 'group_replication_primary_member';
+----------------------------------+--------------------------------------+
| Variable_name                    | Value                                |
+----------------------------------+--------------------------------------+
| group_replication_primary_member | c032e9c7-99e4-11e8-8ac3-525400034dc1 |
+----------------------------------+--------------------------------------+
1 row in set (0.00 sec)

mysql> SELECT * FROM performance_schema.replication_group_members;
+---------------------------+--------------------------------------+-------------+-------------+--------------+
| CHANNEL_NAME              | MEMBER_ID                            | MEMBER_HOST | MEMBER_PORT | MEMBER_STATE |
+---------------------------+--------------------------------------+-------------+-------------+--------------+
| group_replication_applier | ae23bd5e-99e4-11e8-8867-5254007ac14e | 172.16.3.11 |        3306 | ONLINE       |
| group_replication_applier | afb1b626-99e4-11e8-88e4-525400661c00 | 172.16.3.14 |        3306 | ONLINE       |
| group_replication_applier | c032e9c7-99e4-11e8-8ac3-525400034dc1 | 172.16.3.2  |        3306 | ONLINE       |
+---------------------------+--------------------------------------+-------------+-------------+--------------+
3 rows in set (0.00 sec)

mysql> SELECT * FROM performance_schema.replication_group_member_stats\G
*************************** 1. row ***************************
                      CHANNEL_NAME: group_replication_applier
                           VIEW_ID: 15336072637117830:3
                         MEMBER_ID: c032e9c7-99e4-11e8-8ac3-525400034dc1
       COUNT_TRANSACTIONS_IN_QUEUE: 0
        COUNT_TRANSACTIONS_CHECKED: 4
          COUNT_CONFLICTS_DETECTED: 0
COUNT_TRANSACTIONS_ROWS_VALIDATING: 0
TRANSACTIONS_COMMITTED_ALL_MEMBERS: 30951147-d56e-46a5-bb8a-ac2739f4d742:1-30:1000018-1000023
    LAST_CONFLICT_FREE_TRANSACTION: 30951147-d56e-46a5-bb8a-ac2739f4d742:1000024
1 row in set (0.00 sec)
```

Q & A

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Thanks!

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