最火的MySQL高可用方案
MySQL群组复制

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2017-03-25

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MySQL

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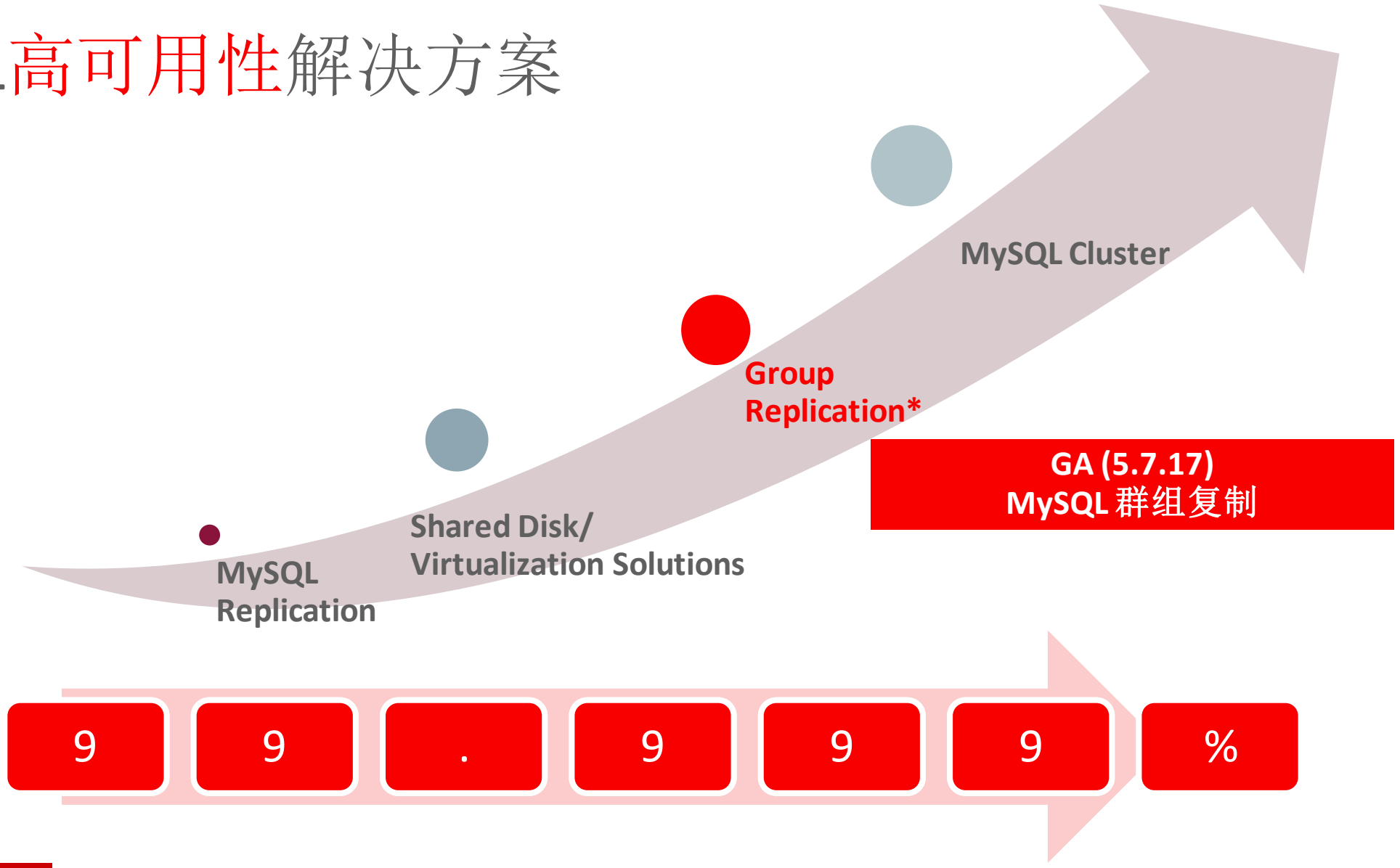
MySQL高可用性解决方案

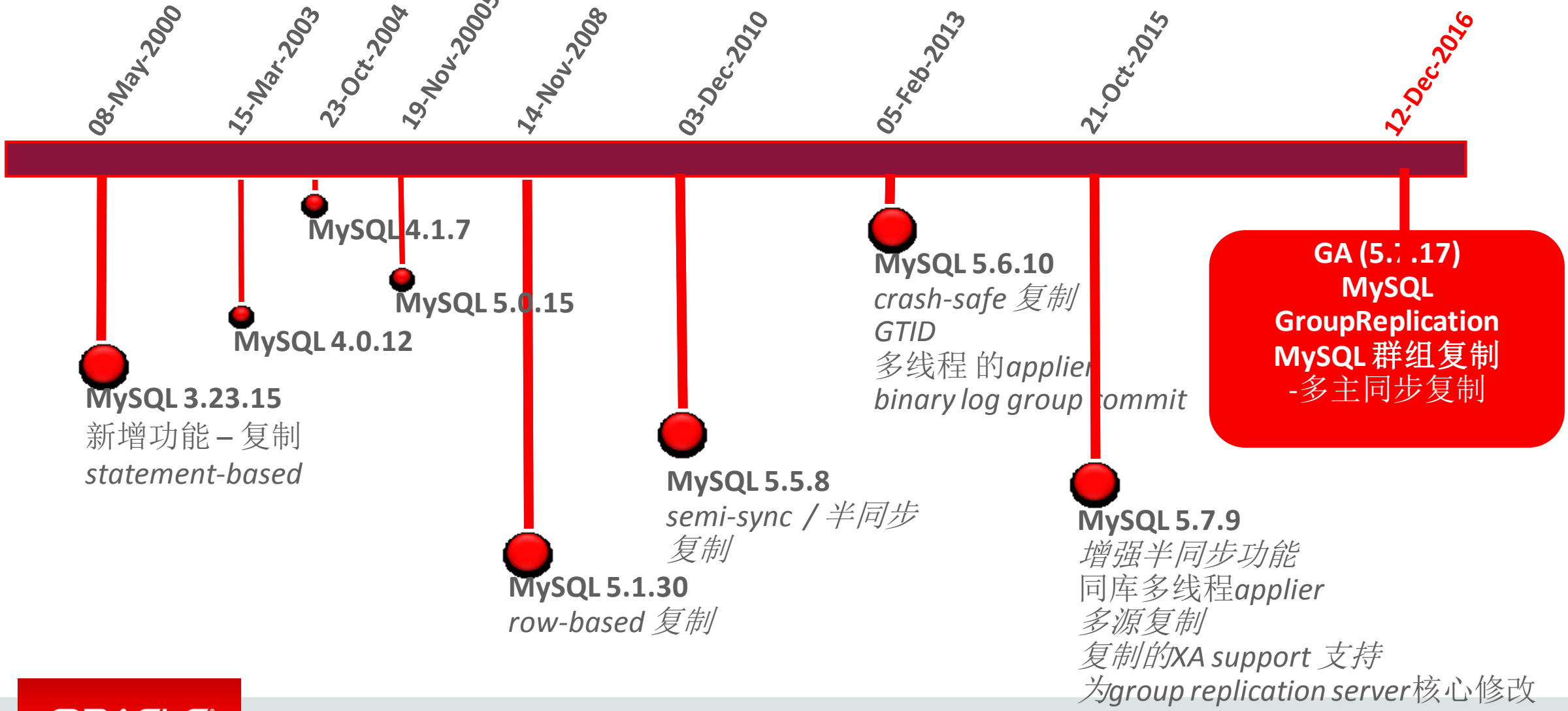


MySQL技术更新:议程

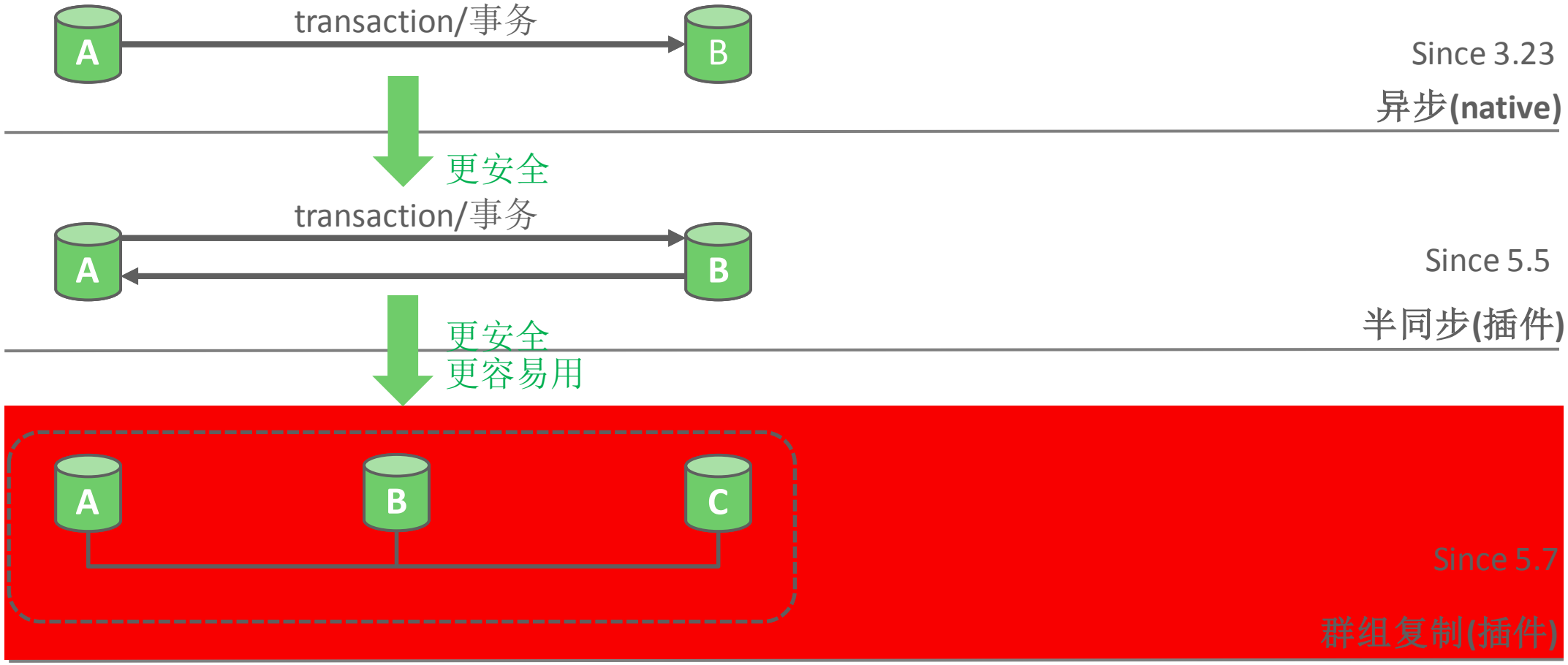
1. MySQL 群组复制 (MySQL Group Replication)
2. MySQL群组复制基本
3. MySQL群组复制特性
4. MySQL群组复制性能
5. MySQL InnoDB Cluster – 路线发展

1 MySQL复制的演变

MySQL复制发布的历史

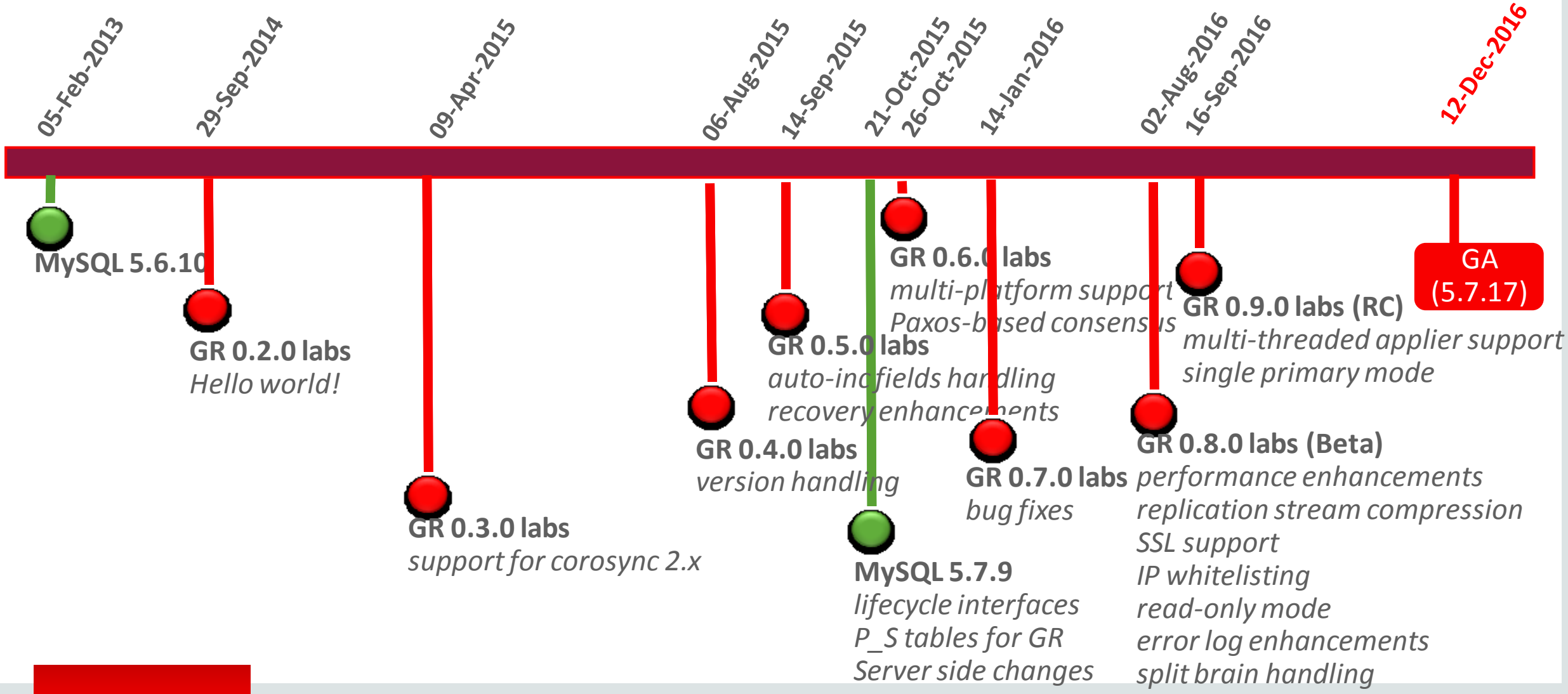


MySQL高可用性的演变



MySQL Group Replication 在5.7.17 已经发布

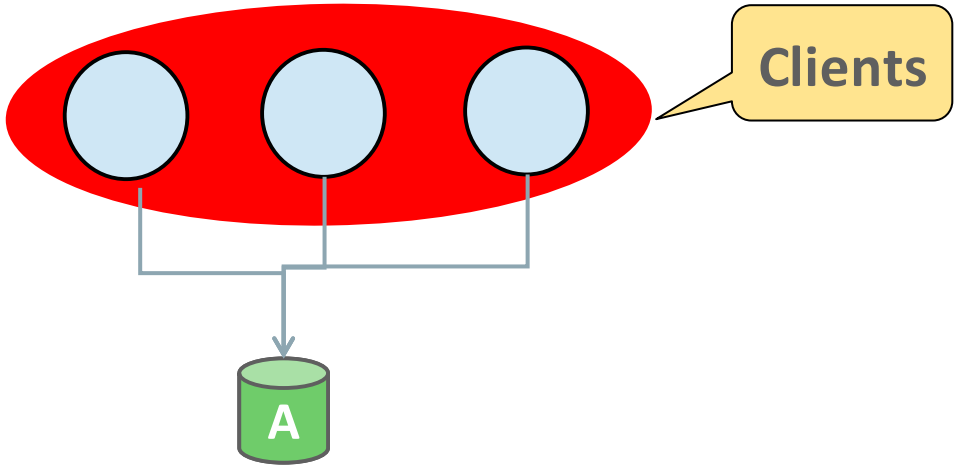
群组复制发布的时间轴



MySQL Group Replication 在5.7.17 已经发布

更安全, 更容易用,可扩展

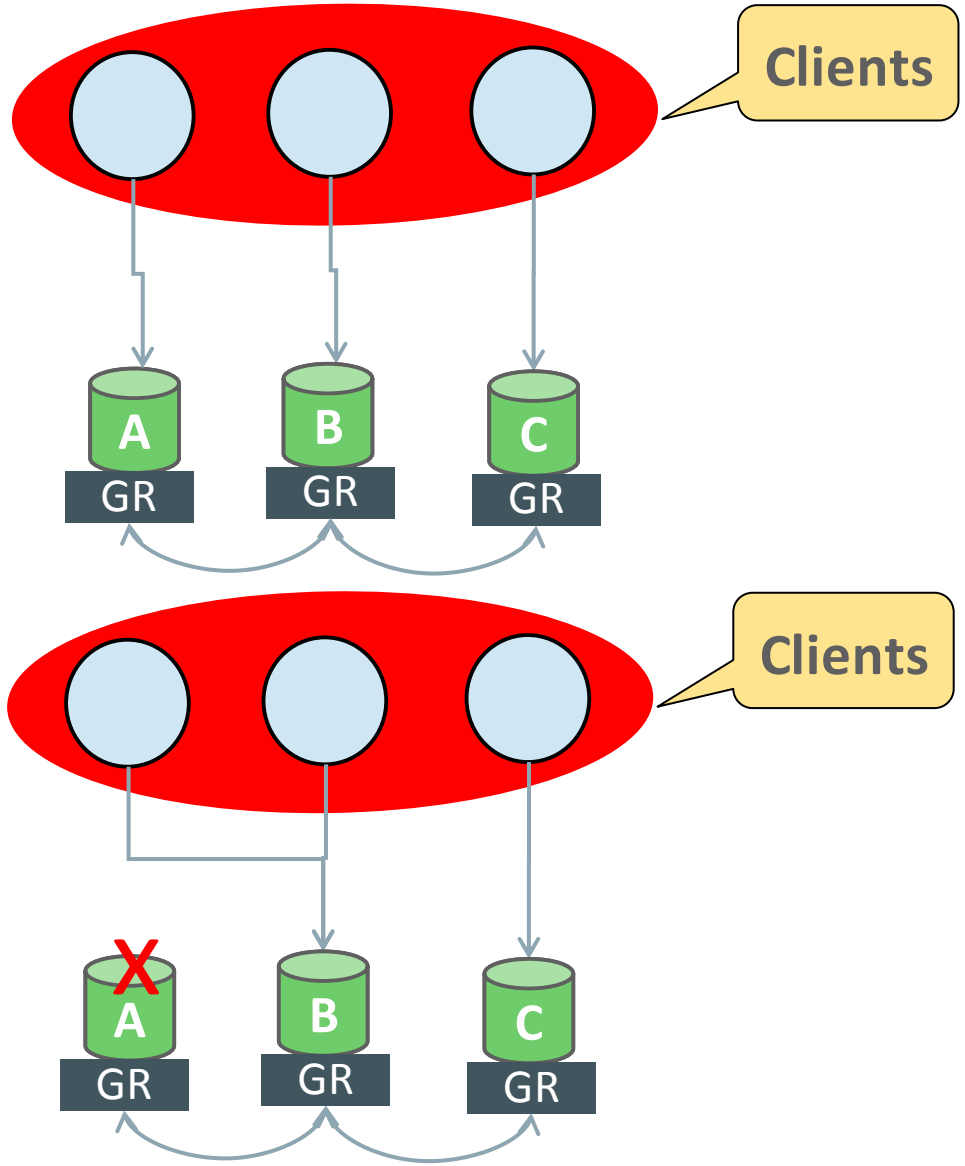
- 更安全
  - 多分数据，没有数据丢失

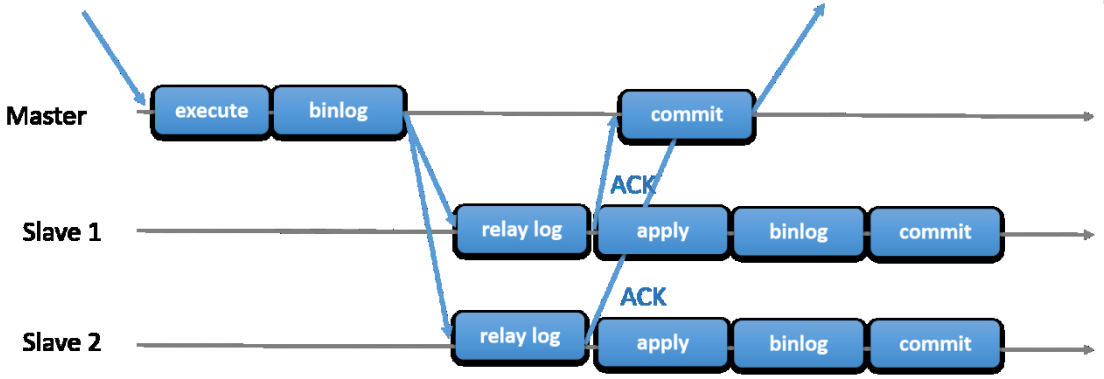


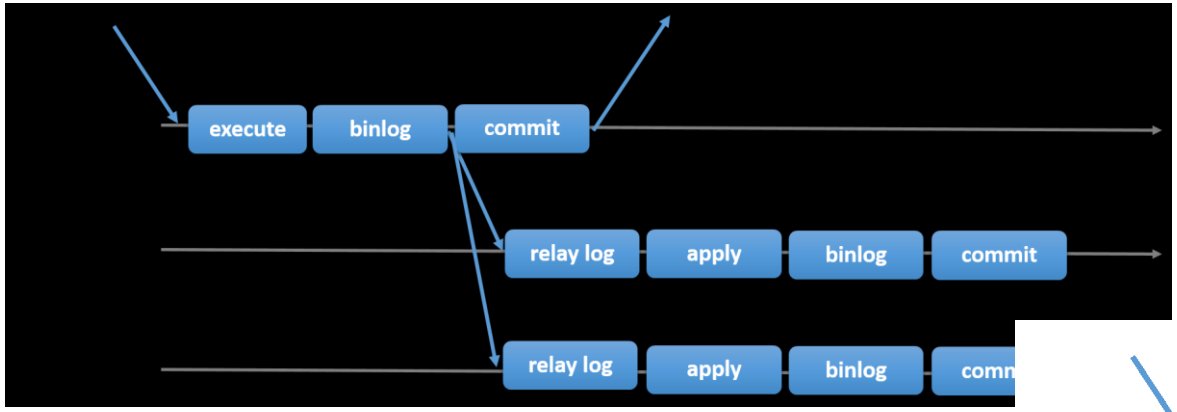
MySQL Group Replication 在5.7.17 已经发布

更安全, 更容易用,可扩展

- 更安全
  - 多分数据，没有数据丢失
- 更容易用，可扩展
  - 可以增加数据库实例
  - 高可用性
    - 多台实例群组，提供高可用操作





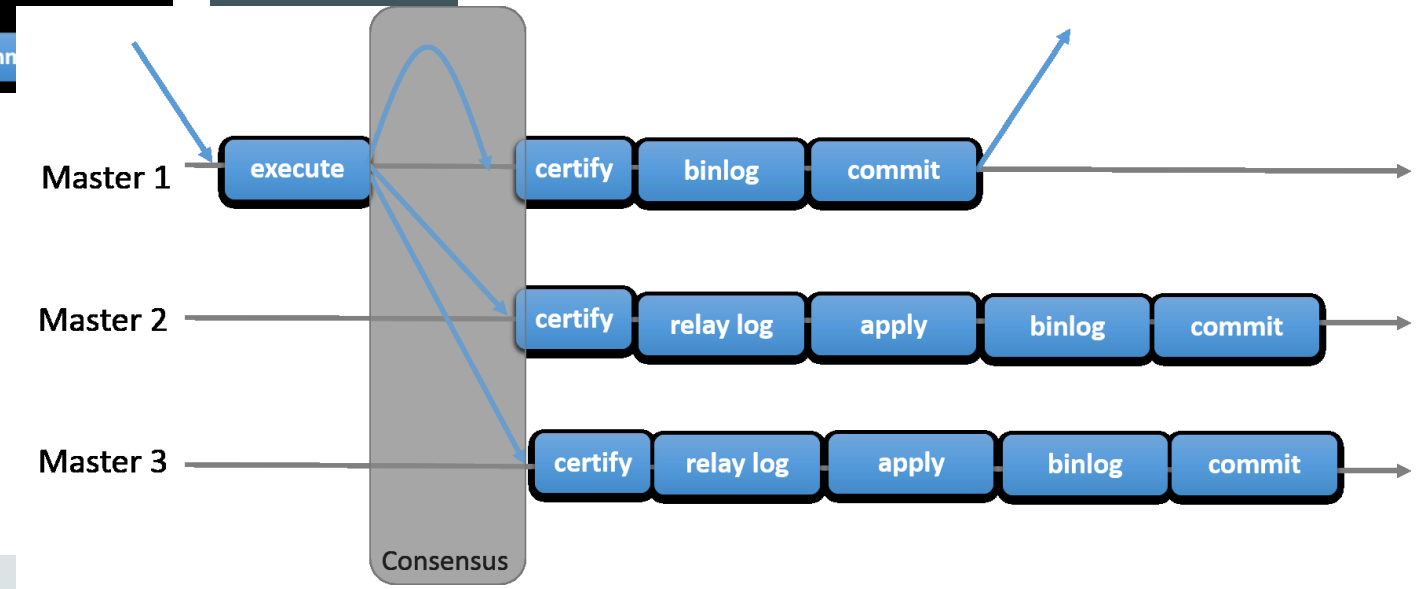


配对

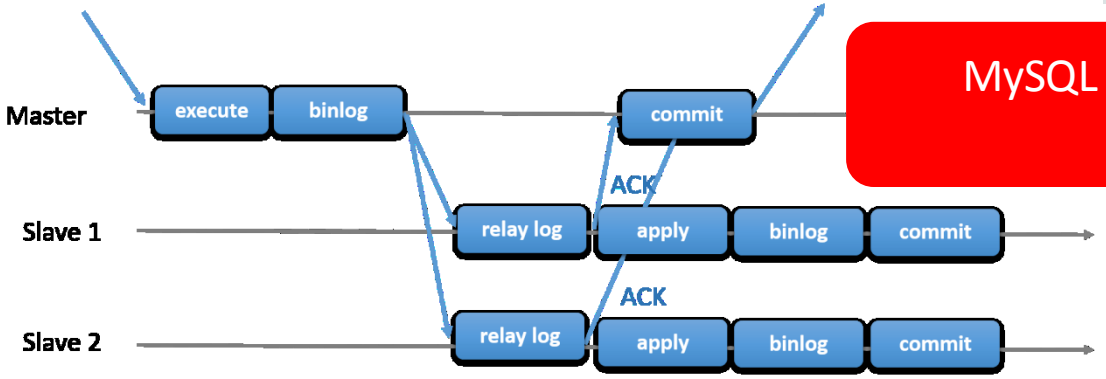
MySQL asynchronous Replication

MySQL Semi-synchronous Replication

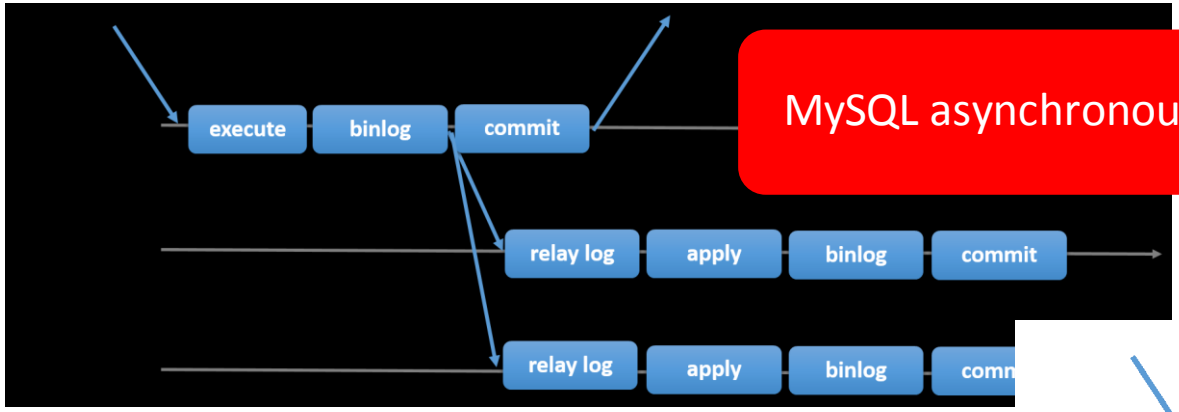
MySQL Group Replication



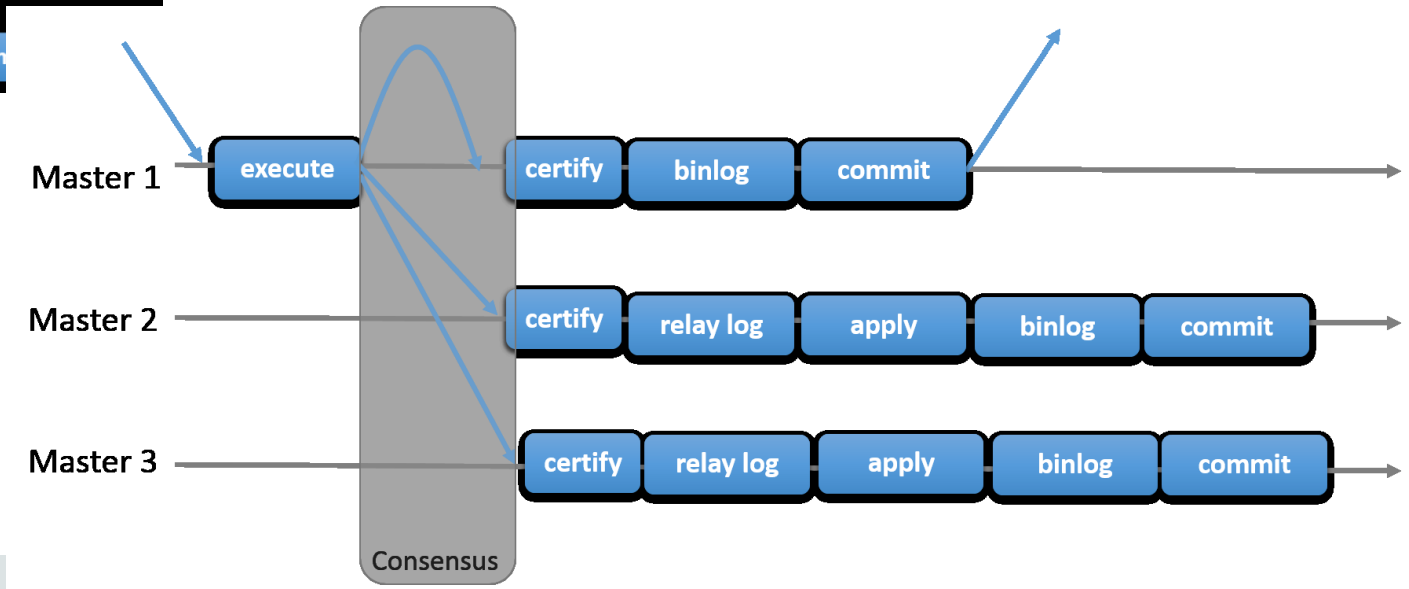
MySQL Semi-synchronous Replication



MySQL asynchronous Replication



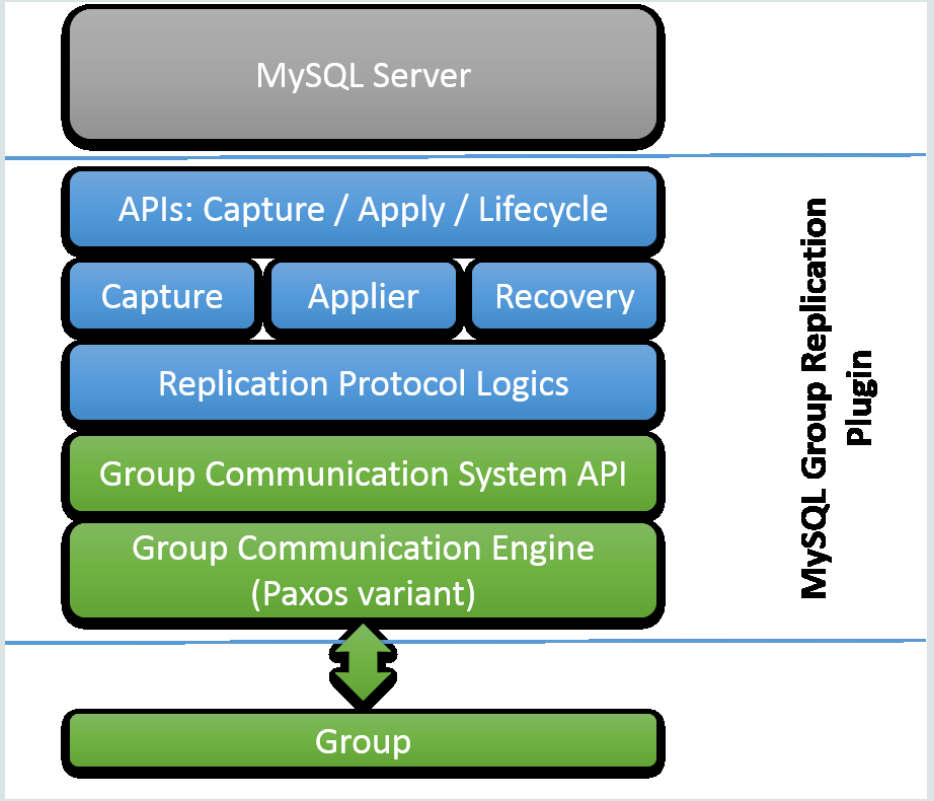
MySQL Group Replication



2 MySQL群组复制基础

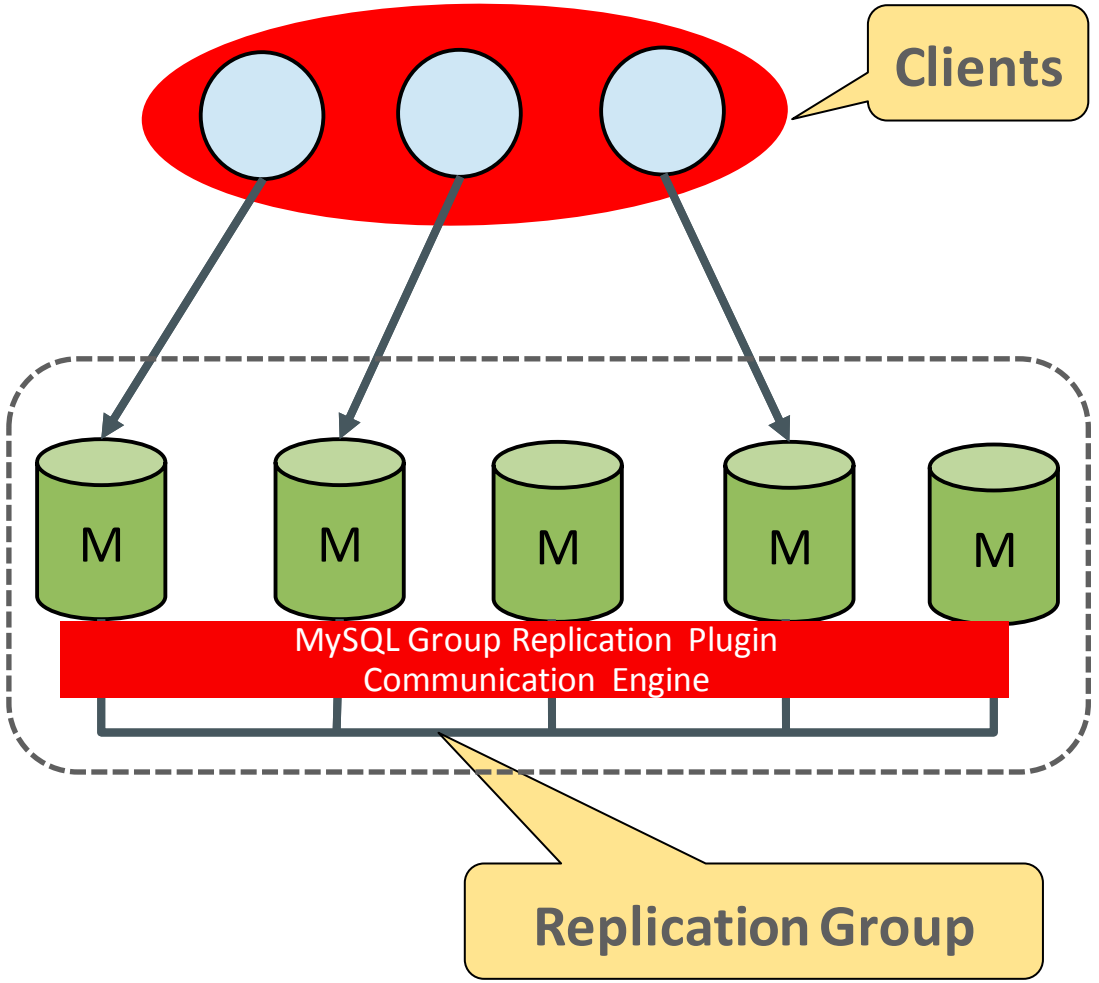
2.1 什么是 - Group Replication?

http://mysqlhighavailability.com/mysqlha/gr/doc/index.html

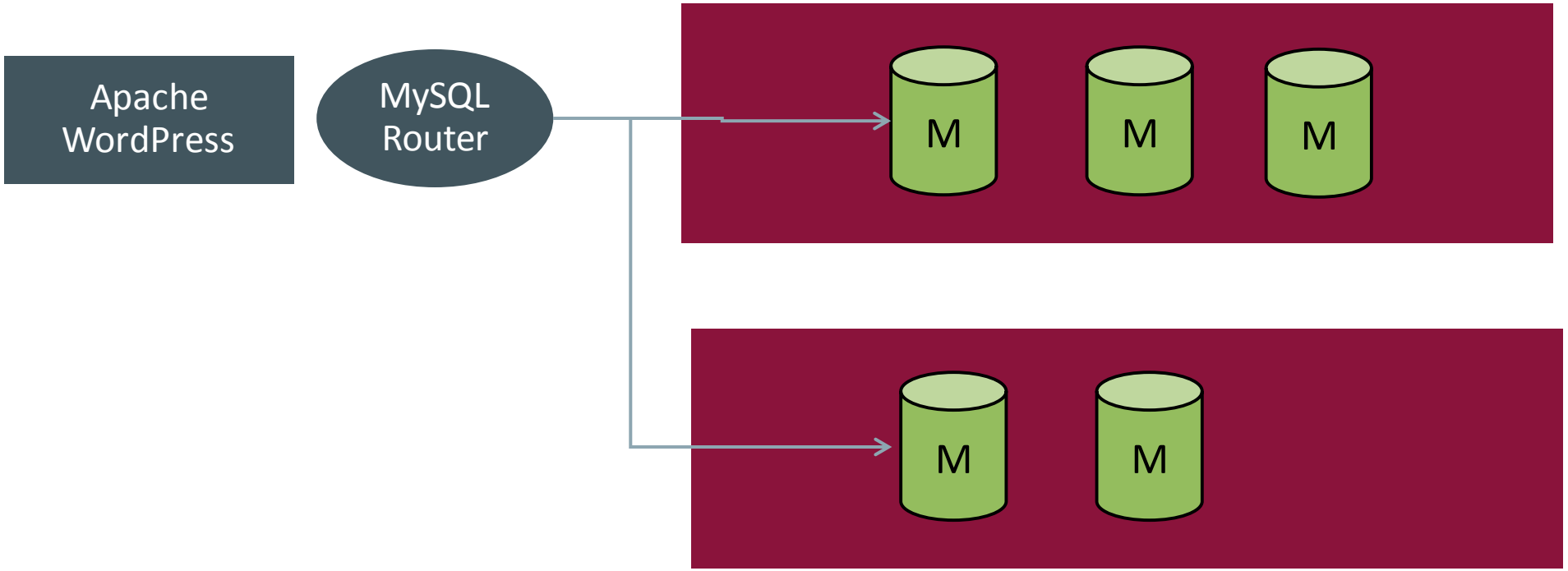


MySQL群组复制基础

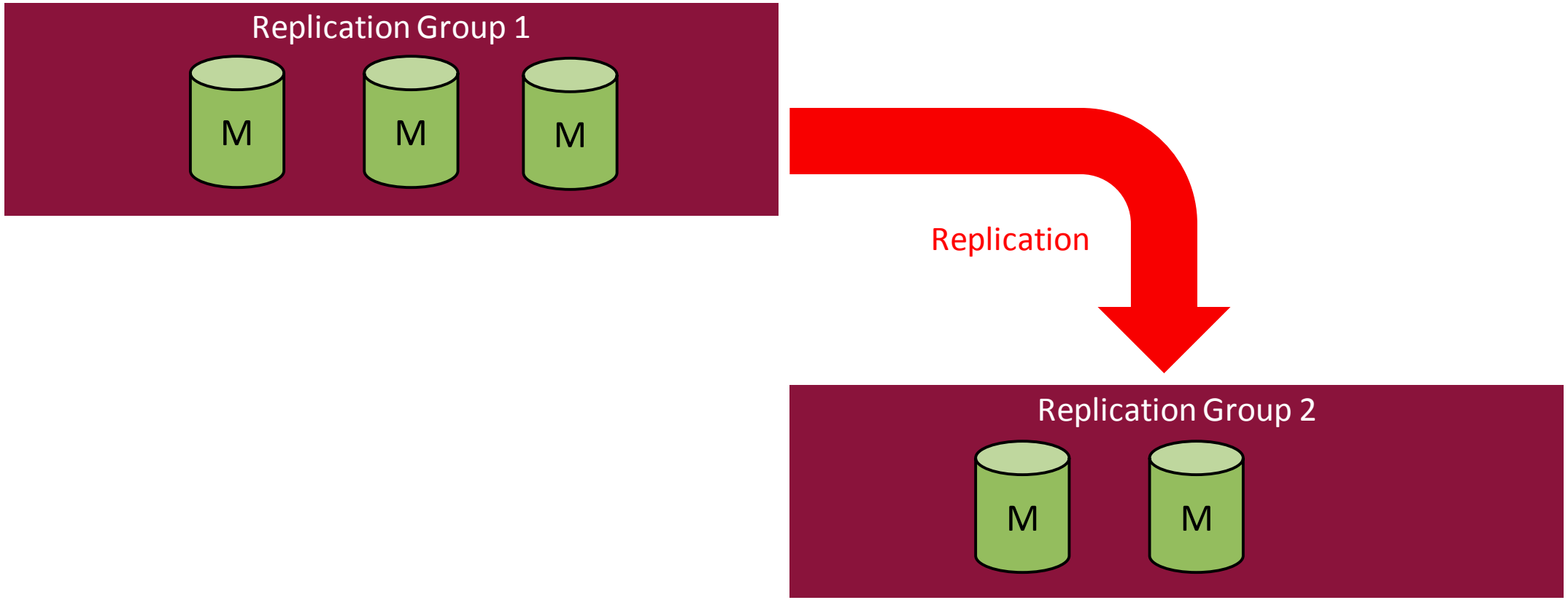
- 什么是 **MySQL Group Replication?**
  - MySQL 插件
  - 非共享, 多台数据库实例复制
  - 同时多数据库作并行数据变更操作
  - 群组自动化管理
    - 新加入的- 数据同步
    - 离开-群组通知
  - 通过现有的复制技术实现



演示1



演示2



2 MySQL群组复制基础

2.1 什么是 Group Replication?

2.2 设置 群组复制 Group Replication

http://mysqlhighavailability.com/mysqlha/gr/doc/getting_started.html

设置群组复制

群组初始化: 启动第一台

group_name 可以用UUID
SELECT UUID();
所有的成员用同一个group_name

```
mysql> INSTALL PLUGIN “group_replication” SONAME “group_replication.so”;
mysql> SET GLOBAL group_replication_group_name = “8a94f357-aab4-11df-86ab-c80aa9429562”
mysql> SET GLOBAL group_replication_local_address = “127.0.0.1:24901”
mysql> SET GLOBAL group_replication_bootstrap_group = ON;
mysql> START GROUP_REPLICATION;
```

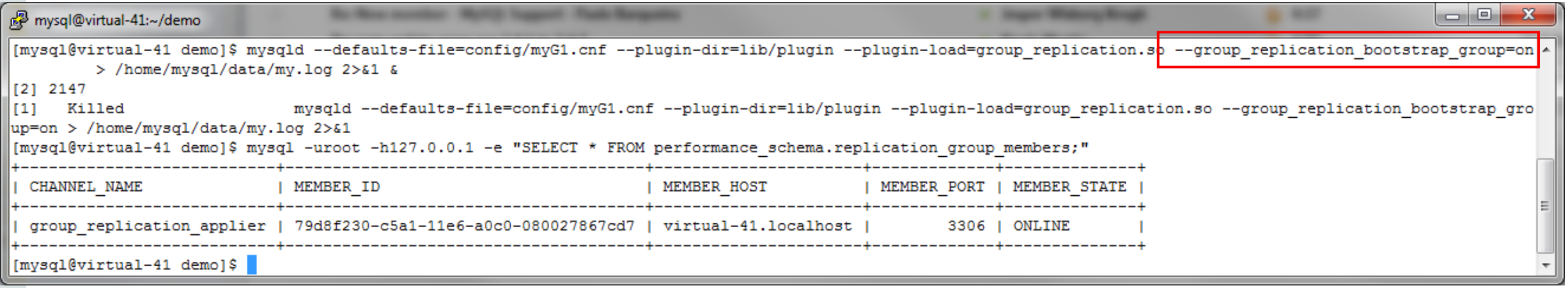
第一台启动以后，可以设定
group_replication_bootstrap_group=OFF

设置群组复制

群组初始化:启动第一台 ： 检查 群组成员状态

```
mysql> INSTALL PLUGIN “group_replication” SONAME “group_replication.so”;
mysql> SET GLOBAL group_replication_group_name = “8a94f357-aab4-11df-86ab-c80aa9429562”
mysql> SET GLOBAL group_replication_local_address = “primary:4306”
mysql> SET GLOBAL group_replication_bootstrap_group = ON;
mysql> START GROUP_REPLICATION;
```

检查 群组成员状态： "SELECT * FROM performance_schema.replication_group_members;"

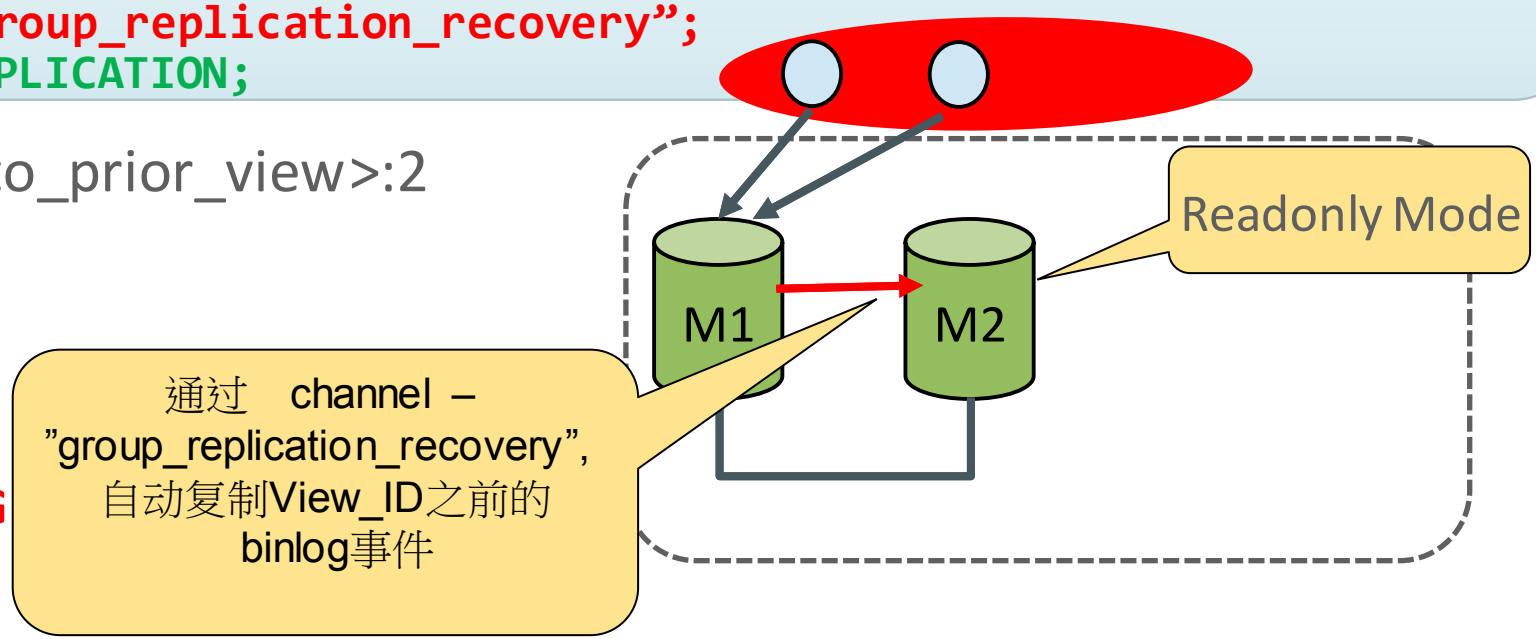


设置群组复制

添加群组成员:启动第二台

```
mysql> INSTALL PLUGIN “group_replication” SONAME “group_replication.so”;
mysql> SET GLOBAL group_replication_group_name = “8a94f357-aab4-11df-86ab-c80aa9429562”
mysql> SET GLOBAL group_replication_local_address = “primary:4316”
mysql> SET GLOBAL group_replication_group_seeds = “Primary:4306”;
mysql> CHANGE MASTER TO MASTER_USER=“rpl_user”, MASTER_PASSWORD=“rpl_pass”
mysql> FOR CHANNEL “group_replication_recovery”;
mysql> START GROUP_REPLICATION;
```

- View_ID=<same_to_prior_view>:2
- Group size: 2
- Status:
  - M1: ONLINE
  - M2: **RECOVERYING**



设置群组复制

添加群组成员:启动第二台

```
mysql> INSTALL PLUGIN “group_replication” SONAME “group_replication.so”;
mysql> SET GLOBAL group_replication_group_name = “8a94f357-aab4-11df-86ab-c80aa9429562”
mysql> SET GLOBAL group_replication_local_address = “primary 4316”
mysql> SET GLOBAL group_replication_group_seeds = “primary:4306”;
mysql> CHANGE MASTER TO MASTER_USER=“rpl_user”, MASTER_PASSWORD=“rpl_pass”
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```
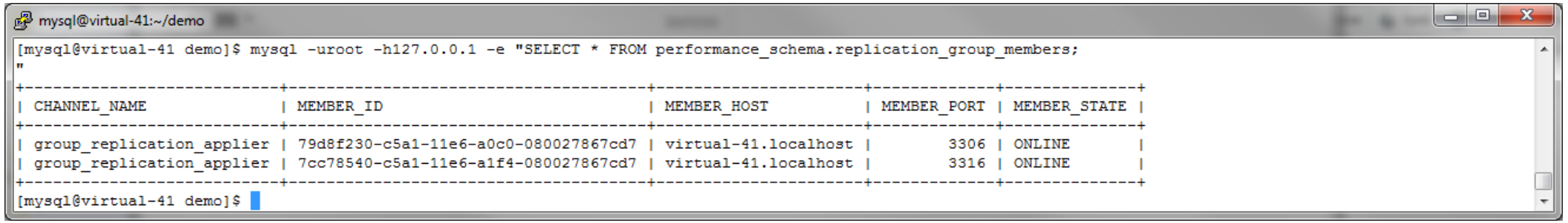
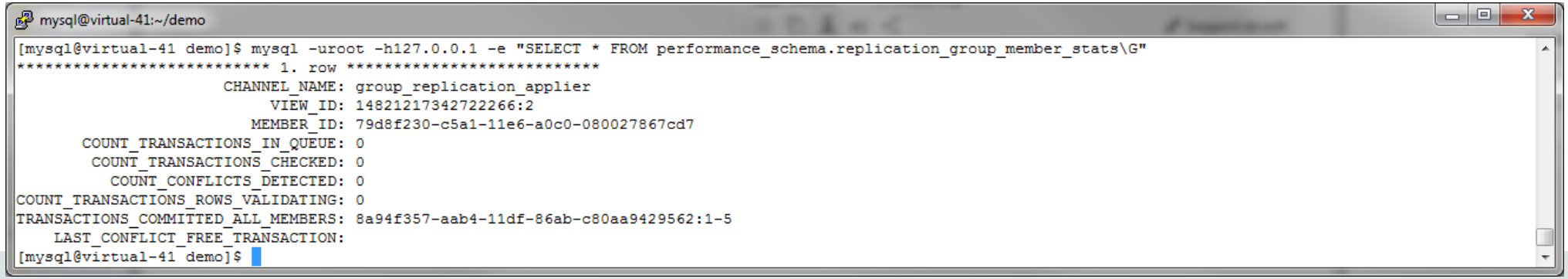





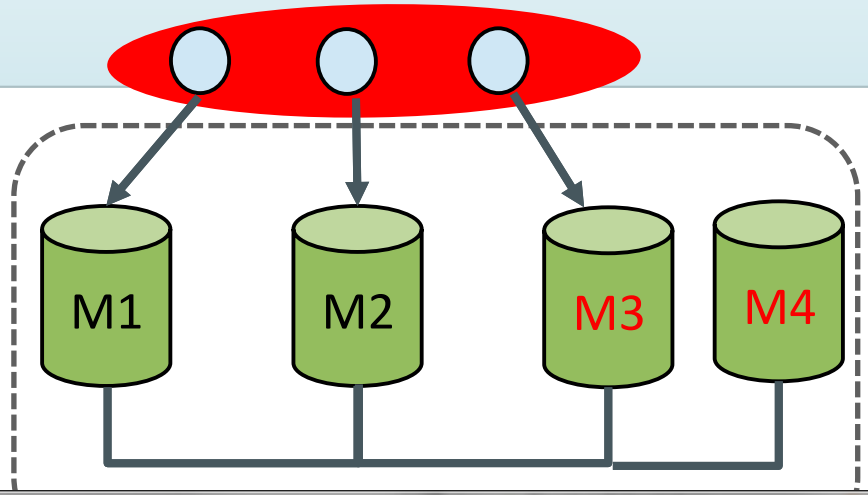
Details: http://mysqlhighavailability.com/gr/doc/getting_started.html

设置群组复制

添加群组成员:增加更多群组成员

```
mysql> INSTALL PLUGIN “group_replication” SONAME “group_replication.so”;
mysql> SET GLOBAL group_replication_group_name = “8a94f357-aab4-11df-86ab-c80aa9429562”
mysql> SET GLOBAL group_replication_local_address = “primary:4326” <M3 and M4>
mysql> SET GLOBAL group_replication_group_seeds = “primary:4306,primary:4316,primary:4326”;
mysql> CHANGE MASTER TO MASTER_USER=“rpl_user”, MASTER_PASSWORD=“rpl_pass”
mysql> FOR CHANNEL “group_replication_recovery”;
mysql> START GROUP_REPLICATION;
```

- View_ID=<same_to_prior_view>:3
- Group size: 4
- Status:
  - M1: ONLINE
  - M2: ONLINE
  - M3: ONLINE
  - M4: ONLINE




```
mysql@virtual-41:~/demo
    LAST_CONFLICT_FREE_TRANSACTION:
[mysql@virtual-41 demo]$ mysql -uroot -h127.0.0.1 -e "SELECT * FROM performance_schema.replication_group_members;
"
+---------------------------+--------------------------------------+---------------------+-------------+--------------+
| CHANNEL_NAME              | MEMBER_ID                            | MEMBER_HOST         | MEMBER_PORT | MEMBER_STATE |
+---------------------------+--------------------------------------+---------------------+-------------+--------------+
| group_replication_applier | 79d8f230-c5a1-11e6-a0c0-080027867cd7 | virtual-41.localhost |        3306 | ONLINE       |
| group_replication_applier | 7cc78540-c5a1-11e6-a1f4-080027867cd7 | virtual-41.localhost |        3316 | ONLINE       |
| group_replication_applier | f49525b1-c5a8-11e6-a697-0800279c1260 | virtual-42.localhost |        3306 | ONLINE       |
| group_replication_applier | f78597d2-c5a8-11e6-a7e4-0800279c1260 | virtual-42.localhost |        3316 | ONLINE       |
+---------------------------+--------------------------------------+---------------------+-------------+--------------+
[mysql@virtual-41 demo]$
```

群组复制的高可用性

更好的容错度

- 故障（F）所需的服务器数量（N）
  N = 2F + 1.
- 最多支持9个成员
  - 允许4个成员故障。
- 没有脑裂的问题
  - 仅当大多数成员在线时，群组才是可用

Group Size	Majority	Instant Failures Tolerated
1	1	0
2	2	0
3	2	1
4	3	1
5	3	2
6	4	2
7	4	3
8	5	3
9	5	4

3 MySQL Group Replication 功能

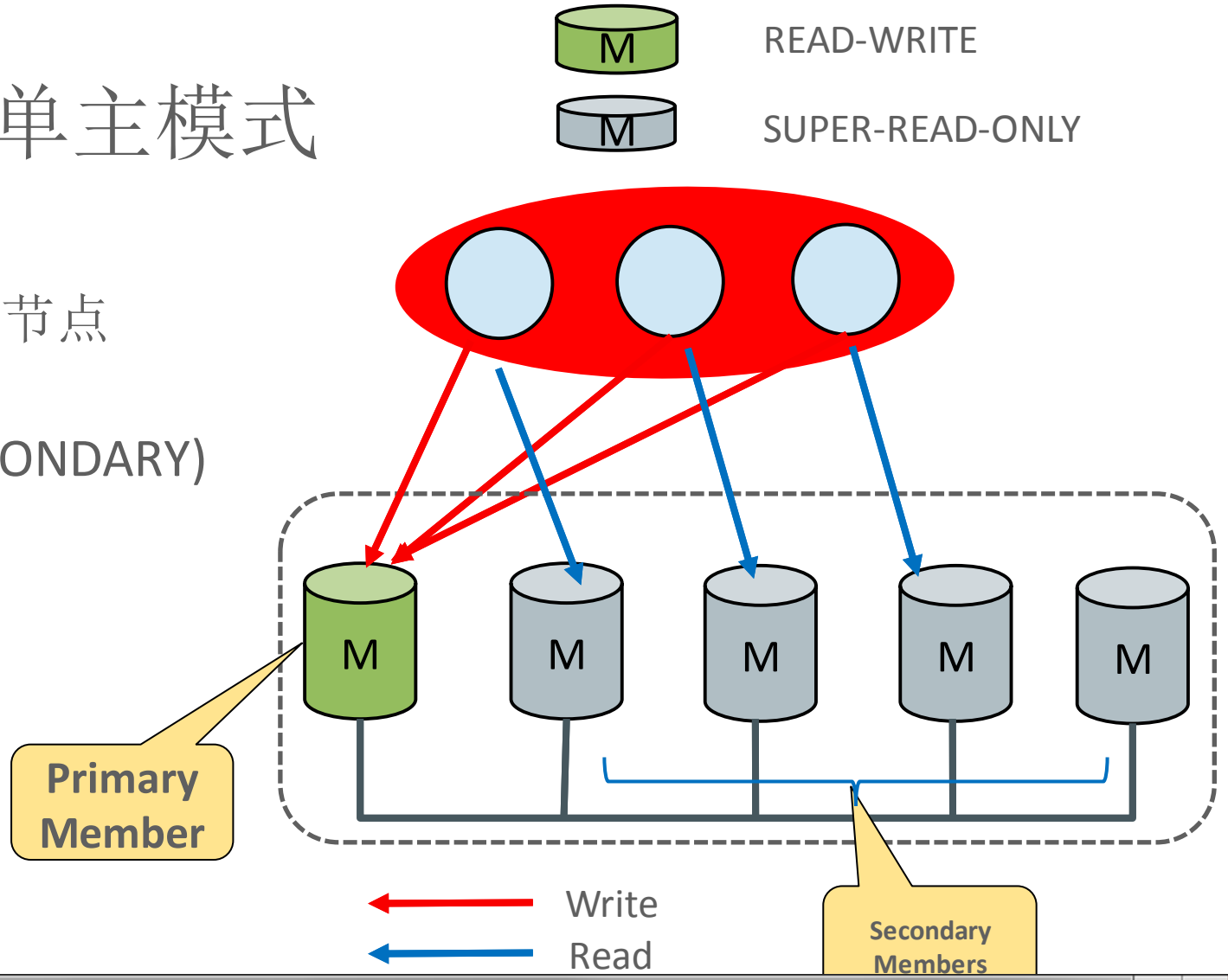
3 MySQL Group Replication 功能

3.1 Single Primary Mode (Default) －单主模式

3.2 Multi-Master Update Everywhere －多主模式

Single Primary Mode / 单主模式

- 单个MySQL实例充当可写的主节点（PRIMARY）
- 其它的群组成员为热备用(SECONDARY)




```
mysql@virtual-41:~/demo
mysql>
mysql>
mysql> create table mytable (f1 int not null primary key auto_increment, f2 varchar(20));
ERROR 1290 (HY000): The MySQL server is running with the --super-read-only option so it cannot execute this statement
mysql>
```

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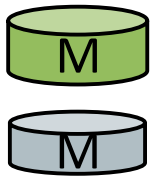
Single Primary Mode / 单主模式



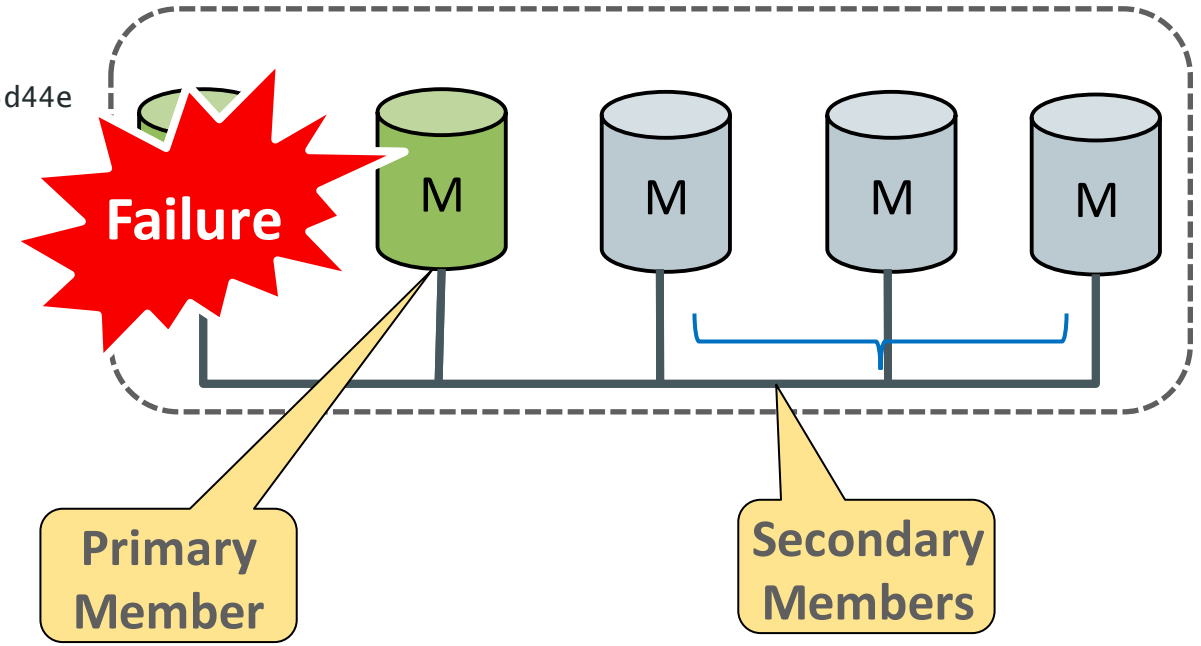
READ-WRITE

SUPER-READ-ONLY

自动PRIMARY启动机制

- 当发生故障或主成员离开时，自动选择PRIMARY成员

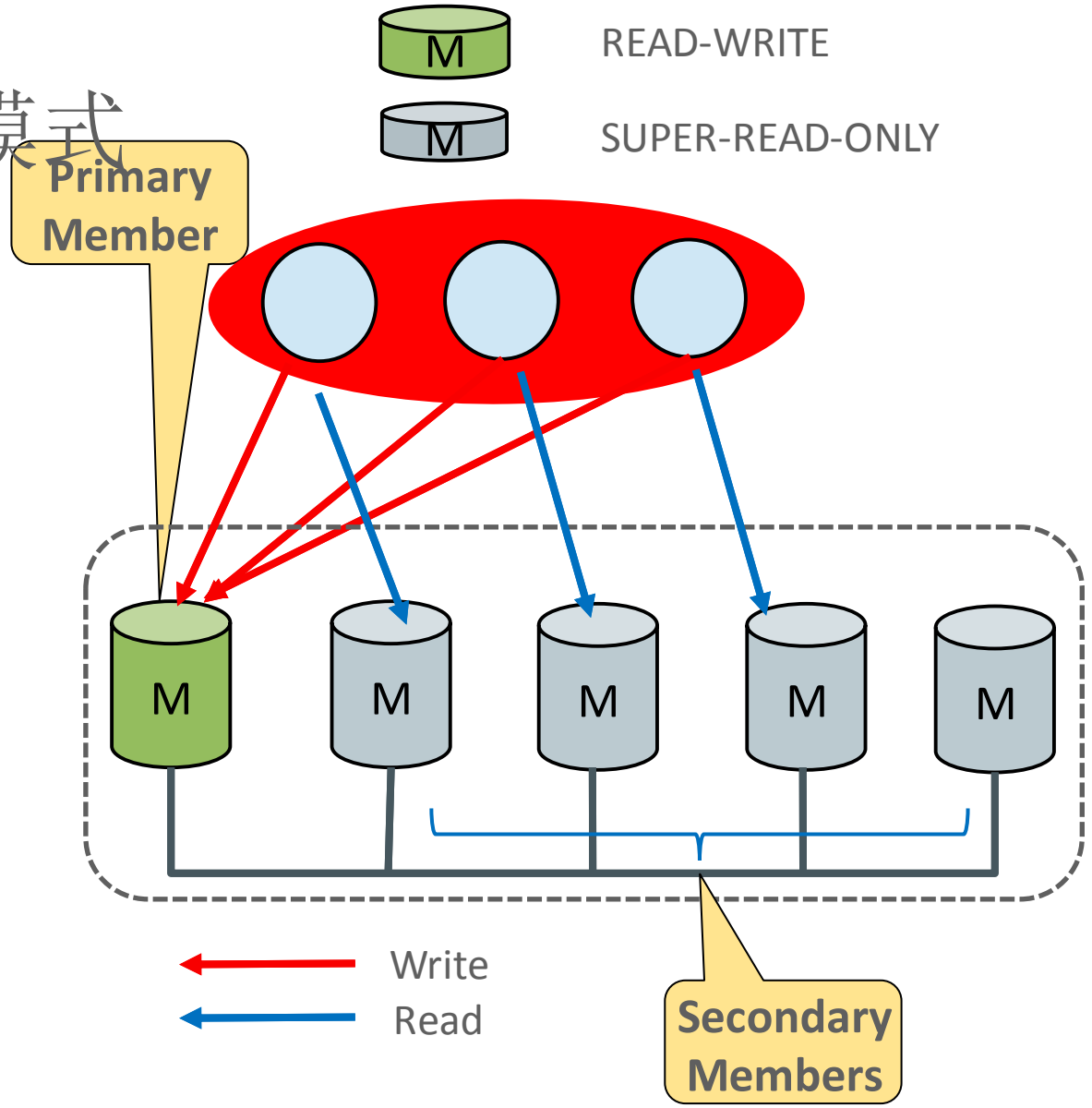
```
mysql> SELECT * FROM performance_schema.global_status WHERE
VARIABLE_NAME='group_replication_primary_member';
VARIABLE_NAME                       VARIABLE_VALUE
group_replication_primary_member    dcd3b36b-79c5-11e6-97b8-00212844d44e
```



Single Primary Mode / 单主模式

默认模式

- group_replication_single_primary_mode = ON
- 现有的应用更容易采用。
  - 主备部署（热备）
  - 读写分离
- 避免多主模式的限制。



3 MySQL Group Replication 功能

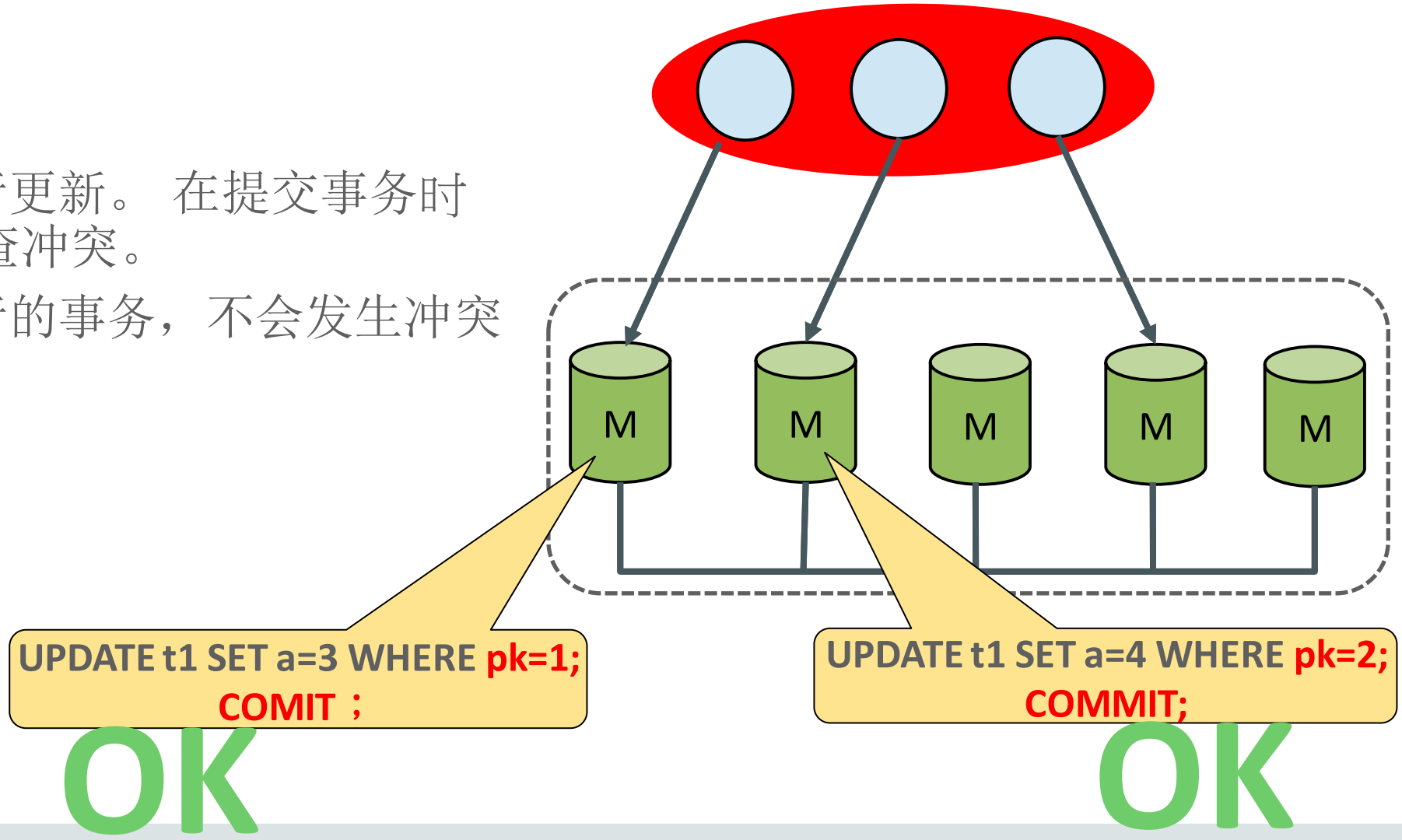
3.1 Single Primary Mode (Default) －单主模式

3.2 Multi-Master Update Everywhere －多主模式

多主同步模式

冲突检测

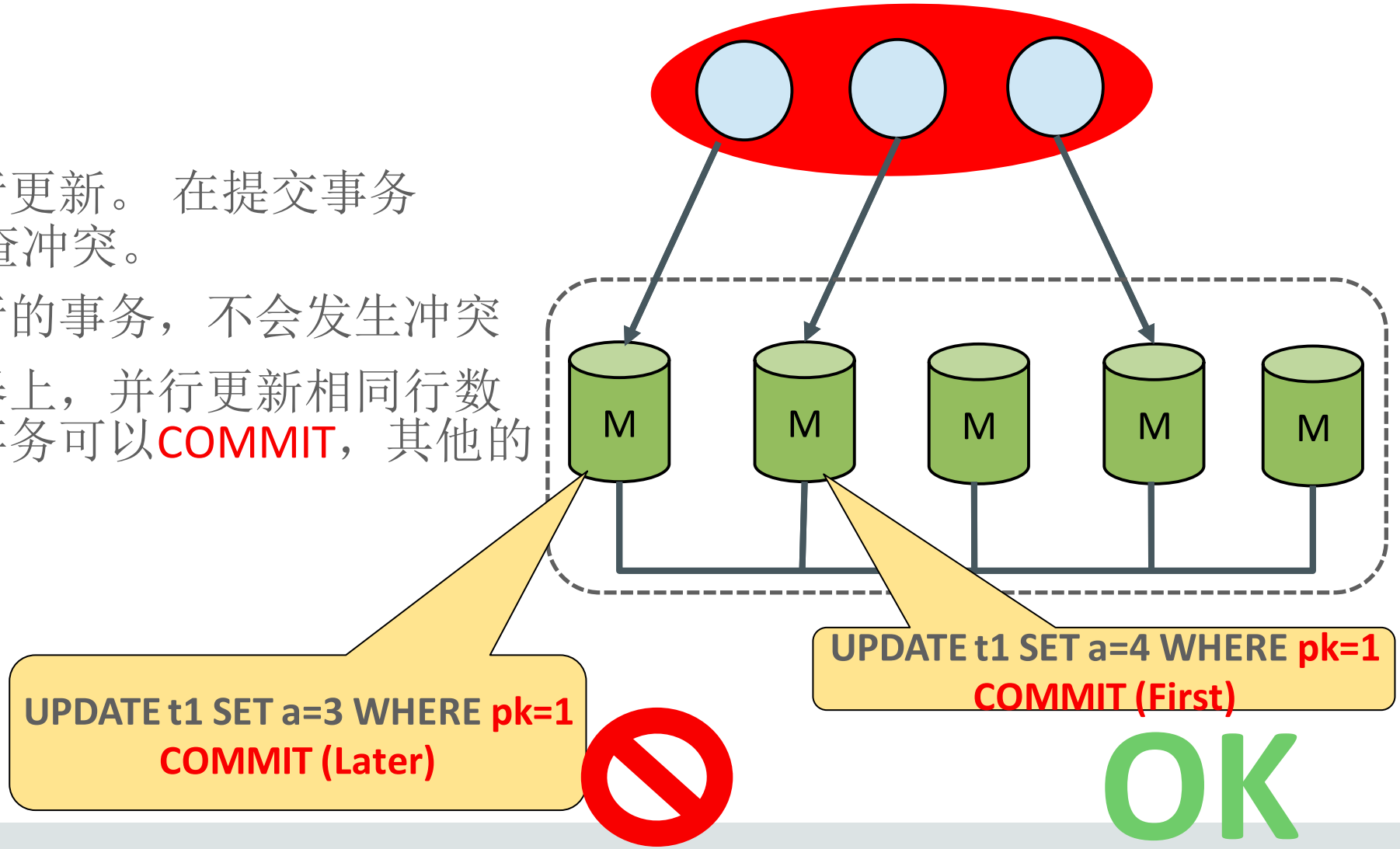
- 使用主键检测
- 多主上并行执行更新。 在提交事务时(COMMIT)，检查冲突。
- 并行更新不同行的事务，不会发生冲突



多主同步模式

冲突检测

- 使用主键检测
- 多主上并行执行更新。 在提交事务(COMMIT)，检查冲突。
- 并行更新不同行的事务，不会发生冲突
- 在不同的服务器上，并行更新相同行数据，只有一个事务可以COMMIT，其他的都必须回滚



多主同步模式

MySQL Group Replication http://mysqlhighavailability.com/mysqlha/gr/doc/limitations.html

- 注意的规则
  - 仅InnoDB Engine(Transactional and row level lock)
  - 表必须有主键
  - gtid-mode=ON
  - binlog格式 要Row-based
  - DDL和冲突DML应在同一成员上执行;不支持在不同服务器上执行冲突DDL。
  - 不完全支持有外键 Cascading constraints
  - 不支持（isolation level “serializable”）

多主同步模式

Auto-Increment 配置/处理

Row	Auto_incr value
1	1
2	2?
3	3?
…	..
10	10?

```
mysql> create table mytable (f1 int not null primary key auto_increment, f2 varchar(20));
Query OK, 0 rows affected (0.05 sec)

mysql> insert into mytable (f2) values ('aaa');
Query OK, 1 row affected (0.05 sec)

mysql> insert into mytable (f2) values ('aaa');
Query OK, 1 row affected (0.03 sec)

mysql> select * from mytable;
+----+------+
| f1 | f2   |
+----+------+
|  1 | aaa  |
|  8 | aaa  |
+----+------+
2 rows in set (0.00 sec)
```

```
mysql@virtual-41:~/demo
mysql> show variables like '%increment_increment%';
+----------------------------------------------+-------+
| Variable_name                                | Value |
+----------------------------------------------+-------+
| auto_increment_increment                     | 1     |
| group_replication_auto_increment_increment   | 7     |
+----------------------------------------------+-------+
2 rows in set (0.01 sec)

mysql>
```

Row	Auto_incr value
1 by M1	1
2 by M2	2
3 by M3	3
…	..
10 by M1	8
11 by M3	10

Row	Auto_incr value
12 by M1	15
13 by M2	9
14 by M3	17
…	..

[1]: http://mysqlhighavailability.com/mysql-group-replication-auto-increment-configuration-handling/

3 MySQL Group Replication 功能

- 3.1 **Single Primary Mode (Default)** —单主模式
- 3.2 **Multi-Master Update Everywhere** —多主模式
- 3.3 **Parallel Appliers Support** **- 多线程 applier 支持**

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多线程 applier 支持

- 以异步复制体系结构为基础
  - 有自带的 ‘channel’
    - group_replication_applier channel
  - 将binlog事件插入group_replication_applier通道的 relay log
  - 以异步复制相同的方式配置

```
--slave_parallel_workers = NUMBER
--slave_parallel_type = logical_clock
--slave_preserve_commit_order = ON
```

3 MySQL Group Replication 功能

- 3.1 **Single Primary Mode (Default)** —单主模式
- 3.2 **Multi-Master Update Everywhere** —多主模式
- 3.3 **Parallel Appliers Support** - 多线程 applier 支持
- 3.4 **Full GTID Replication Support** - GTID 复制支持

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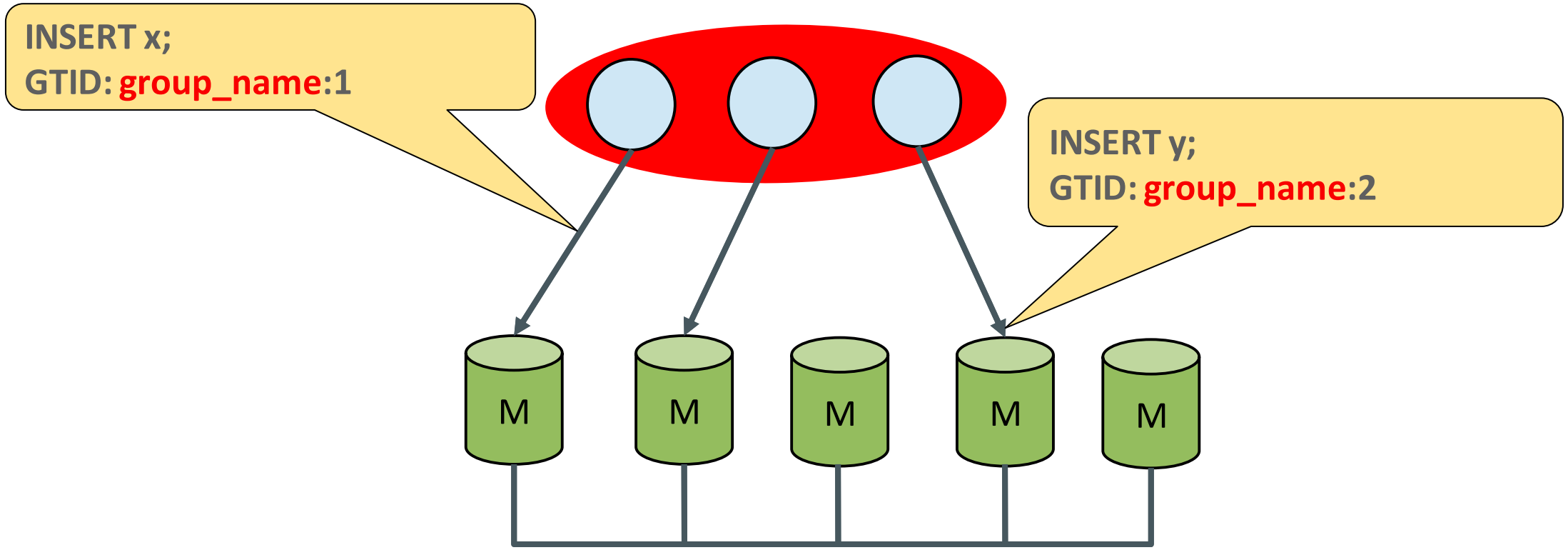
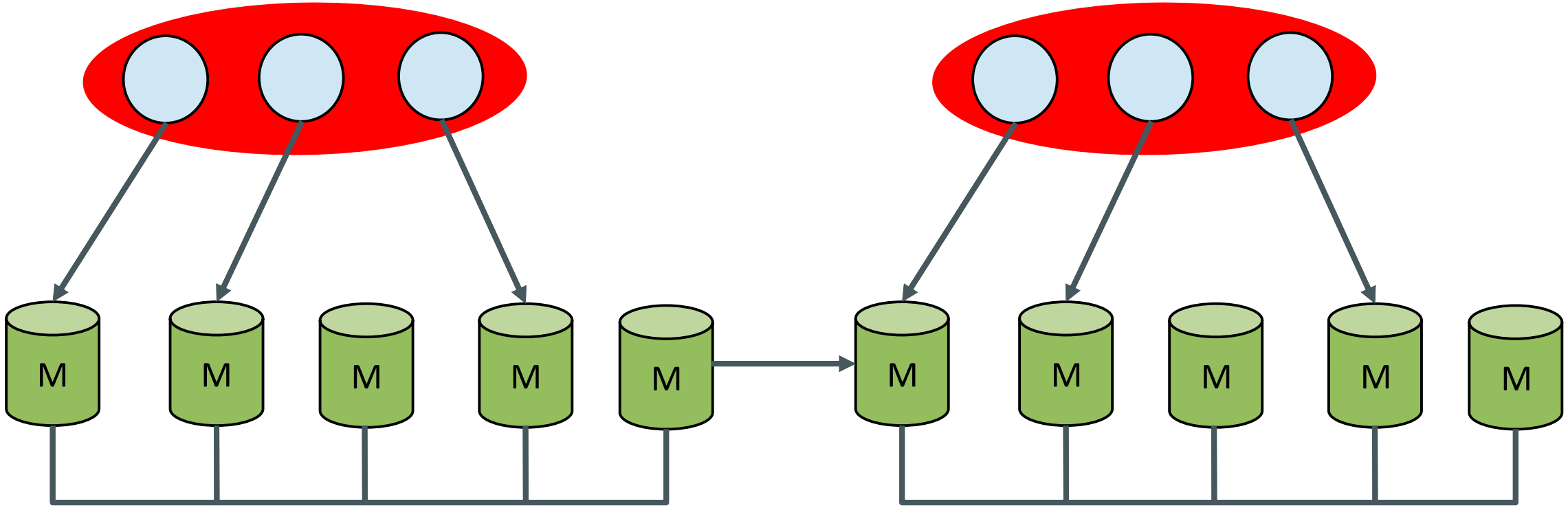
完全GTID复制支持

- 所有群组成员生成具有相同UUID（group_name）的GTID 。



完全GTID复制支持

- 跨群组复制支持



3 MySQL Group Replication 功能

- 3.1 Single Primary Mode (Default) —单主模式
- 3.2 Multi-Master Update Everywhere —多主模式
- 3.3 Parallel Appliers Support - 多线程 applier 支持
- 3.4 Full GTID Replication Support - GTID 复制支持
- 3.5 Group Replication Monitor - 检查状态

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Group Replication Monitor-检查状态

- 两个新的performance_schema表
  - replication_group_members

```
mysql@virtual-41:~/demo
[mysql@virtual-41 demo]$ mysql -uroot -h127.0.0.1 -e "SELECT * FROM performance_schema.replication_group_members;
> "
+---------------------------+--------------------------------------+---------------------+-------------+--------------+
| CHANNEL_NAME              | MEMBER_ID                            | MEMBER_HOST         | MEMBER_PORT | MEMBER_STATE |
+---------------------------+--------------------------------------+---------------------+-------------+--------------+
| group_replication_applier | 79d8f230-c5a1-11e6-a0c0-080027867cd7 | virtual-41.localhost |        3306 | ONLINE       |
| group_replication_applier | 7cc78540-c5a1-11e6-a1f4-080027867cd7 | virtual-41.localhost |        3316 | ONLINE       |
+---------------------------+--------------------------------------+---------------------+-------------+--------------+
[mysql@virtual-41 demo]$
```

  - replication_group_member_stats

    Stats of local member

```
mysql@virtual-41:~/demo
mysql@virtual-41 demo]$ mysql -t -uroot -h127.0.0.1 -e "SELECT * FROM performance_schema.replication_group_member_stats\G"
*************************** 1. row ***************************
                      CHANNEL_NAME: group_replication_applier
                           VIEW_ID: 14821385998969119:2
                         MEMBER_ID: 79d8f230-c5a1-11e6-a0c0-080027867cd7
       COUNT_TRANSACTIONS_IN_QUEUE: 0
        COUNT_TRANSACTIONS_CHECKED: 4
          COUNT_CONFLICTS_DETECTED: 0
OUNT_TRANSACTIONS_ROWS_VALIDATING: 0
RANSACTIONS_COMMITTED_ALL_MEMBERS: 8a94f357-aab4-11df-86ab-c80aa9429562:1-16
    LAST_CONFLICT_FREE_TRANSACTION: 8a94f357-aab4-11df-86ab-c80aa9429562:16
mysql@virtual-41 demo]$
```

- Expands Replication performance_schema Tables
  - group_replication_recovery channel information
  - group_replication_applier channel information
- New Global Status
  - group_replication_primary_member

```
mysql@virtual-41:~/demo
mysql@virtual-41 demo]$ mysql -t -uroot -h127.0.0.1 -e "show global status like 'group_replication_primary_member';"
+----------------------------------+--------------------------------------+
| Variable_name                    | Value                                |
+----------------------------------+--------------------------------------+
| group_replication_primary_member | 79d8f230-c5a1-11e6-a0c0-080027867cd7 |
+----------------------------------+--------------------------------------+
mysql@virtual-41 demo]$
```

3 MySQL Group Replication 功能

- 3.1 Single Primary Mode (Default) —单主模式
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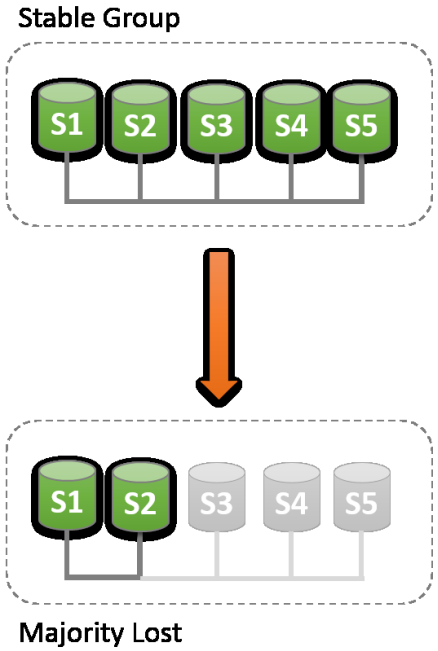
- 3.4 Full GTID Replication Support - GTID 复制支持
- 3.5 Group Replication Monitor - 检查状态
- 3.5 Group Replication (quorum) - 脑裂处理

ORACLE

MySQL Group Replication- 脑裂处理

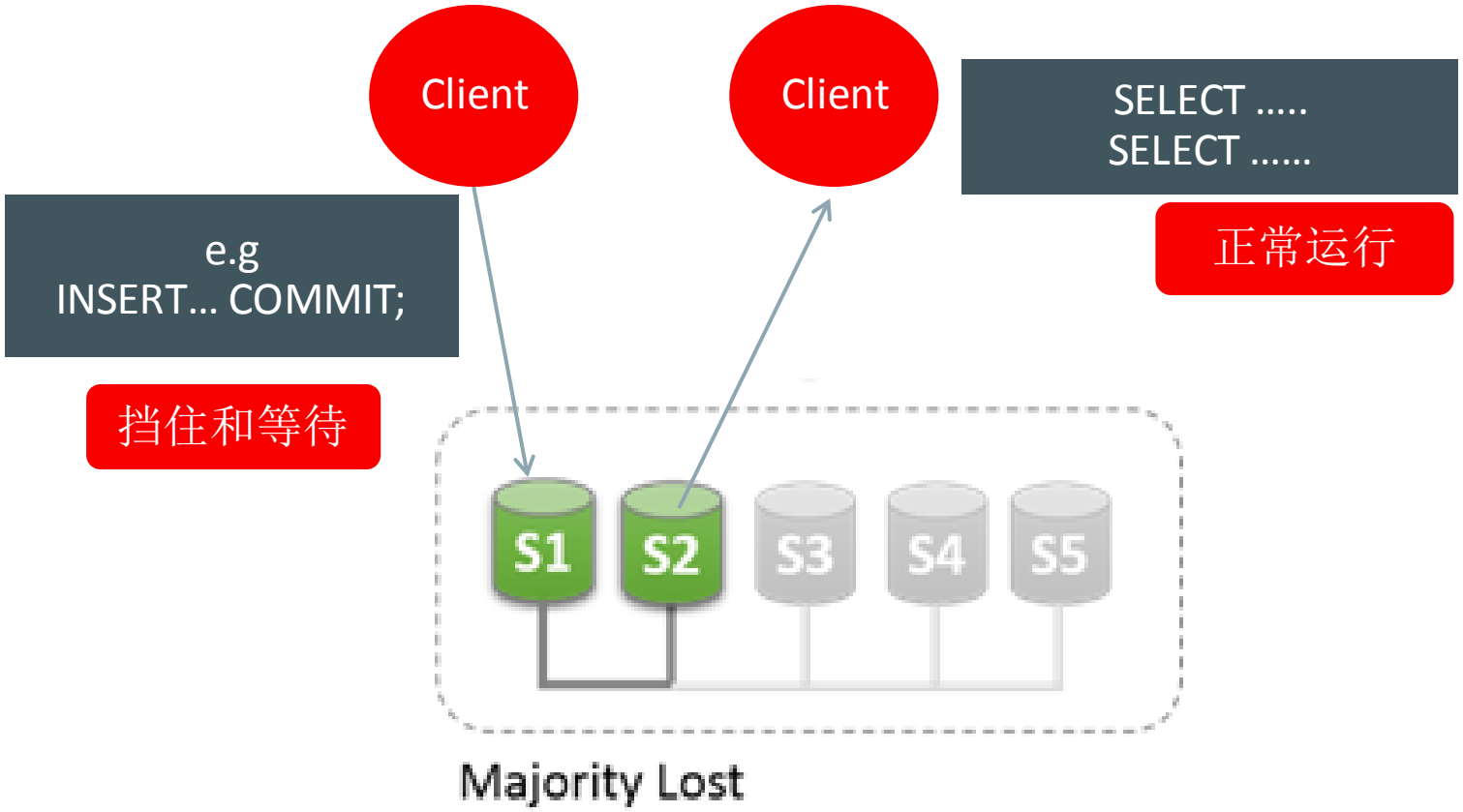
- 检测分区
  - Performance_Schema.replication_group_members




```
mysql> SELECT * FROM performance_schema.replication_group_members;
+---------------------------+--------------------------------------+-------------+-------------+--------------+
| CHANNEL_NAME              | MEMBER_ID                            | MEMBER_HOST | MEMBER_PORT | MEMBER_STATE |
+---------------------------+--------------------------------------+-------------+-------------+--------------+
| group_replication_applier | 1999b9fb-4aaf-11e6-bb54-28b2bd168d07 | 127.0.0.1   | 13002       | UNREACHABLE  |
| group_replication_applier | 199b2df7-4aaf-11e6-bb16-28b2bd168d07 | 127.0.0.1   | 13001       | ONLINE       |
| group_replication_applier | 199bb88e-4aaf-11e6-babe-28b2bd168d07 | 127.0.0.1   | 13000       | ONLINE       |
| group_replication_applier | 19ab72fc-4aaf-11e6-bb51-28b2bd168d07 | 127.0.0.1   | 13003       | UNREACHABLE  |
| group_replication_applier | 19b33846-4aaf-11e6-ba81-28b2bd168d07 | 127.0.0.1   | 13004       | UNREACHABLE  |
+---------------------------+--------------------------------------+-------------+-------------+--------------+
5 rows in set (0,00 sec)
```

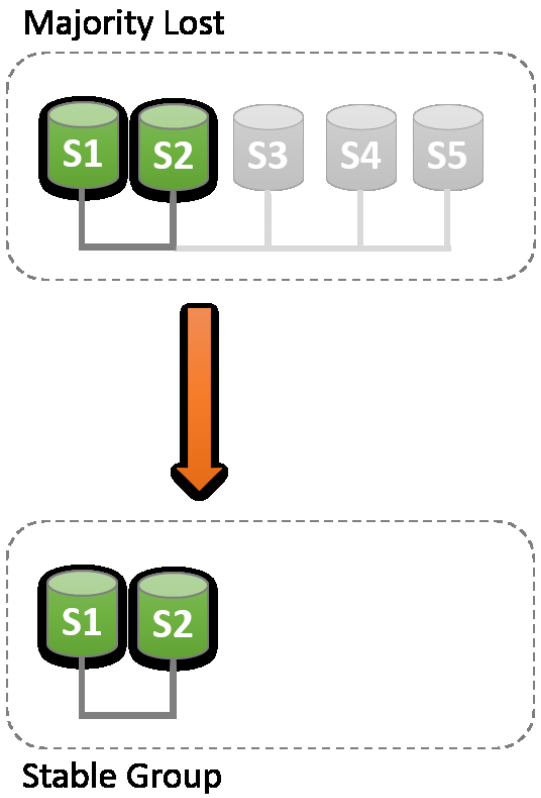
UNREACHABLE

MySQL Group Replication- 脑裂处理



MySQL Group Replication- 脑裂处理

group_replication_force_members



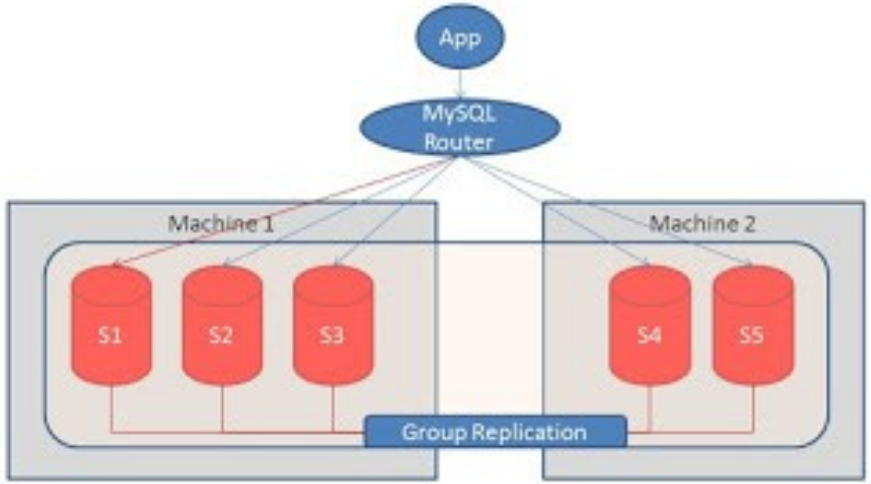

```
mysql> SET GLOBAL group_replication_force_members="localhost:10000,localhost:10001";
Query OK, 0 rows affected (7,13 sec)
```

```
mysql> select * from performance_schema.replication_group_members;
+---------------------------+--------------------------------------+-------------+-------------+--------------+
| CHANNEL_NAME              | MEMBER_ID                            | MEMBER_HOST | MEMBER_PORT | MEMBER_STATE |
+---------------------------+--------------------------------------+-------------+-------------+--------------+
| group_replication_applier | b5ffe505-4ab6-11e6-b04b-28b2bd168d07 | 127.0.0.1   | 13000       | ONLINE       |
| group_replication_applier | b60907e7-4ab6-11e6-afb7-28b2bd168d07 | 127.0.0.1   | 13001       | ONLINE       |
+---------------------------+--------------------------------------+-------------+-------------+--------------+
2 rows in set (0,00 sec)
```

gr_watchdog

http://mysqlhk.blogspot.hk/2017/03/watchdog-for-mysql-group-replication.html

- **WatchDog for MySQL Group Replication Servers**




```
mysql@virtual-23:~/demo/GroupReplication
Your MySQL connection id is 26
Server version: 5.7.17-enterprise-commercial-advanced-log MySQL Enterprise Server - Advanced Edition (Commercial)

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affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql> select * from performance_schema.replication_group_members;
+---------------------------+--------------------------------------+---------------------+-------------+--------------+
| CHANNEL_NAME              | MEMBER_ID                            | MEMBER_HOST         | MEMBER_PORT | MEMBER_STATE |
+---------------------------+--------------------------------------+---------------------+-------------+--------------+
| group_replication_applier | 2c9f7b30-f89d-11e6-ac44-08002728c7c8 | virtual-23.localhost |        3306 | ONLINE       |
| group_replication_applier | 2fdcca12-f89d-11e6-ae46-08002728c7c8 | virtual-23.localhost |        3316 | ONLINE       |
| group_replication_applier | 3378c864-f89d-11e6-b00e-08002728c7c8 | virtual-23.localhost |        3326 | ONLINE       |
| group_replication_applier | b7582800-fd7e-11e6-af97-080027437c74 | virtual-24.localhost |        3306 | ONLINE       |
| group_replication_applier | ba3bdde4-fd7e-11e6-b028-080027437c74 | virtual-24.localhost |        3316 | ONLINE       |
+---------------------------+--------------------------------------+---------------------+-------------+--------------+
5 rows in set (0.00 sec)

mysql>
```
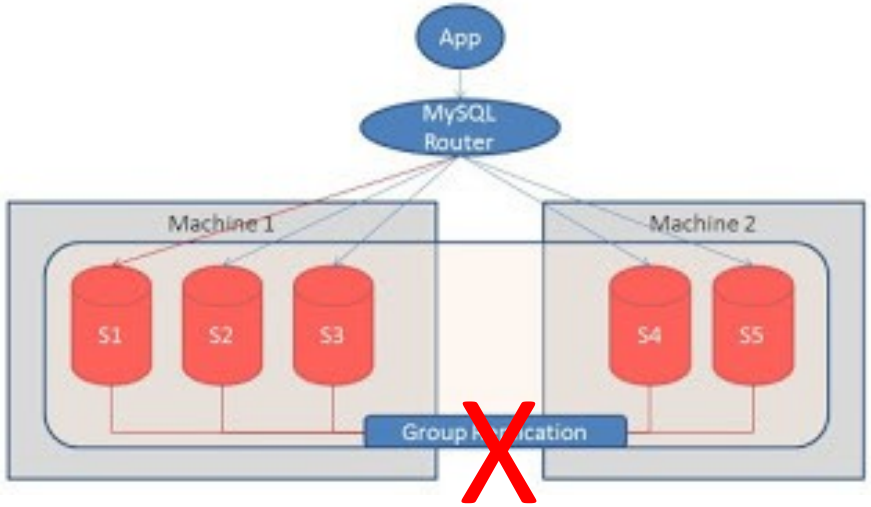

gr_watchdog

http://mysqlhk.blogspot.hk/2017/03/watchdog-for-mysql-group-replication.html

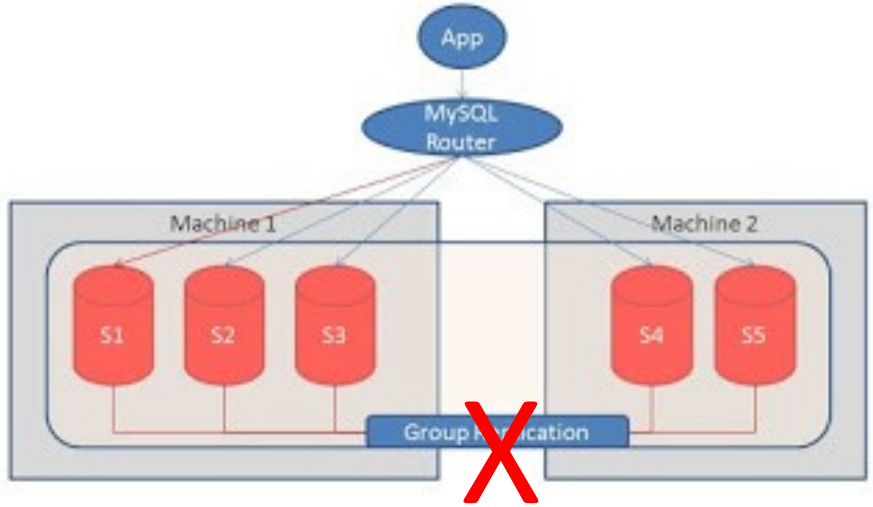
- **WatchDog for MySQL Group Replication Servers**



gr_watchdog

http://mysqlhk.blogspot.hk/2017/03/watchdog-for-mysql-group-replication.html

- **WatchDog for MySQL Group Replication Servers**



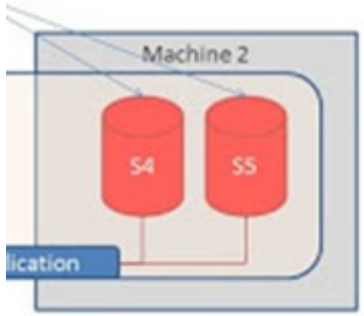

```
+----------------------+-------------+--------------+
| member_host          | member_port | member_state |
+----------------------+-------------+--------------+
| virtual-23.localhost |        3306 | UNREACHABLE  |
| virtual-23.localhost |        3316 | UNREACHABLE  |
| virtual-23.localhost |        3326 | UNREACHABLE  |
| virtual-24.localhost |        3306 | ONLINE       |
| virtual-24.localhost |        3316 | ONLINE       |
+----------------------+-------------+--------------+
```

```
+----------------------+-------------+--------------+
| member_host          | member_port | member_state |
+----------------------+-------------+--------------+
| virtual-23.localhost |        3306 | ONLINE       |
| virtual-23.localhost |        3316 | ONLINE       |
| virtual-23.localhost |        3326 | ONLINE       |
+----------------------+-------------+--------------+
3 rows in set (0.00 sec)
```

gr_watchdog - ACTION

http://mysqlhk.blogspot.hk/2017/03/watchdog-for-mysql-group-replication.html

- **WatchDog for MySQL Group Replication Servers**




```
+----------------------+-------------+--------------+
| member_host          | member_port | member_state |
+----------------------+-------------+--------------+
| virtual-23.localhost |        3306 | UNREACHABLE  |
| virtual-23.localhost |        3316 | UNREACHABLE  |
| virtual-23.localhost |        3326 | UNREACHABLE  |
| virtual-24.localhost |        3306 | ONLINE       |
| virtual-24.localhost |        3316 | ONLINE       |
+----------------------+-------------+--------------+
```

小数的一组

ACTION –
- SHUTDOWN / 关机
- RESTARTGR / 重起
- READONLY / 唯读

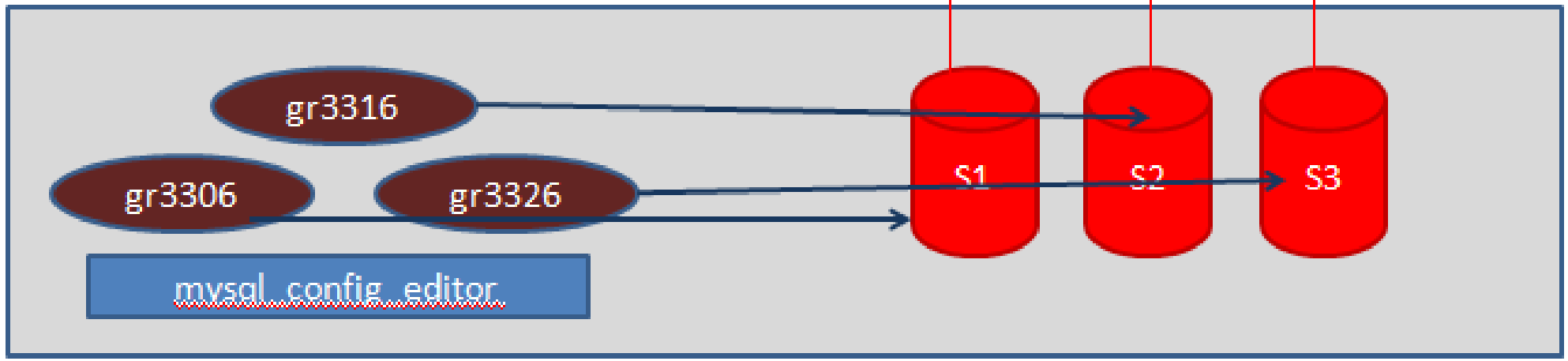
```
gr_comm.sh
==========================================

export MYSQL_HOME=/usr/local/mysql
export PATH=$MYSQL_HOME/bin:$PATH

# ACTION can be SHUTDOWN, READONLY
export ACTION=READONLY
export RETRY_COUNT=3
export QUIET_MODE=0

export GRSERVERS=gr3306:gr3316:gr3326
export GRINTERVAL=30
export OUTDIR=/home/mysql/demo/GroupReplication/grwatchdog/log
```

gr_watchdog.sh

Stored Function (from this DEMO)
==========
gr_is_major_online_member()

At interval "GRINTERVAL" Check if it is a ONLINE MEMBER in MAJORITY GROUP

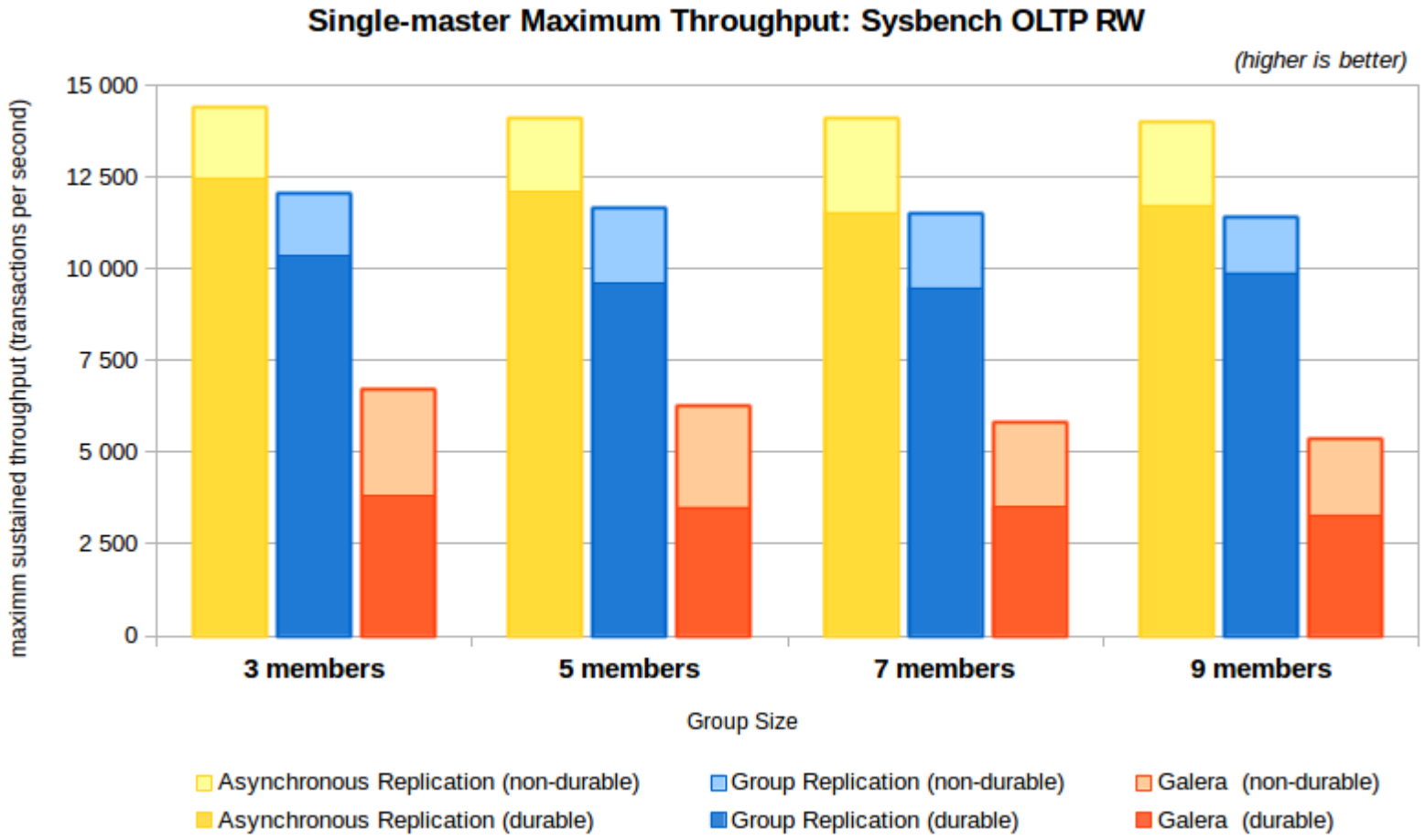
ACTION (SHUTDOWN | READONLY | RESTARTGR) if not ONLINE in MAJORITY GROUP



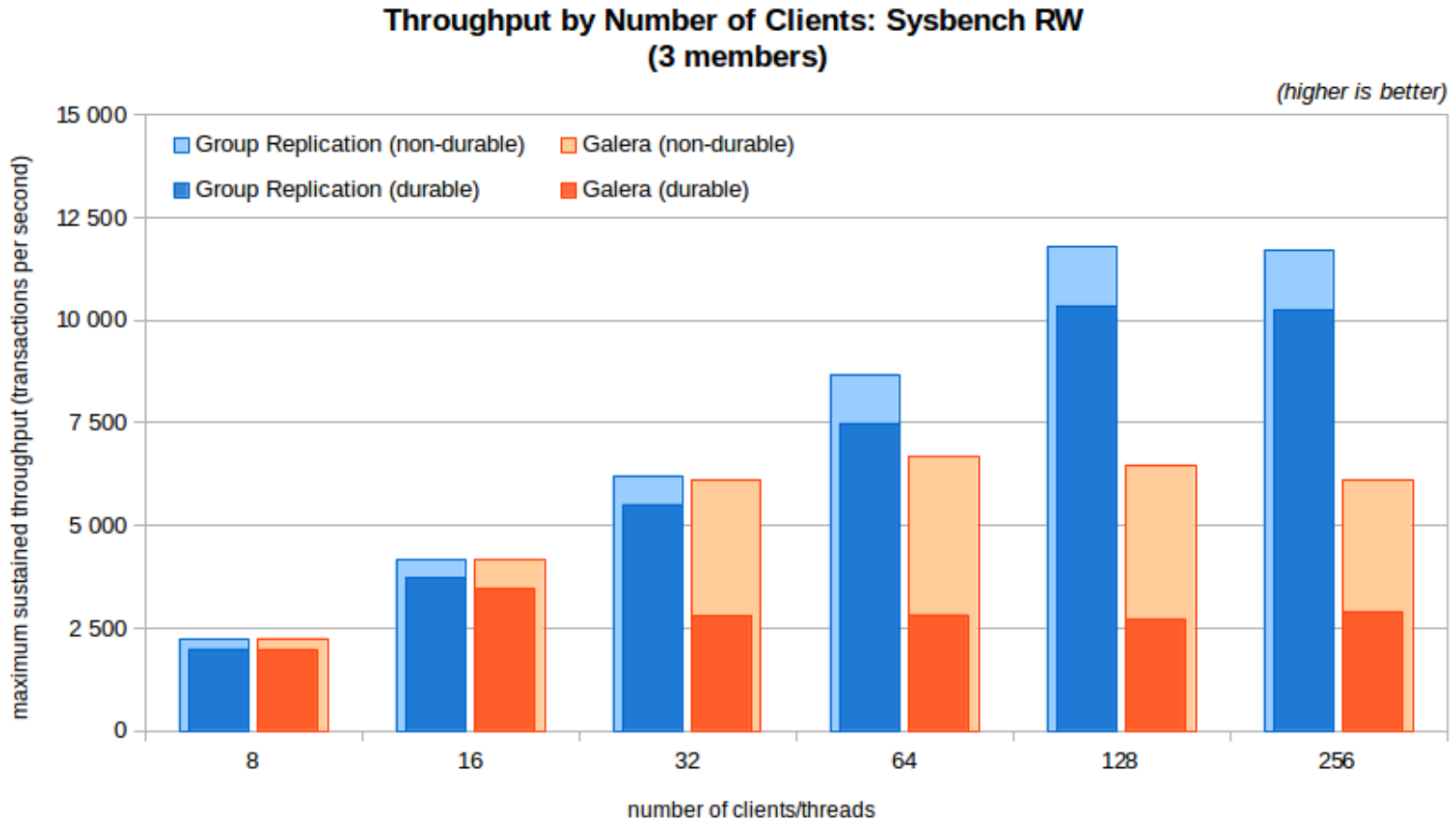
4 Performance / 性能

http://mysqlhighavailability.com/performance-evaluation-mysql-5-7-group-replication/

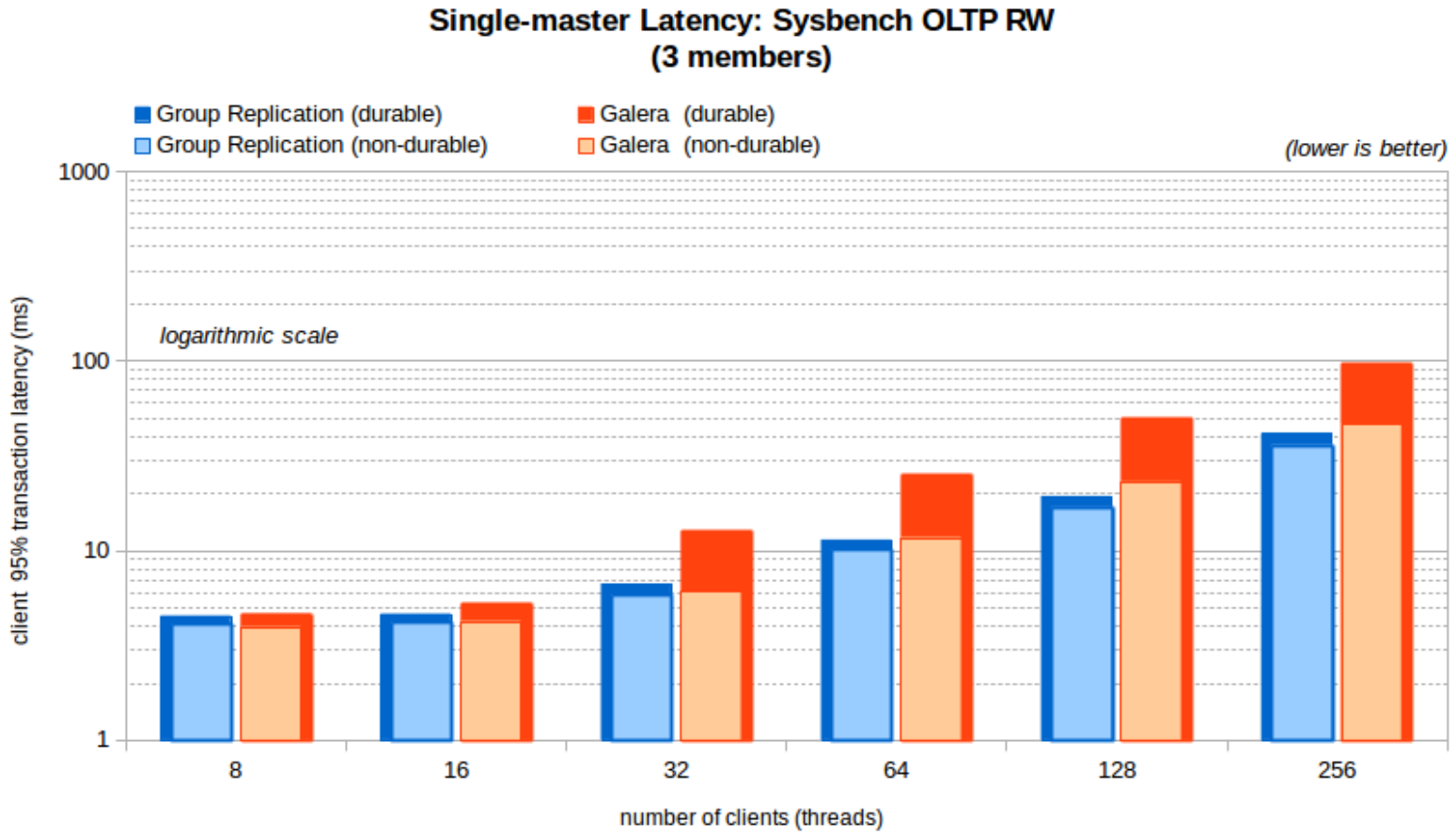
- The tests were performed using MySQL 5.7.17 with Group Replication and Percona XtraDB Cluster 5.7.14-26.17, which contains a fork of G



Throughput /吞吐量

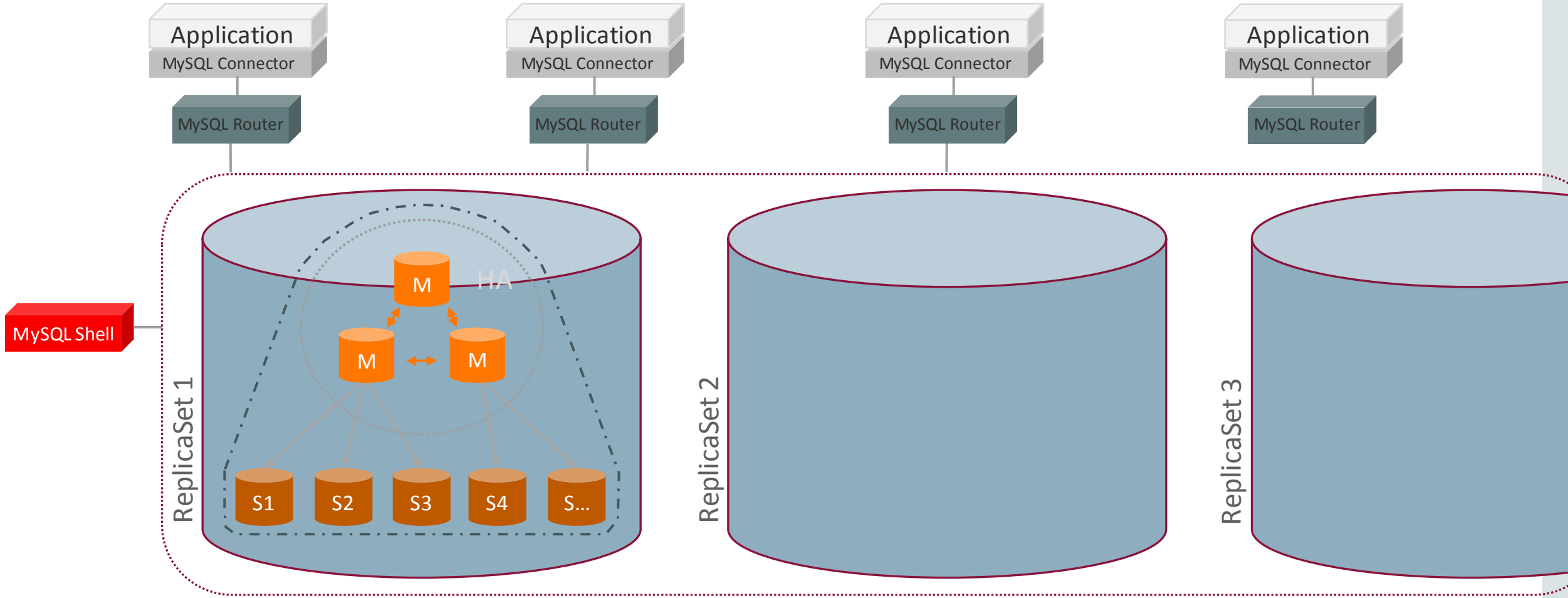


Latency /响应时间



5 MySQL InnoDB Cluster路线发展

MySQL InnoDB Cluster:最终目标



MySQL Group Replicatin 总结

- 更安全，容易用的高可用MySQL数据库平台
  - 通过稳定和成熟的核心API/插件来制定MySQL Group Replication
  - 通过 GTIDs, row based replication, performance schema tables 来搭建
  - 成员数据修复：服务器故障转移处理。
  - 提供容错，实现多主机更新和可靠的MySQL服务
  - 提供单主模式，多主模式–方便应用采用！
- **Cloud Friendly**
  - 用于需要弹性技术的部署，如基于云平台的基础
  - 不使用tcp广播，可用于云平台
- Group Replication 群组复制文档
  - http://mysqlhighavailability.com/gr/doc/