发挥MySQL 8.0的优势

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2018年10月22日
8.0.13 发布

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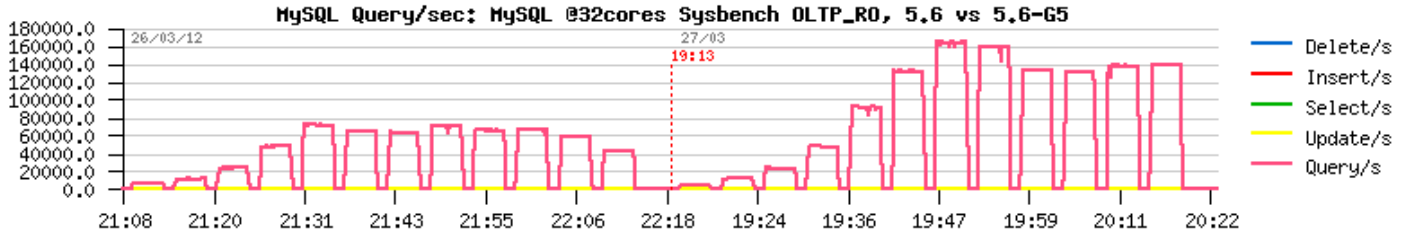
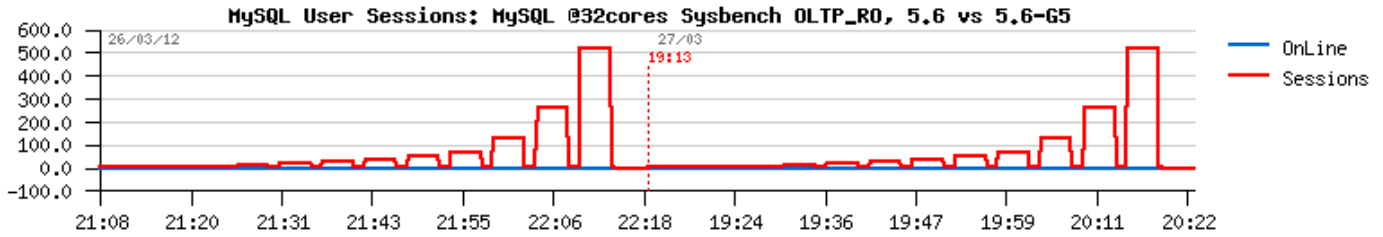
议程

1. MySQL 8.0 新功能
2. 文档存储的优势
3. MySQL 8.0 部署方案
4. Q & A

MySQL 扩展性优化阶段

- MySQL 5.5
  - Delivered “already known” solution (except Buffer Pool[BP] instances and few others)
- MySQL 5.6
  - 基本变化（kernel_mutex拆分，G5补丁，RO交易等...
  - http://dimitrik.free.fr/blog/archives/2012/04/mysql-performance-56labs-is-opening-a-new-era.html





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- MySQL 5.6
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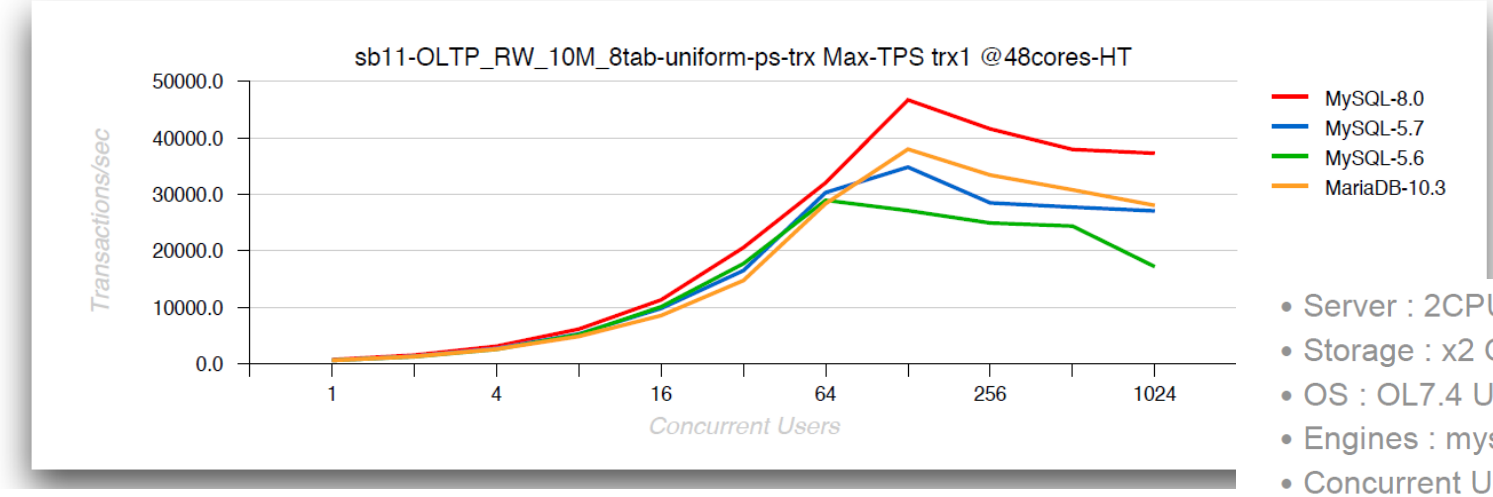
- MySQL 5.7
  - 只读(readonly)性能提升+“服务器”层的锁定争用
- MySQL 8.0
  - 用于InnoDB REDO处理的新设计（RW更快）
  - Resource Group (CPU resource), etc…

OLTP_RW latin1 @ MySQL 8.0 (Apr.2018)

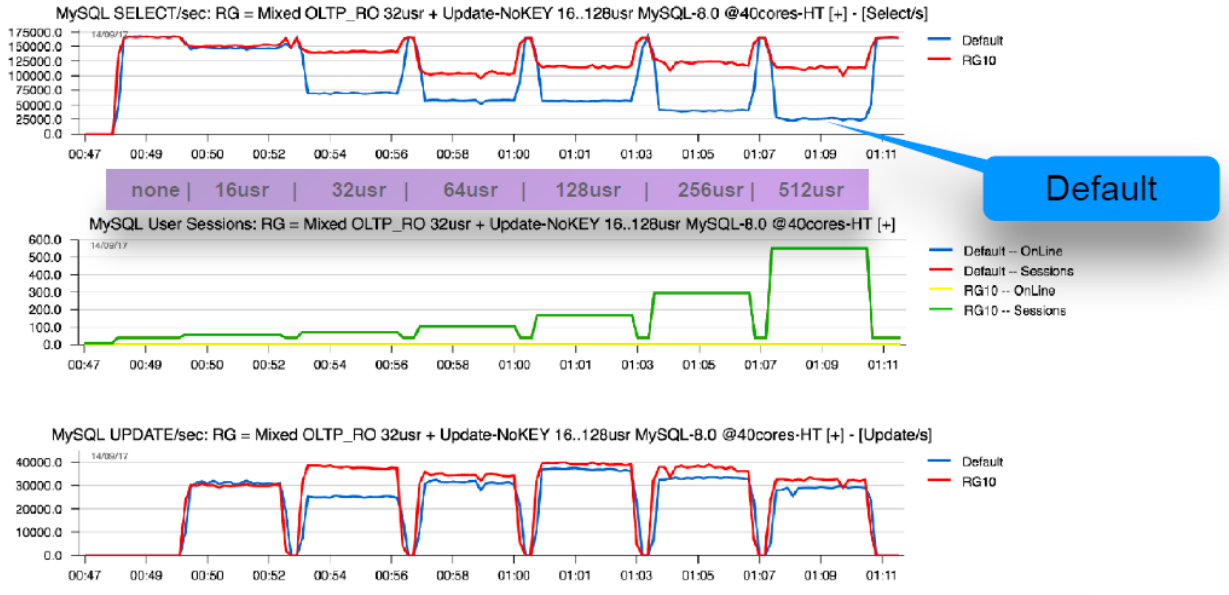
- **45K (!!) TPS** Sysbench OLTP_RW 10Mx8tab, trx_commit=1, 2S
  - **30**% gain vs MySQL 5.7
  - **50**% gain vs MySQL 5.6



- Server : 2CPU Sockets (2S) 48cores-HT Skylake
- Storage : x2 Optane NVMe, MDM-raid0, EXT4
- OS : OL7.4 UEK4
- Engines : mysql5.6, mysql5.7, mysql8.0, mariadb10.3.5
- Concurrent Users : **1**, **2**, **4**, .. **1024**
- charset : **latin1** (!! ;-))
- **trx_commit=1**
- REDO = 32GB
- O_DIRECT
- DBLWR=off, binlog=off, SSL=off, PFS=off, UNDO auto-truncate=off..

MySQL Resource Groups – 更少的资源争用

- Test case :
  - 40 cores – 4S (Broadwell) Server, OL7
  - 32 concurrent users running SELECT
  - UPDATE /*+ RESOURCE GROUP(RG10) */
    …
    - RG10 : CREATE RESOURCE GROUP RG10 type=user vcpu=0-9,40-49 thread_priority=0;



Derived Tables - 提取表

- Subquery in FROM clause

```
SELECT AVG(o_totalprice) FROM
        ( SELECT * FROM orders   ORDER BY o_totalprice DESC LIMIT 100000 ) td;
```

- MySQL 5.6 :单独执行并将结果存储在临时表中
- MySQL 5.7:处理提取表如视图：可以与外部查询块合并

MySQL 8.0 CTE : Readability / Performance

使用CTE获得更好的性能（MySQL 8.0）

- Derive tables cannot be referenced twice BUT CTEs can
- Better performance with materialization
  - Multiple CTE references are only materialized once
  - Dervied tables and views will be materialized once per reference

例：

Using view

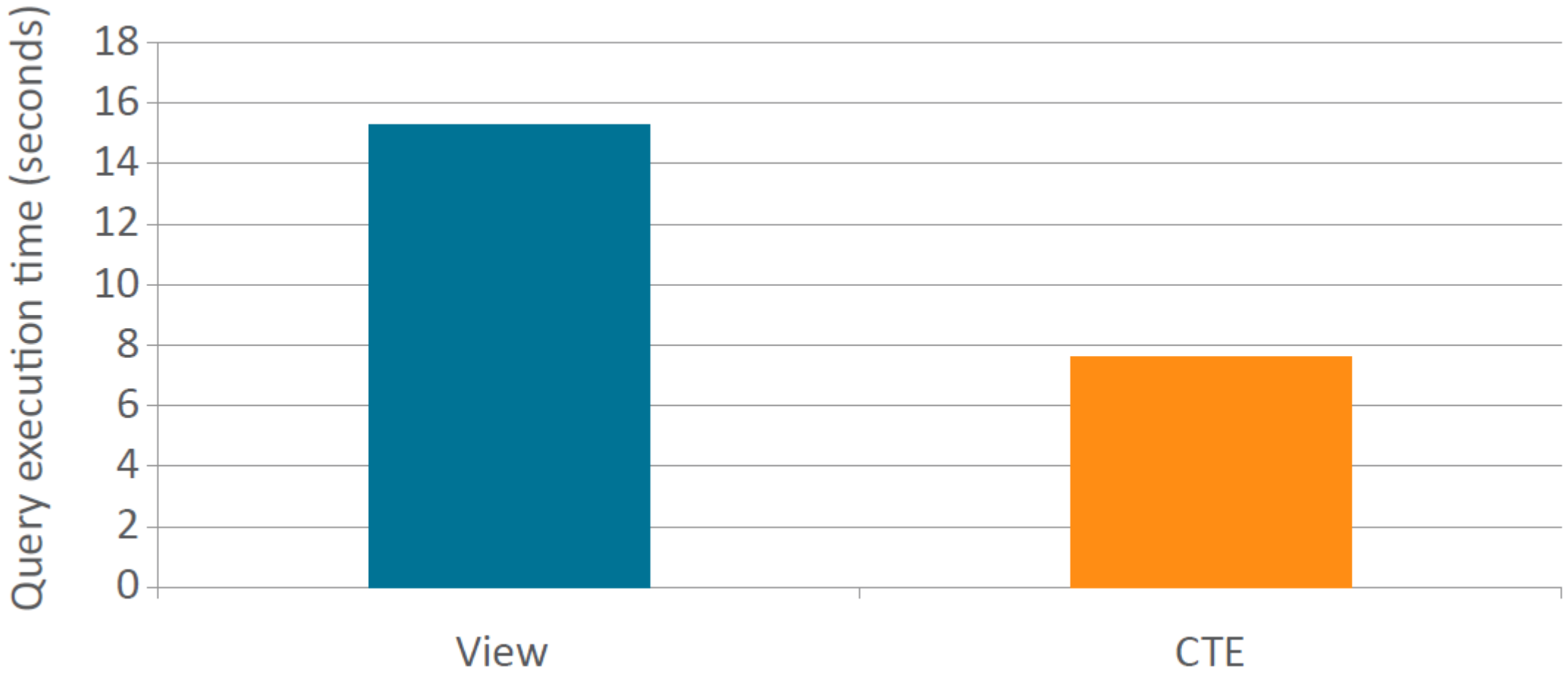
```
CREATE VIEW revenue0 (supplier_no, total_revenue) AS
(
   SELECT l_suppkey,
          SUM(l_extendedprice * (1- l_discount))
   FROM  lineitem
   WHERE l_shipdate >= '1996-07-01'
      AND l_shipdate < DATE_ADD('1996-07-01',
          INTERVAL '90' DAY)
   GROUP BY l_suppkey
);
```

Using CTE

```
WITH revenue0 (supplier_no, total_revenue) AS
(
   SELECT l_suppkey,
          SUM(l_extendedprice *  (1-l_discount))
   FROM  lineitem
   WHERE l_shipdate >= '1996-07-01'
      AND l_shipdate < DATE_ADD('1996-07-01',
          INTERVAL '90' DAY)
   GROUP BY  l_suppkey
)
```

```
SELECT s_suppkey, s_name, s_address, s_phone, total_revenue
FROM supplier, revenue0
WHERE s_suppkey = supplier_no AND total_revenue = (SELECT MAX(total_revenue) FROM revenue0)
ORDER BY s_suppkey;
```

性能



MySQL 复制

- MySQL 5.6
  - 快速传输：多线程从站（按数据库）轻松实现GTID故障切换
- MySQL 5.7
  - 多源复制，多线程从属，无损半同步复制
  - 崩溃安全复制(REPOSITORY=TABLE)
- MySQL InnoDB Cluster
  - 开箱即用的MySQL HA解决方案
- MySQL 8.0

高效的复制 - Applier

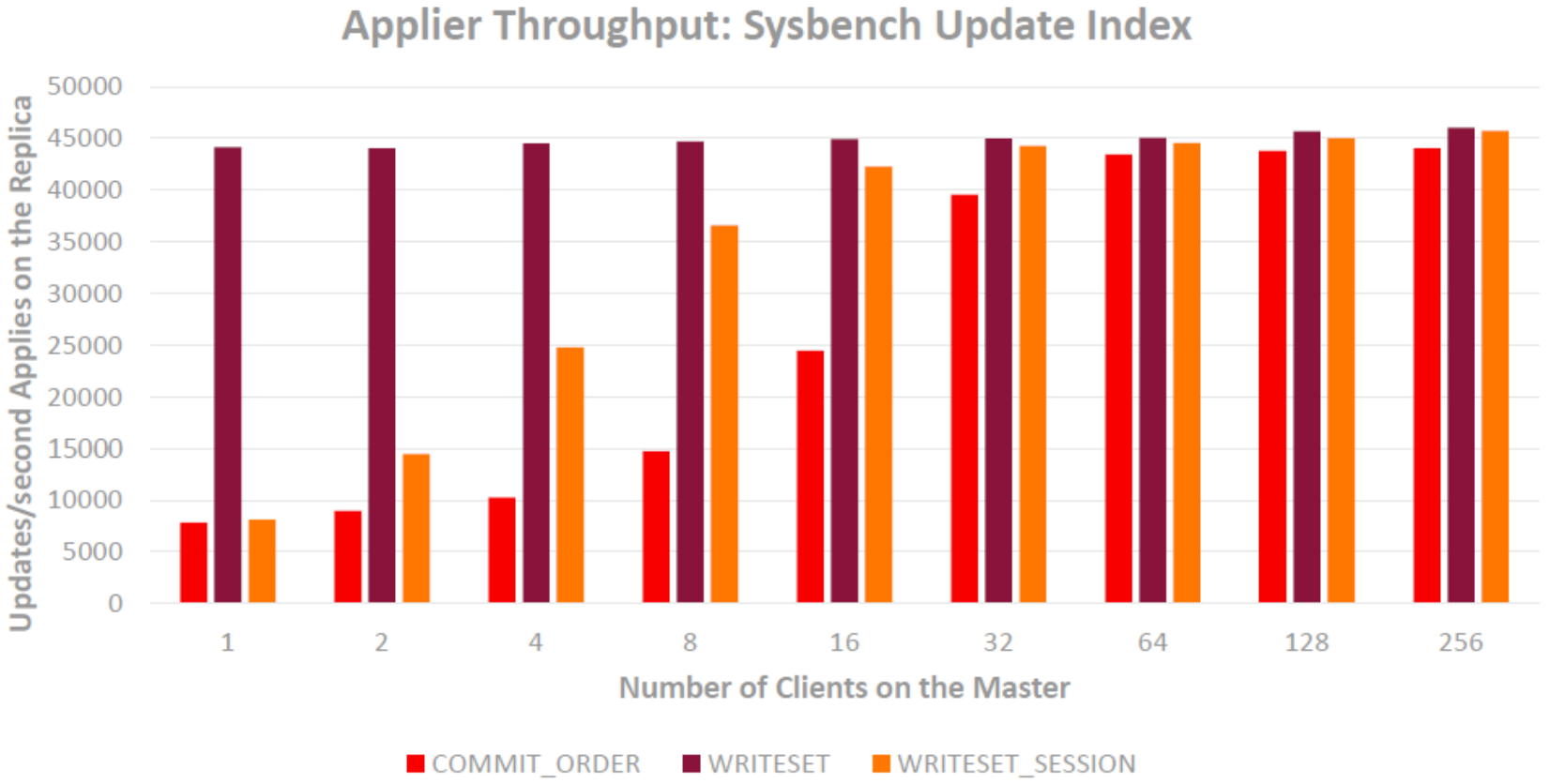
Write set 并发

- WRITESET 依赖关系跟踪允许并行应用单个线程工作负载
- WRITESET_SESSION in addition to writesets tracks sessions dependencies.
- 快速组复制恢复 - 追赶数据滞后

高效的复制 - Applier

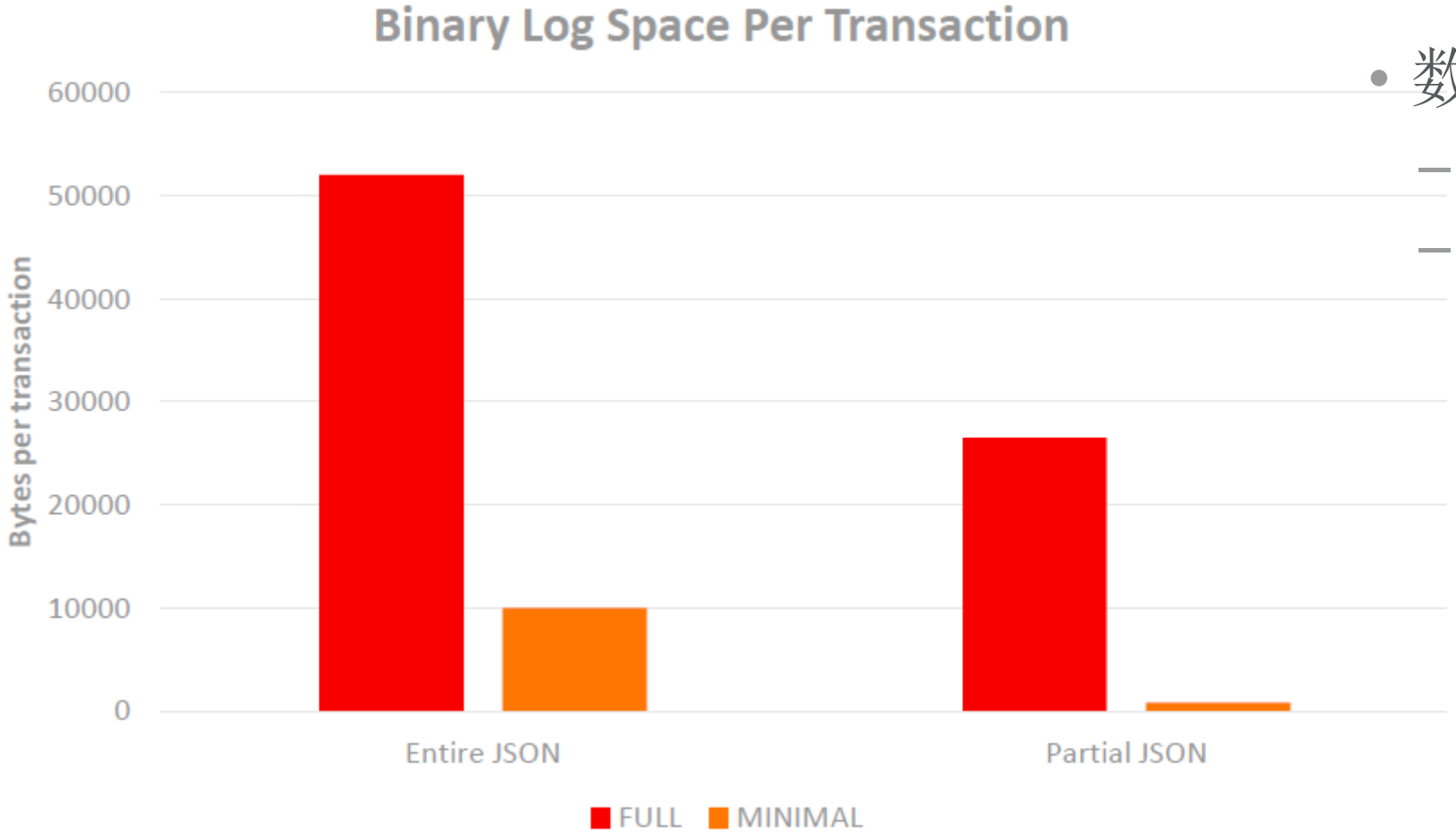
Write set 并行

- WRITESET & WRITESET_SESSION dependency tracking



高效复制JSON文档

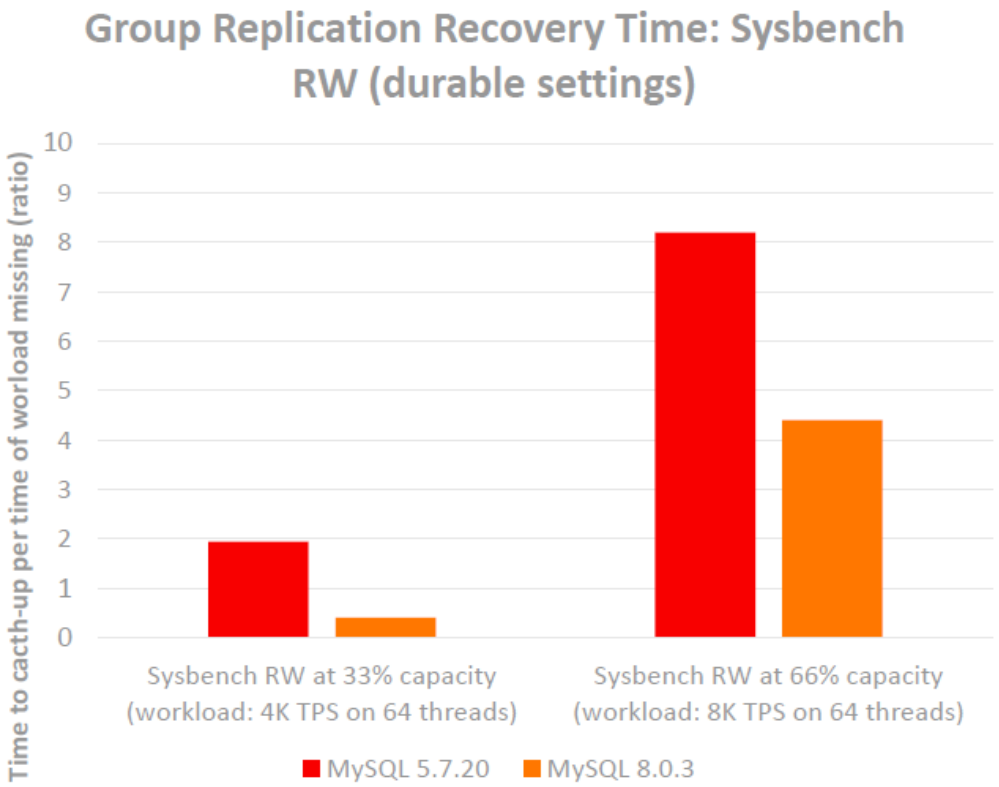
仅复制更改(Partial JSON Updates)

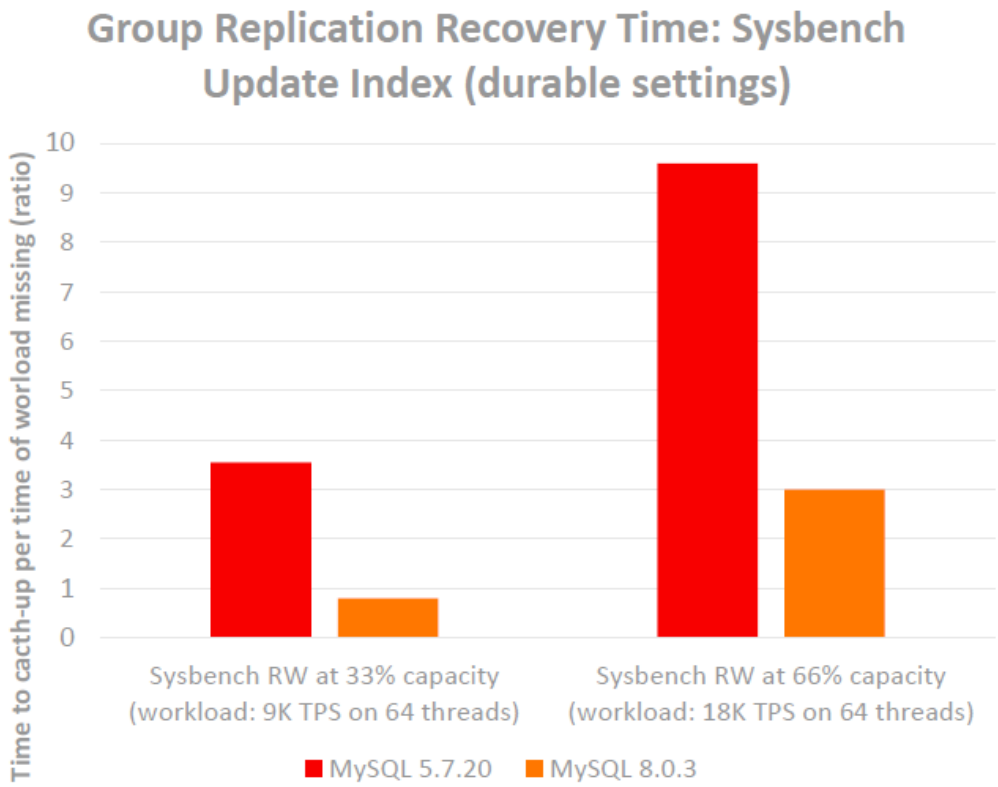


- 数据基准：：
  - 表有10个JSON字段，
  - 每笔交易修改~10%的数据

快速组复制恢复

使用WRITESET快速在线复制副本





All these features **plus…**

- Source code now documented with Doxygen
- New Plugin Infrastructure
- Improved BLOB Storage
- Improved Memcached Interface
- InnoDB Auto Increment Persists
- Parser Refactoring
- Improvements to Temporary Tables
- C++11 and Toolchain Improvements
- GTID_PURGED always settable
- Undo tablespaces now dynamic
- In memory storage engine
- SQL Roles Support
- Encryption for Redo and General Tablespaces
- InnoDB Cats lock scheduler algorithm
- Improved Parallel Replication
- SQL Grouping Function
- Optimizer Trace detailed sort statistics
- Smaller Package Downloads
- Improved usability of cost constant configuration

MySQL作为文档存储

NoSQL的魅力

- 越来越多 用户/公司 开始尝试NoSQL

对 RDBMS的疑惑	后来发现NoSQL的不足，限制和问题
RDBMS扩展性低	缺乏“参照完整性””Referential Integrity”
开发人员不喜欢SQL，等等	缺乏ACID支持

- 结果：
  - 对传统数据库上开发NoSQL接口（例如Uber使用Schemaless）
  - 开发存储引擎，实现NoSQL（例如Facebook使用MyRocks /RocksDB)
  - 使用一些支持JSON的RDBMS

MySQL文档存储【Document Store】

- 使用MySQL文档存储，轻松保存和检索“JSON”数据
- 提供JSON列为数据存储，以新语法 + 新JSON函数 (jsoncol->”$.item” / Generated Columns) 来处理文档，方便使用
- 提供跟MySQL的RDBMS的逻辑一致性支持
- 同时，跨文档/关系表的混合使用
- 灵活性是关键

JSON 与 TABLE 的转换

- TABLE → JSON

```
+------+------+------+
| id   | name | age  |
+------+------+------+
|    1 | John |   34 |
|    2 | Mary |   40 |
|    3 | Mike |   44 |
+------+------+------+
```

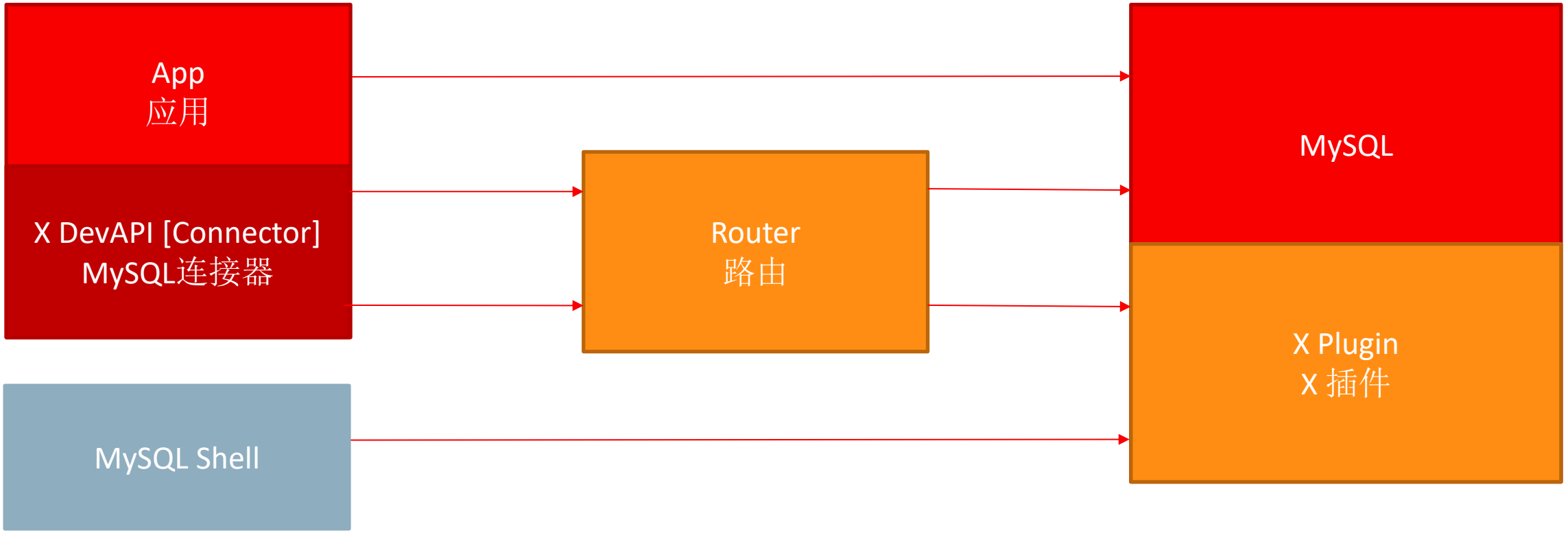
- SET @jsonempl=(
  SELECT JSON_ARRAYAGG(
- JSON_OBJECT("id", id,
  "name", name,
  "age", age))
- FROM mydb.employees);
- SELECT JSON_PRETTY(@jsonempl)\G

```
JSON_PRETTY(@jsonempl): [
  {
    "id": 1,
    "age": 34,
    "name": "John"
  },
  {
    "id": 2,
    "age": 40,
    "name": "Mary"
  },
  {
    "id": 3,
    "age": 44,
    "name": "Mike"
  }
]
```

- JSON → TABLE
- mysql> set @myjson=' [{ "id": 1, "age": 34, "name": "John" },
- { "id": 2, "age": 40, "name": "Mary" },
- { "id": 3, "age": 44, "name": "Mike" }]‘ ;
- create table mydb.newemployees as
- SELECT * from JSON_TABLE(@myjson, '$[*]'
- COLUMNS(
- id INT PATH '$.id',
- name VARCHAR(45) PATH '$.name',
- age INT PATH '$.age')) as emps;
- select * from mydb.newemployees;

```
+------+------+------+
| id   | name | age  |
+------+------+------+
|    1 | John |   34 |
|    2 | Mary |   40 |
|    3 | Mike |   44 |
+------+------+------+
```

主要组件



无模式化数据 【Schemaless Data】

- X DevAPI用上CRUD API，可以处理无模式数据
- 在文档存储方法上，允许在不用SQL的情况下处理数据

```
> users.add({ name: 'Rui' }).add({ name: 'Johannes' })
Query OK, 2 items affected (0.0373 sec)

> users.find()
[
    {
        "_id": "00005b50ced40000000000000001",
        "name": "Rui"
    },
    {
        "_id": "00005b50ced40000000000000002",
        "name": "Johannes"
    }
]
2 documents in set (0.0009 sec)
```

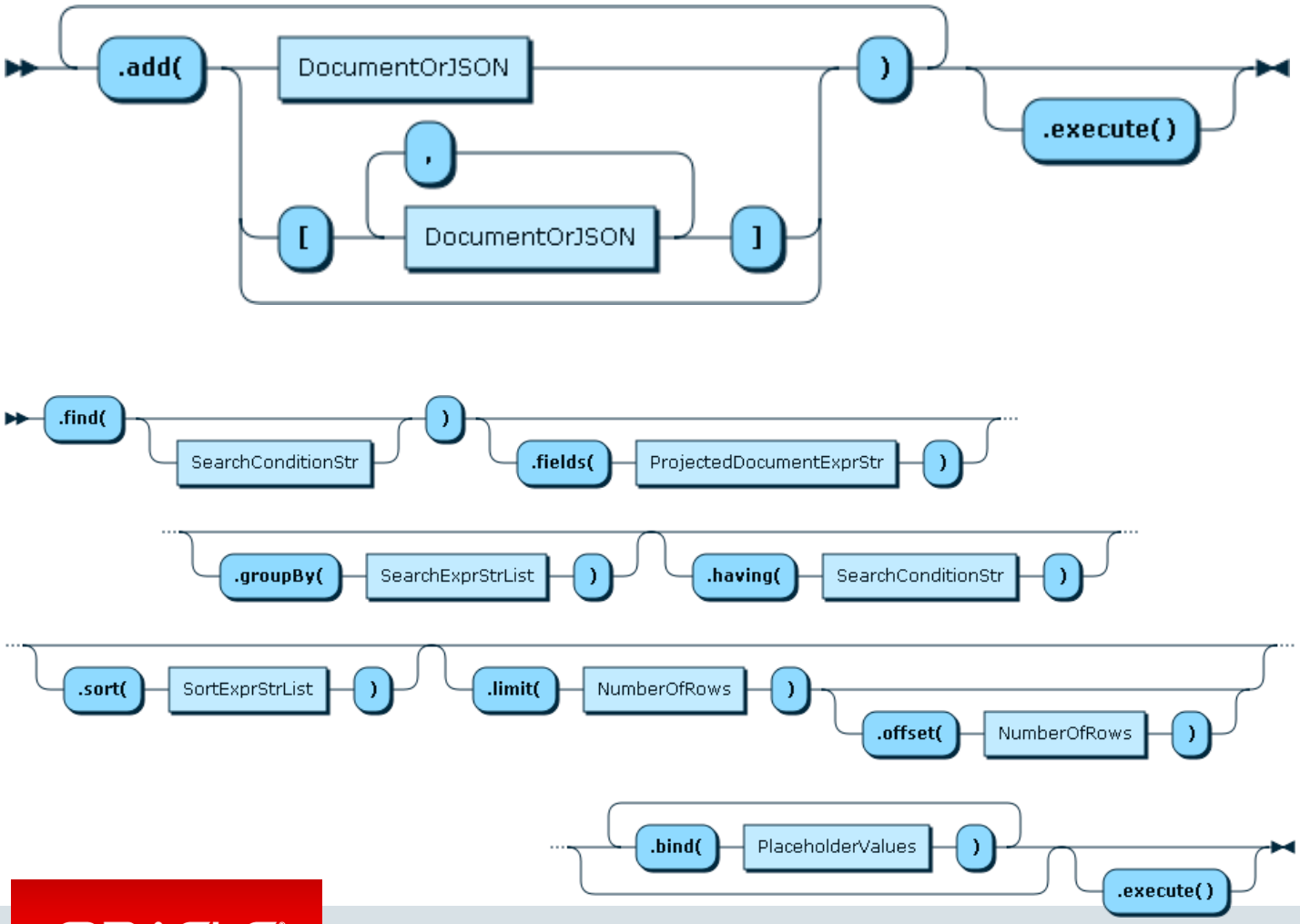
```
> users.modify('true').set('team', 'nodejs')
Query OK, 2 items affected (0.0751 sec)

> users.find('name = "Rui"')
[
    {
        "_id": "00005b50ced40000000000000001",
        "name": "Rui",
        "team": "nodejs"
    }
]
1 document in set (0.0026 sec)
```

易于编写和使用的 API

- 代码从 ***getSession() 开头***
- 更易读，可维护（甚至可测试）
- 操作封装在单行语义方法中
- 为重构任务提供很好的框架
- 提示和自动完成【auto-completion】提供支持

CollectionAdd / CollectionFind




```
collection.add({ name: 'foo', age: 42 })
  .add({ name: 'bar', age: 23 })
  .execute()

collection.add([
  { name: 'baz', age: 50 },
  { name: 'qux', age: 25 }
]).execute()
```

```
collection.find('name = :name')
  .bind('name', 'foo')
  .fields('COUNT(age) AS age')
  .groupBy('age')
  .having('age > 42')
  .sort('age DESC')
  .limit(10)
  .offset(5)
  .execute()
```

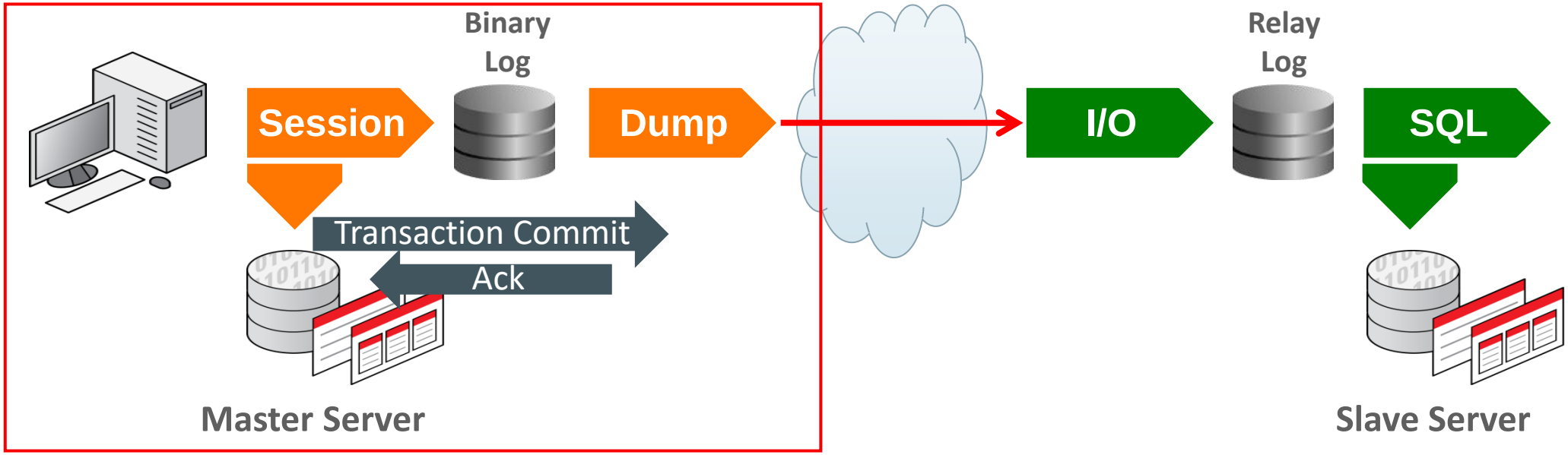
事务和保存点

- 在会话范围内，提供原子性操作
  - 在会话范围内创建，提交或回滚事务
  - 在这些事务中创建，释放或回滚到中间保存点

```
try {
  session.startTransaction()
  // run some operations (1)
  session.createSavepoint('foo')
  // run more operations (2)
  session.releaseSavepoint('foo')
  session.commit()
} catch (err) {
  try {
    session.rollbackTo('foo') // go to (2)
  } catch (err) {
    session.rollback() // revert the entire thing
  }
}
```

MySQL 8.0 不同部署方案

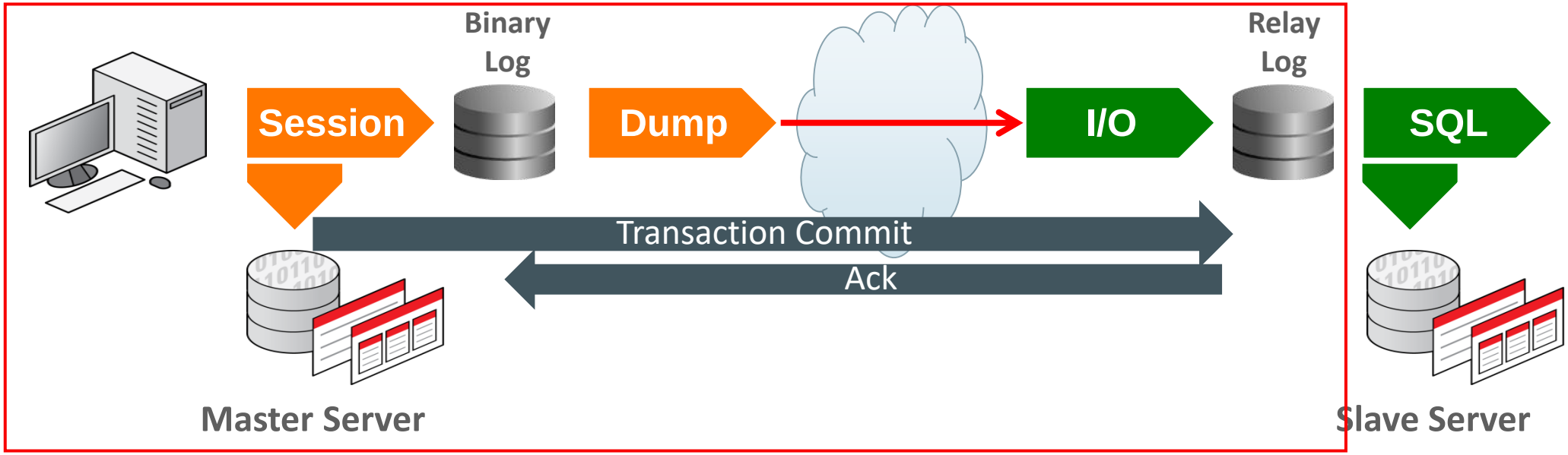
MySQL Replication – 异步复制



- Session thread updates requests to Storage Engine from application, and changes are written to binlog before apply to storage engine

- Dump thread reads event from binlog and propagate them to slave server
- I/O thread read replication events, stores them to relay log
- SQL thread: reads relay log and applies them to storage engines

MySQL Replication – 半同步复制

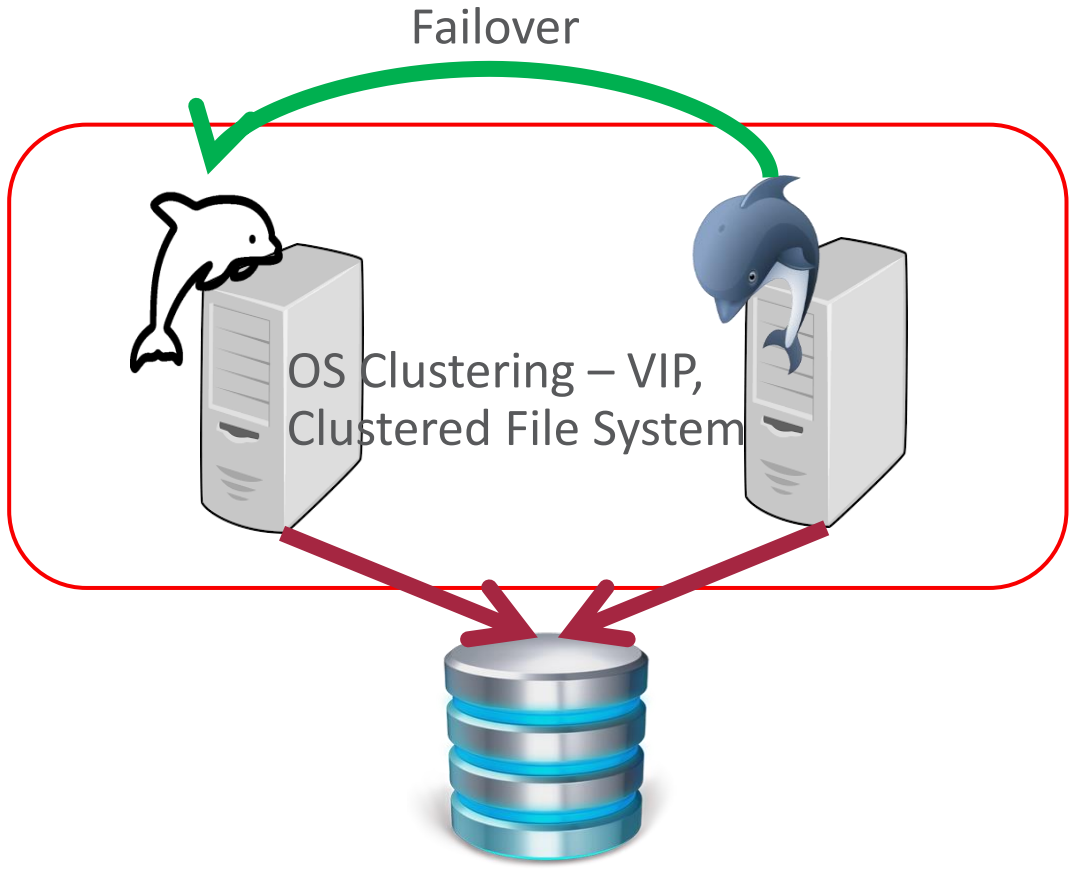


- Session thread updates requests to SE from application, and changes are written to binlog before apply to storage engine
- Dump thread reads event from binlog and propagate them to slave server
- I/O thread read replication events, stores them to relay log

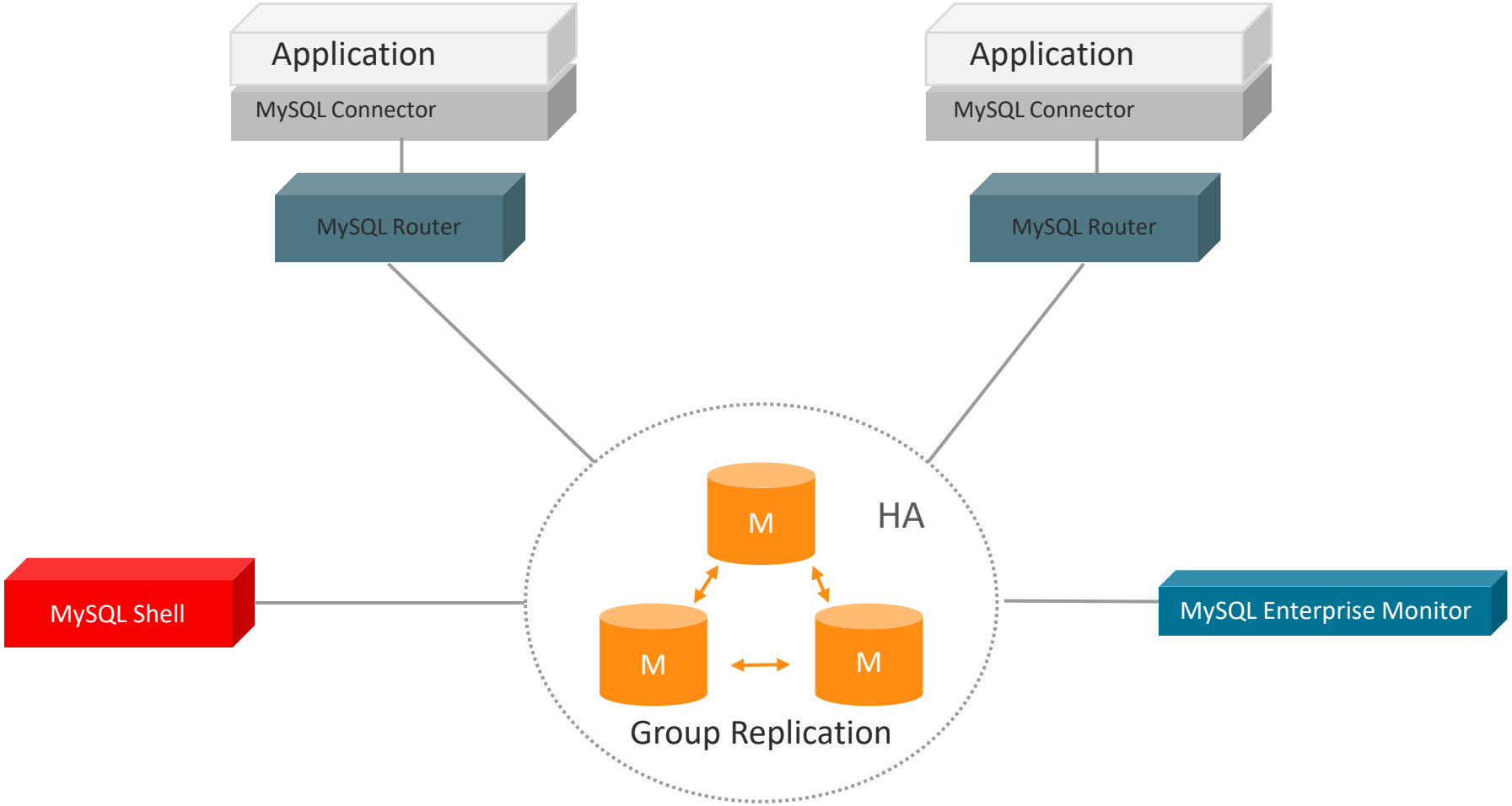
- SQL thread: reads relay log and applies them to storage engines

HA （共享存储） – Active / Passive

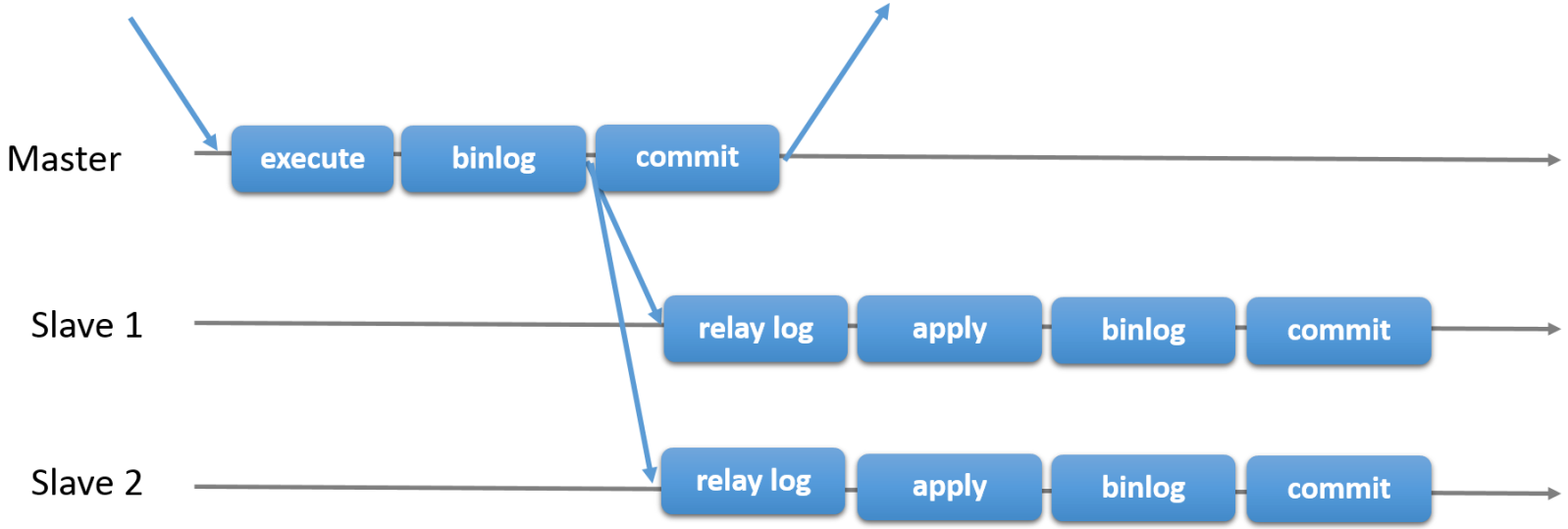
- 条件
  - 需要群集软件或在磁盘层上配置DRBD（可能需要额外的成本）
- 好处
  - VIP – 通用 / 成熟
  - 大多数情况下停机时间非常短
  - 故障时无数据丢失
- 坏处
  - 磁盘是单点故障
  - 在大批量DML失败时，崩溃恢复可能要更长停机时间
  - 没有水平可扩展性



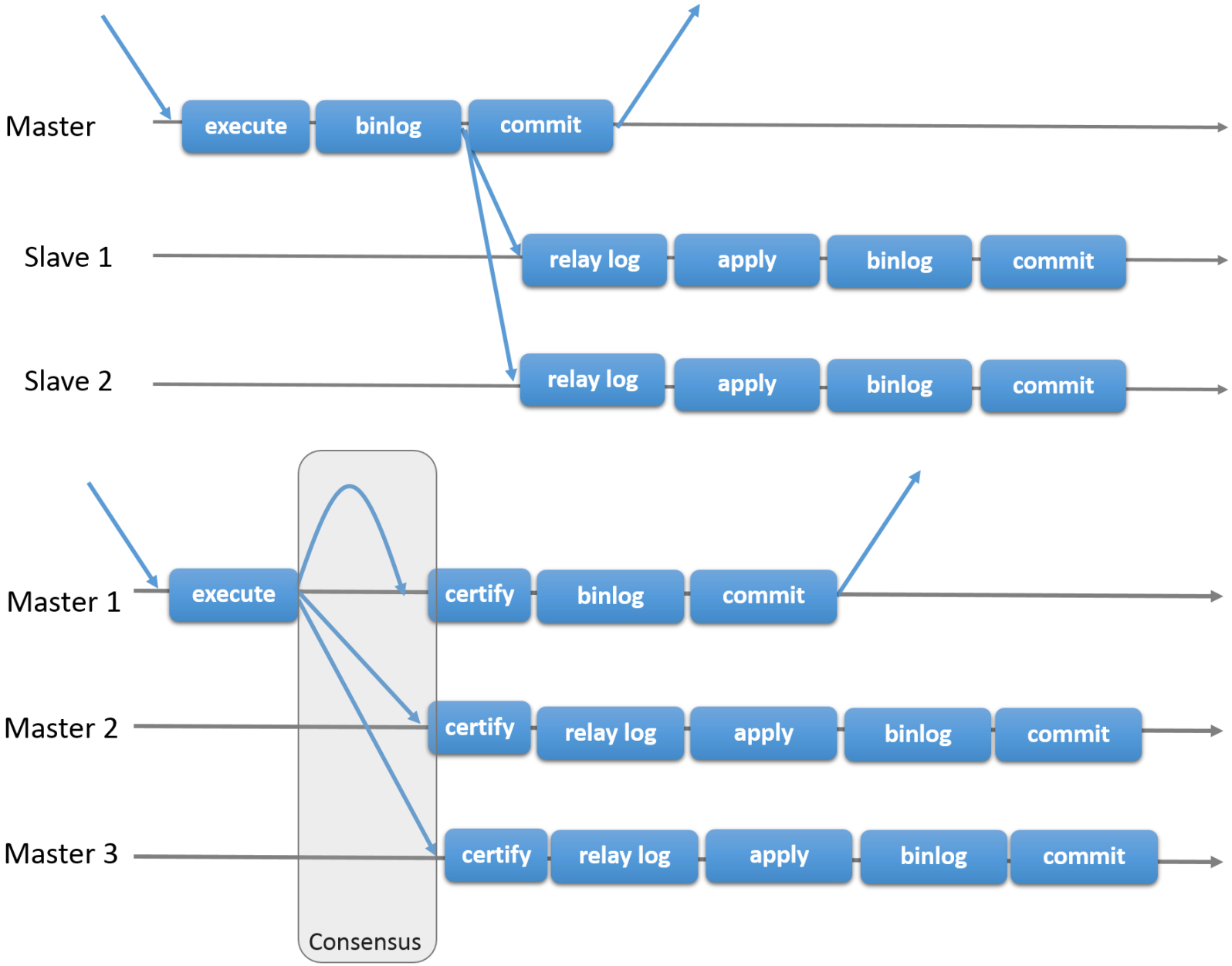
MySQL InnoDB Cluster: 架构



半同步复制

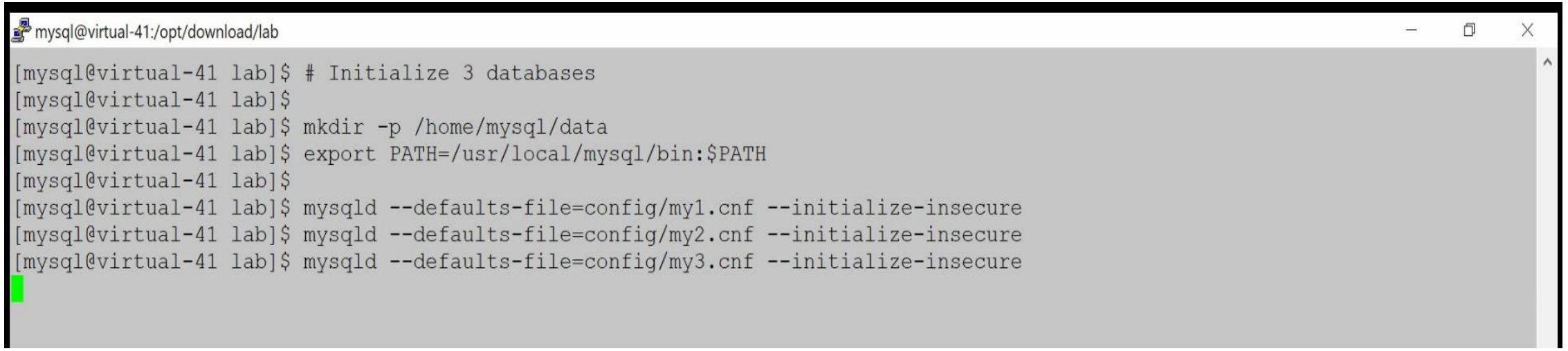


半同步复制 vs 组复制



Initialize 3 database

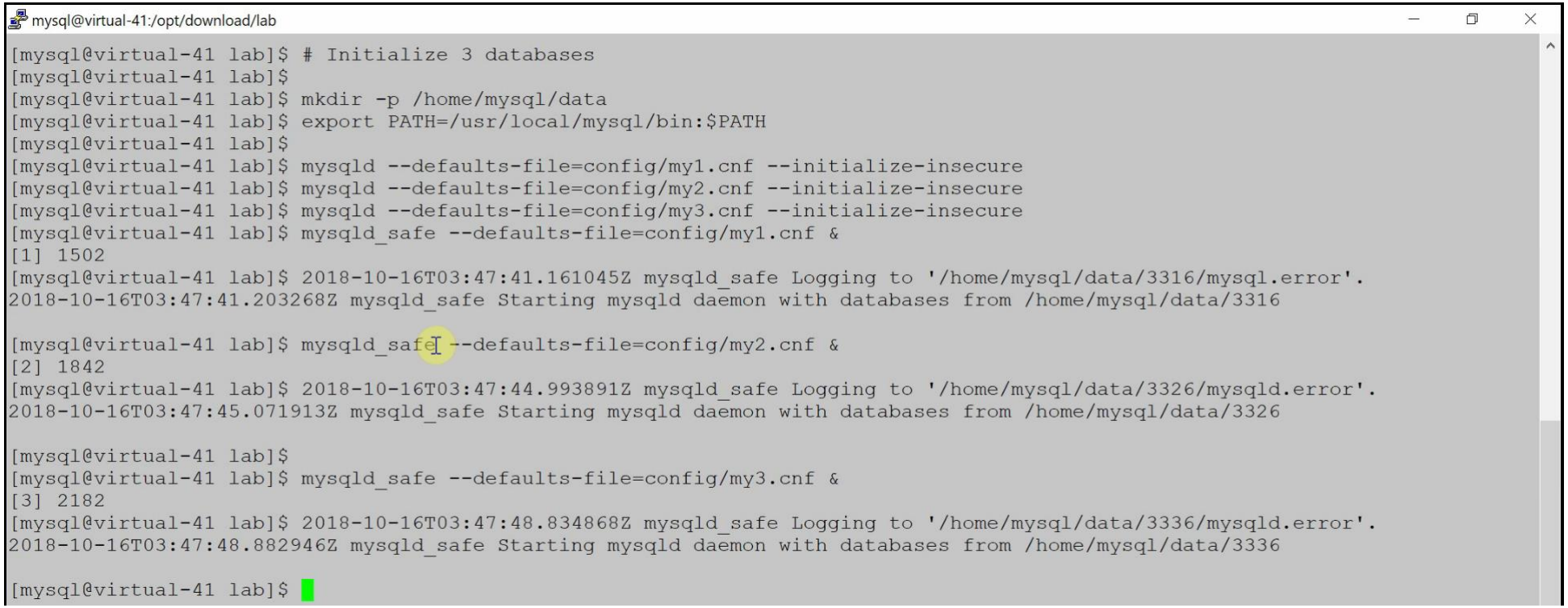
mysqld --defaults-file=<config file> --initialize-insecure



Start Up 3 database

mysqld_safe --defaults-file=<config file>

(3 port # - 3316, 3326, 3336)



Configure REMOTE Group Replication ADMIN User to each of the MySQL Server (gradmin@% / grpass) - using MySQL Shell (mysqlsh)

```
mysqlsh>dba.configureInstance('<connection>',
{clusterAdmin:'gradmin', clusterAdminPassword:'grpass'})
```

```
MySQL  localhost:3316 ssl  JS  dba.configureInstance('root@localhost:3316', {clusterAdmin:'gradmin',clusterAdminPassword:'g
rpass'})
Please provide the password for 'root@localhost:3316':
Save password for 'root@localhost:3316'? [Y]es/[N]o/Ne[v]er (default No):
Configuring local MySQL instance listening at port 3316 for use in an InnoDB cluster...

This instance reports its own address as virtual-41.localhost
Clients and other cluster members will communicate with it through this address by default. If this is not correct, the repor
t_host MySQL system variable should be changed.
Assuming full account name 'gradmin'@'%' for gradmin

The instance 'localhost:3316' is valid for InnoDB cluster usage.

Cluster admin user 'gradmin'@'%' created.
```

```
 MySQL  localhost:3316 ssl  JS  dba.configureInstance('root@localhost:3326', {clusterAdmin:'gradmin',clusterAdminPassword:'g
rpass'})
Please provide the password for 'root@localhost:3326':
Save password for 'root@localhost:3326'? [Y]es/[N]o/Ne[v]er (default No):
Configuring local MySQL instance listening at port 3326 for use in an InnoDB cluster...

This instance reports its own address as virtual-41.localhost
Clients and other cluster members will communicate with it through this address by default. If this is not correct, the repor
t_host MySQL system variable should be changed.
Assuming full account name 'gradmin'@'%' for gradmin

The instance 'localhost:3326' is valid for InnoDB cluster usage.

Cluster admin user 'gradmin'@'%' created.

 MySQL  localhost:3316 ssl  JS  dba.configureInstance('root@localhost:3336', {clusterAdmin:'gradmin',clusterAdminPassword:'g
rpass'})
Please provide the password for 'root@localhost:3336':
Save password for 'root@localhost:3336'? [Y]es/[N]o/Ne[v]er (default No):
Configuring local MySQL instance listening at port 3336 for use in an InnoDB cluster...

This instance reports its own address as virtual-41.localhost
Clients and other cluster members will communicate with it through this address by default. If this is not correct, the repor
t_host MySQL system variable should be changed.
Assuming full account name 'gradmin'@'%' for gradmin

The instance 'localhost:3336' is valid for InnoDB cluster usage.

Cluster admin user 'gradmin'@'%' created.

 MySQL  localhost:3316 ssl  JS
```

```
**************************************************************************
3 MySQL Instances are up and running.
**********************************************
REMOTE admin user (gradmin/grpass) is configured using mysqlsh
**************************************************************************
```

Create InnoDB Cluster using mysqlsh

```
mysqlsh> \connect gradmin:grpass@primary:3316
mysqlsh> dba.createCluster('mycluster')
mysqlsh> var x = dba.getCluster()
mysqlsh> x.addInstance('gradmin:grpass@primary:3326')
mysqlsh> x.addInstance('gradmin:grpass@primary:3336')
mysqlsh> x.status()
```

```
MySQL  primary:3316 ssl  JS  dba.createCluster('mycluster')
A new InnoDB cluster will be created on instance 'gradmin@primary:3316'.

Validating instance at primary:3316...

This instance reports its own address as virtual-41.localhost

Instance configuration is suitable.
Creating InnoDB cluster 'mycluster' on 'gradmin@primary:3316'...
Adding Seed Instance...

Cluster successfully created. Use Cluster.addInstance() to add MySQL instances.
At least 3 instances are needed for the cluster to be able to withstand up to
one server failure.

<Cluster:mycluster>
```

```
**************************************************************************
3 MySQL Instances are up and running.
**********************************************
REMOTE admin user (gradmin/grpass) is configured using mysqlsh
**************************************************************************
```

Create InnoDB Cluster using mysqlsh

```
mysqlsh> \connect gradmin:grpass@primary:3316
mysqlsh> dba.createCluster('mycluster')
mysqlsh> var x = dba.getCluster()
mysqlsh> x.addInstance('gradmin:grpass@primary:3326')
mysqlsh> x.addInstance('gradmin:grpass@primary:3336')
mysqlsh> x.status()
```

```
 MySQL  primary:3316 ssl  JS  var x = dba.getCluster()
 MySQL  primary:3316 ssl  JS  x.addInstance('gradmin:grpass@primary:3326')
A new instance will be added to the InnoDB cluster. Depending on the amount of
data on the cluster this might take from a few seconds to several hours.

Adding instance to the cluster ...

Validating instance at primary:3326...

This instance reports its own address as virtual-41.localhost

Instance configuration is suitable.
The instance 'gradmin@primary:3326' was successfully added to the cluster.
```

```
**************************************************************************
3 MySQL Instances are up and running.
**********************************************
REMOTE admin user (gradmin/grpass) is configured using mysqlsh
**************************************************************************
```

Create InnoDB Cluster using mysqlsh

```
mysqlsh> \connect gradmin:grpass@primary:3316
mysqlsh> dba.createCluster('mycluster')
mysqlsh> var x = dba.getCluster()
mysqlsh> x.addInstance('gradmin:grpass@primary:3326')
mysqlsh> x.addInstance('gradmin:grpass@primary:3336')
mysqlsh> x.status()
```

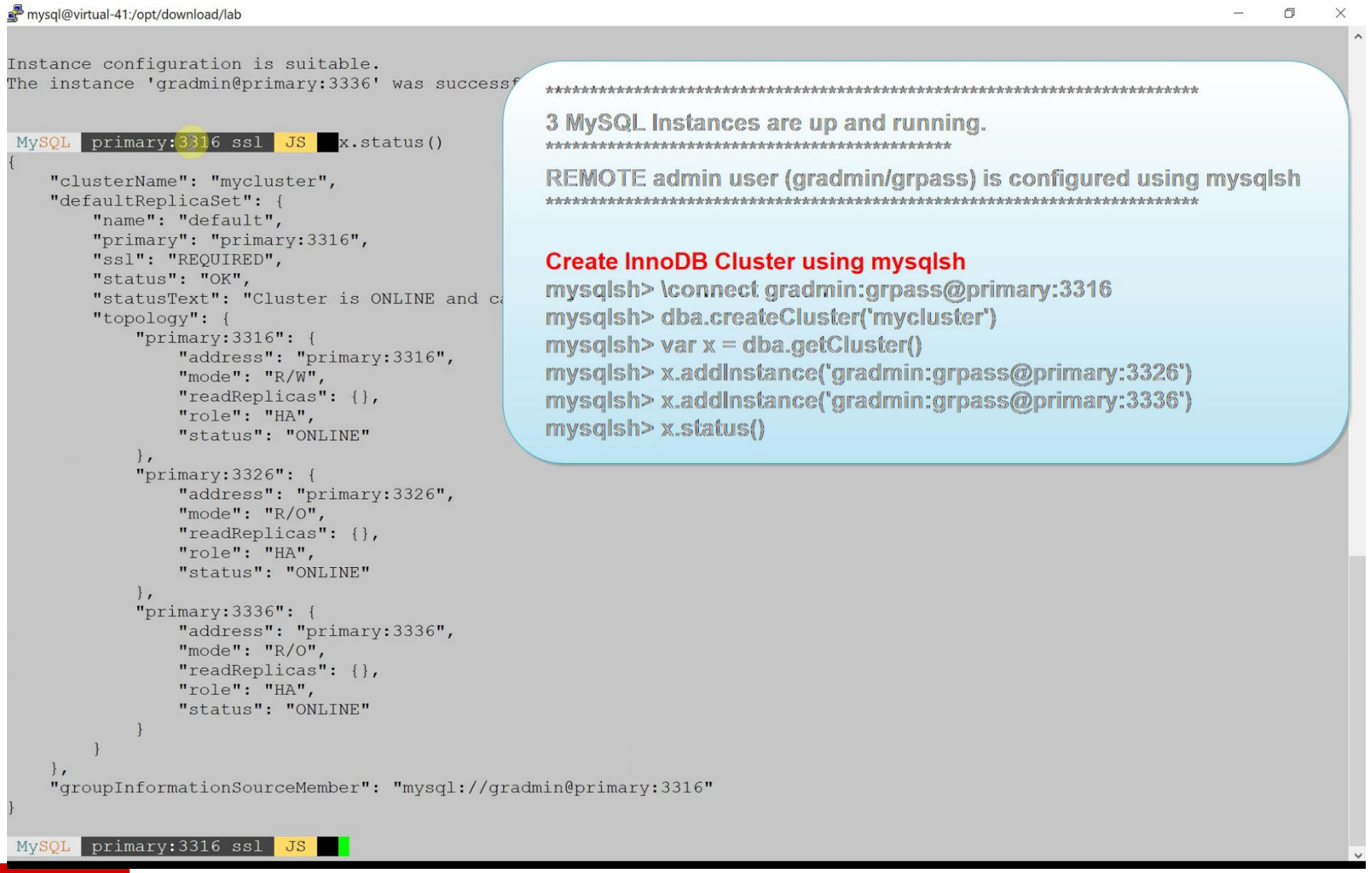
```
 MySQL  primary:3316 ssl  JS  x.addInstance('gradmin:grpass@primary:3336')
A new instance will be added to the InnoDB cluster. Depending on the amount of
data on the cluster this might take from a few seconds to several hours.

Adding instance to the cluster ...

Validating instance at primary:3336...

This instance reports its own address as virtual-41.localhost

Instance configuration is suitable.
The instance 'gradmin@primary:3336' was successfully added to the cluster.
```



Setup the MySQL Router

1. Creating the MySQL Router Configuration files by bootstrapping

   # mysqlrouter --bootstrap gradmin:grpass@primary:3316 --directory config/mysqlrouter01

2. Starting the MySQL Router

Within the config/mysqlrouter01, there is a 'start.sh' script created. Execute the 'start.sh' to bring the MySQL Router up and running with PORT# 6446 for RW and 6447 for RO

```
[mysql@virtual-41 lab]$ mysqlrouter --bootstrap=gradmin:grpass@primary:3316 --directory config/myrouter01 --force

Bootstrapping MySQL Router instance at '/opt/download/lab/config/myrouter01'...
Checking for old Router accounts
Creating account mysql_router4_a8j3jng2oazw@'%'
MySQL Router  has now been configured for the InnoDB cluster 'mycluster'.

The following connection information can be used to connect to the cluster.

Classic MySQL protocol connections to cluster 'mycluster':
- Read/Write Connections: localhost:6446
- Read/Only Connections: localhost:6447
X protocol connections to cluster 'mycluster':
- Read/Write Connections: localhost:64460
- Read/Only Connections: localhost:64470
[mysql@virtual-41 lab]$
```

Setup the MySQL Router

1. Creating the MySQL Router Configuration files by bootstrapping

```
# mysqlrouter --bootstrap gradmin:grpass@primary:3316 --directory config/mysqlrouter01
```

2. Starting the MySQL Router

Within the config/mysqlrouter01, there is a 'start.sh' script created. Execute the 'start.sh' to bring the MySQL Router up and running with PORT# 6446 for RW and 6447 for RO

```
[mysql@virtual-41 config]$ cd myrouter01
[mysql@virtual-41 myrouter01]$ ll
total 28
drwx------ 2 mysql mysql 4096 Oct 16 11:55 data
drwx------ 2 mysql mysql 4096 Oct 16 11:55 log
-rw------- 1 mysql mysql 1318 Oct 16 11:55 mysqlrouter.conf
-rw------- 1 mysql mysql  106 Oct 16 11:55 mysqlrouter.key
drwx------ 2 mysql mysql 4096 Oct 16 11:55 run
-rwx------ 1 mysql mysql  167 Oct 16 11:55 start.sh
-rwx------ 1 mysql mysql  215 Oct 16 11:55 stop.sh
[mysql@virtual-41 myrouter01]$ cat start.sh
#!/bin/bash
basedir=/opt/download/lab/config/myrouter01
ROUTER_PID=$basedir/mysqlrouter.pid /usr/local/router/bin/mysqlrouter -c $basedir/mysqlrouter.conf &
disown %-
[mysql@virtual-41 myrouter01]$ ./start.sh
[mysql@virtual-41 myrouter01]$
```

Start Scripts in the FOLDER

Connecting to ROUTER : 6446 : PRIMARY Routing

SELECT @@port;

```
[mysql@virtual-41 myrouter01]$ mysql -ugradmin -pgrpass -h127.0.0.1 -P6446
mysql: [Warning] Using a password on the command line interface can be insecure.
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 128
Server version: 8.0.12-commercial MySQL Enterprise Server - 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 @@port;
+--------+
| @@port |
+--------+
|   3316 |
+--------+
1 row in set (0.00 sec)
```
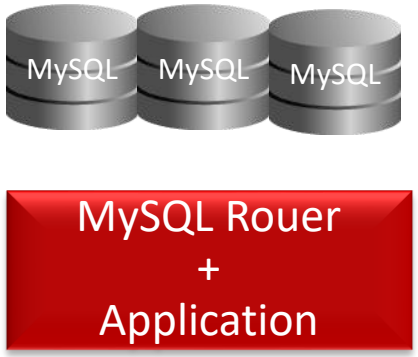

生产系统部署的场景
MySQL InnoDB Cluster

https://dev.mysql.com/doc/refman/8.0/en/mysql-innodb-cluster-production-deployment.html

场景

- 一个数据中心

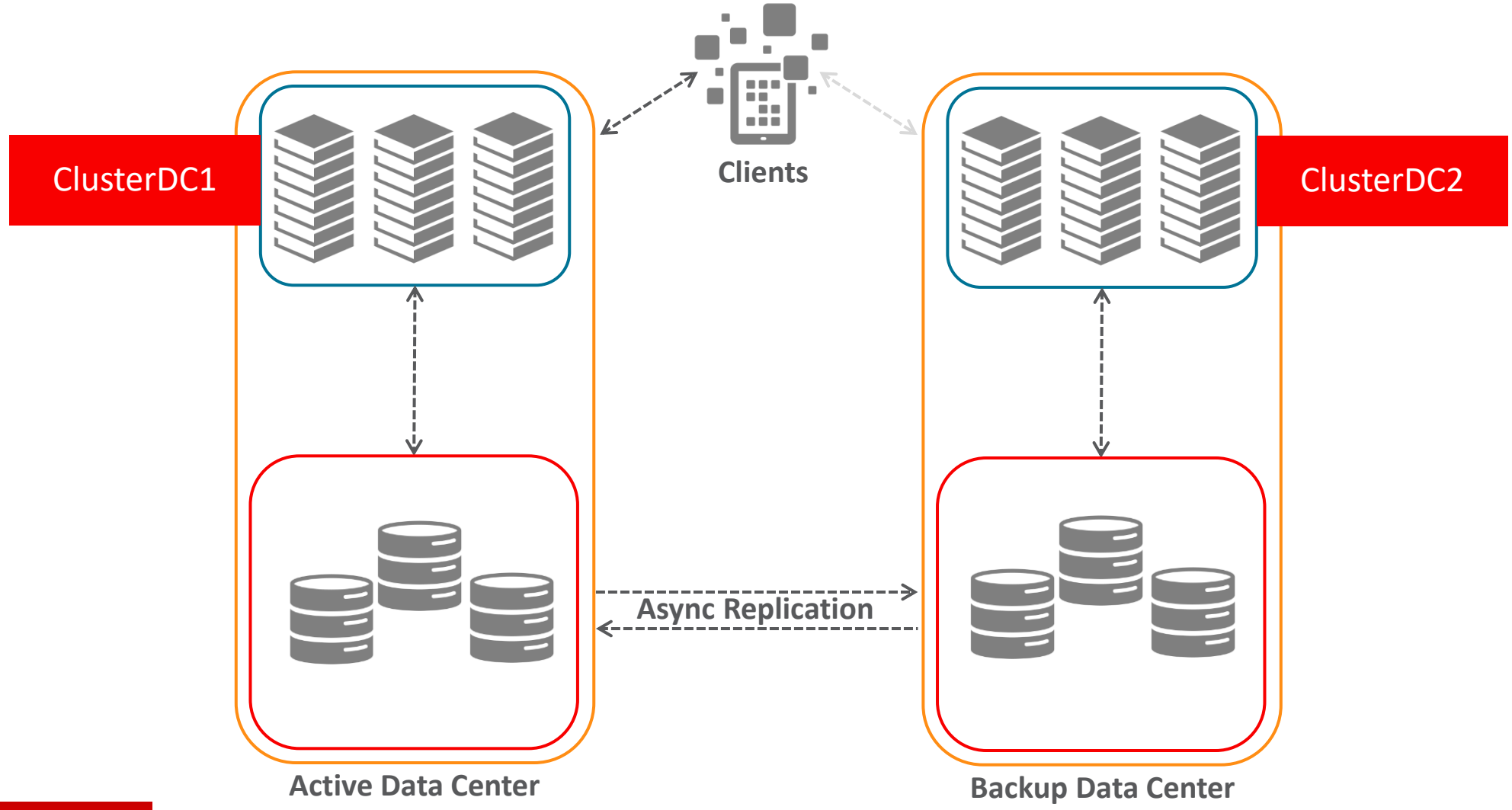


单主模式 - Single Primary Mode

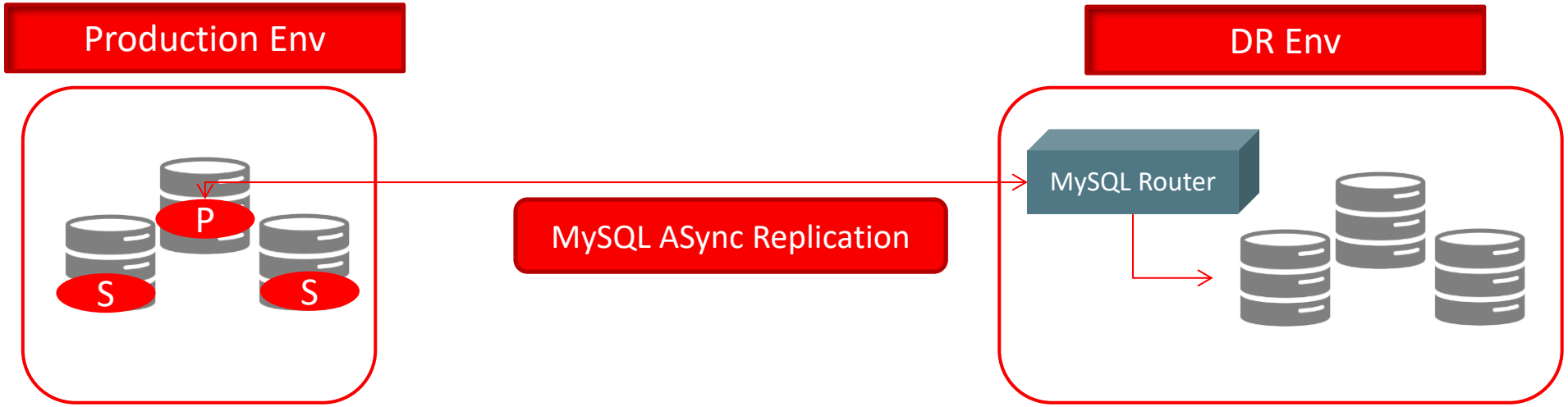
- 主服务器故障
  - 服务器自动切换
  - 应用程序连接到路由器[无影响]
- 辅助服务器故障
  - 冗余服务器可用
  - 应用程序连接到路由器[无影响]
- 故障服务器恢复
  - 数据赶上并开始作为辅助数据

- 主服务切换
  - SELECT group_replication_set_as_primary(uuid)
  - 可能机器有更多更大-资源
  - 用于维护目的

场景 – 异地机房

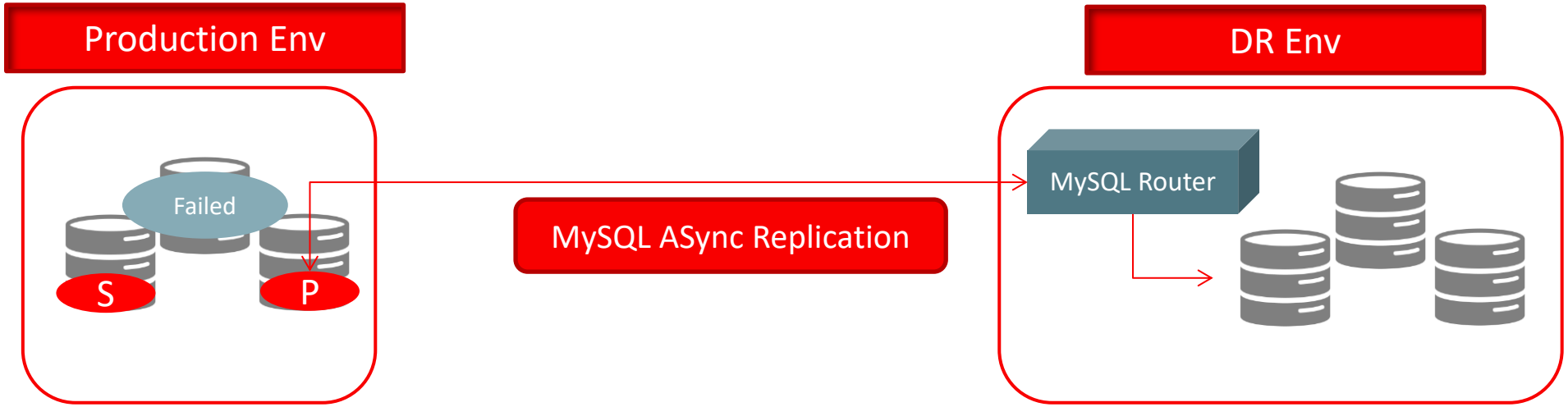


通过路由复制



在DR环境中安装MySQL路由器。 用于复制以指向生产环境中MySQL InnoDB集群的PRIMARY节点。

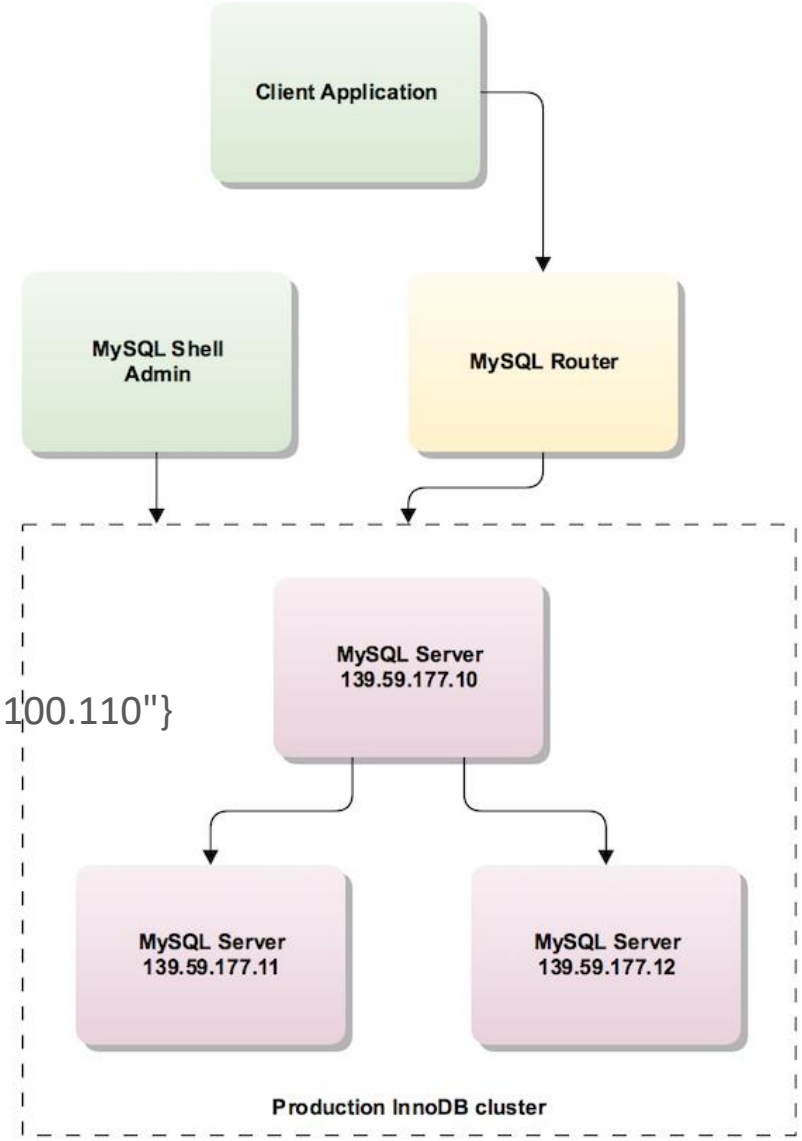
通过路由复制



如果主节点发生故障，则其中一个辅助节点将提升为主节点。 复制通道仍可以连接到活动服务器，以便在两个站点之间进行数据复制。

生产系统部署

- User Privileges
  - Remote Admin User
  - Created By <cluster>.configureInstance(…)
- IP/Hostname
  - configure ***report_host*** MySQL parameter
  - Configure WhiteList of Servers
  - mysql-js> cluster.addInstance("ic@ic-3:3306", {ipWhitelist: "203.0.113.0/24, 198.51.100.110"}
- if MySQL 8.0
  - persisted_globals_load is set to ON
- Create the Cluster
  - addInstance (…)



升级MySQL InnoDB集群
https://dev.mysql.com/doc/refman/8.0/en/group-replication-upgrade.html

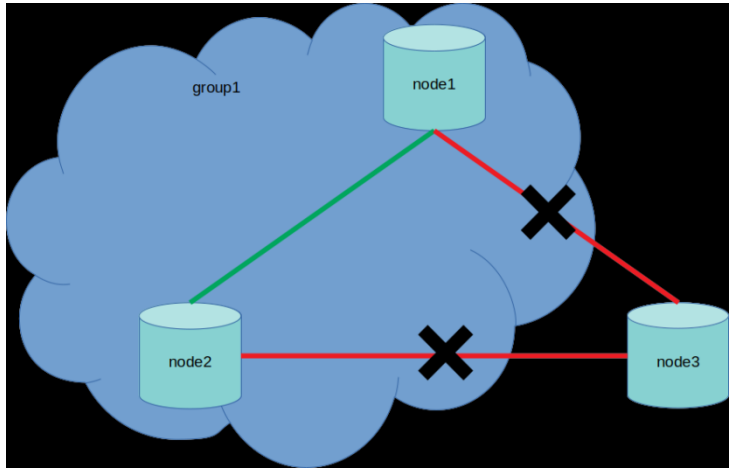
- 离线升级
  - 全部关机
  - 升级每个成员
  - 重新开始

- 在线升级
  - 注意： 具有较低版本的组+具有较高版本的新节点（检查版本兼容性）
  - 仅在低版本上写入（不是新加入更高版本）
- Upgrade
  - 首先升级RO节点（最后在RW节点上）
  - set persist group_replication_start_on_boot = 0
  - shutdown
  - my.cnf更改basedir指向NEW VERSION
  - restart，确认节点不在群组内
  - mysql_upgrade（来自New Binary）
  - set persist group_replication_start_on_boot = 1
  - restart - 加入群组

网络可靠性

https://mysqlhighavailability.com/group-replication-coping-with-unreliable-failure-detection/

- Default the heart beat is 5 seconds.
- In MySQL 8.0.13, new setting ：*group_replication_member_expel_timeout*

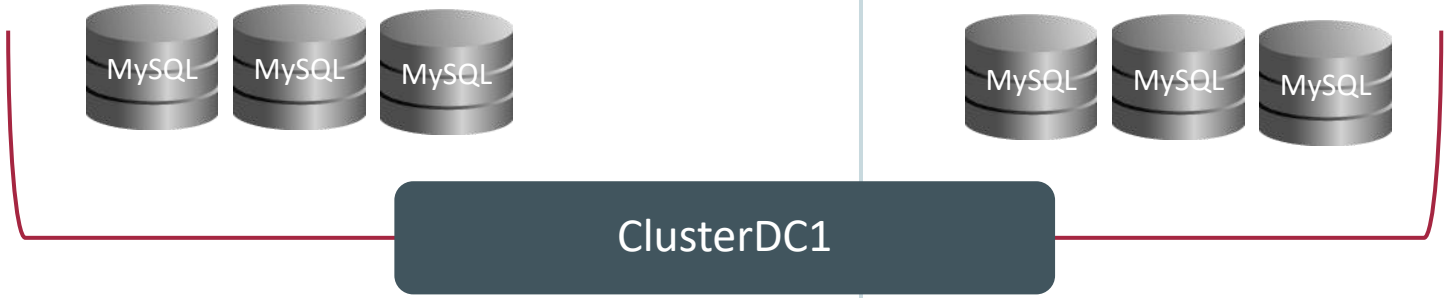


Node3如果在group_replication_member_expel_timeout
时间内重新加入，则GROUP将接受。

执行TIMEOUT，节点将根据
group_replication_exit_state_action
中定义的值执行操作

MySQL InnoDB Cluster - 异地复制场景

- DC1
- DC2

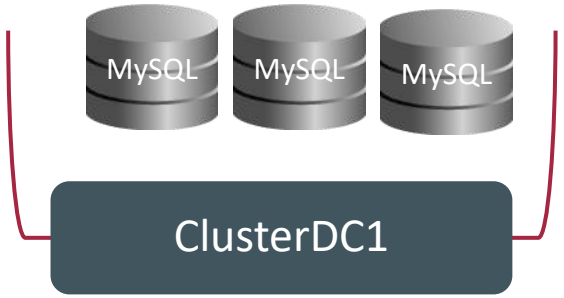


mysql_innodb_cluster_metadata
- clusterDC1

https://lefred.be/content/mysql-innodb-cluster-with-2-data-centers-for-disaster-recovery-howto/

MySQL InnoDB Cluster - 异地复制场景

- DC1



mysql_innodb_cluster_metadata
- clusterDC1

- DC2

cluster.removeInstance (...)

MySQL InnoDB Cluster - 异地复制场景

- DC1

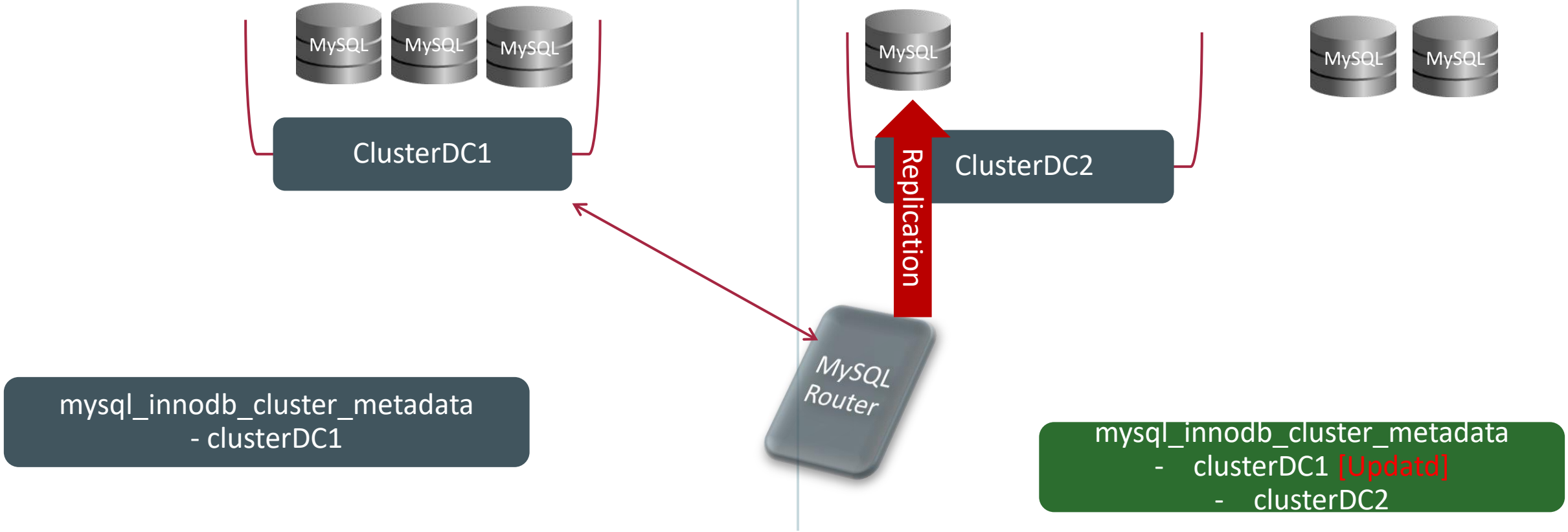
mysql_innodb_cluster_metadata
- clusterDC1

- DC2

mysql_innodb_cluster_metadata
- clusterDC1
- clusterDC2

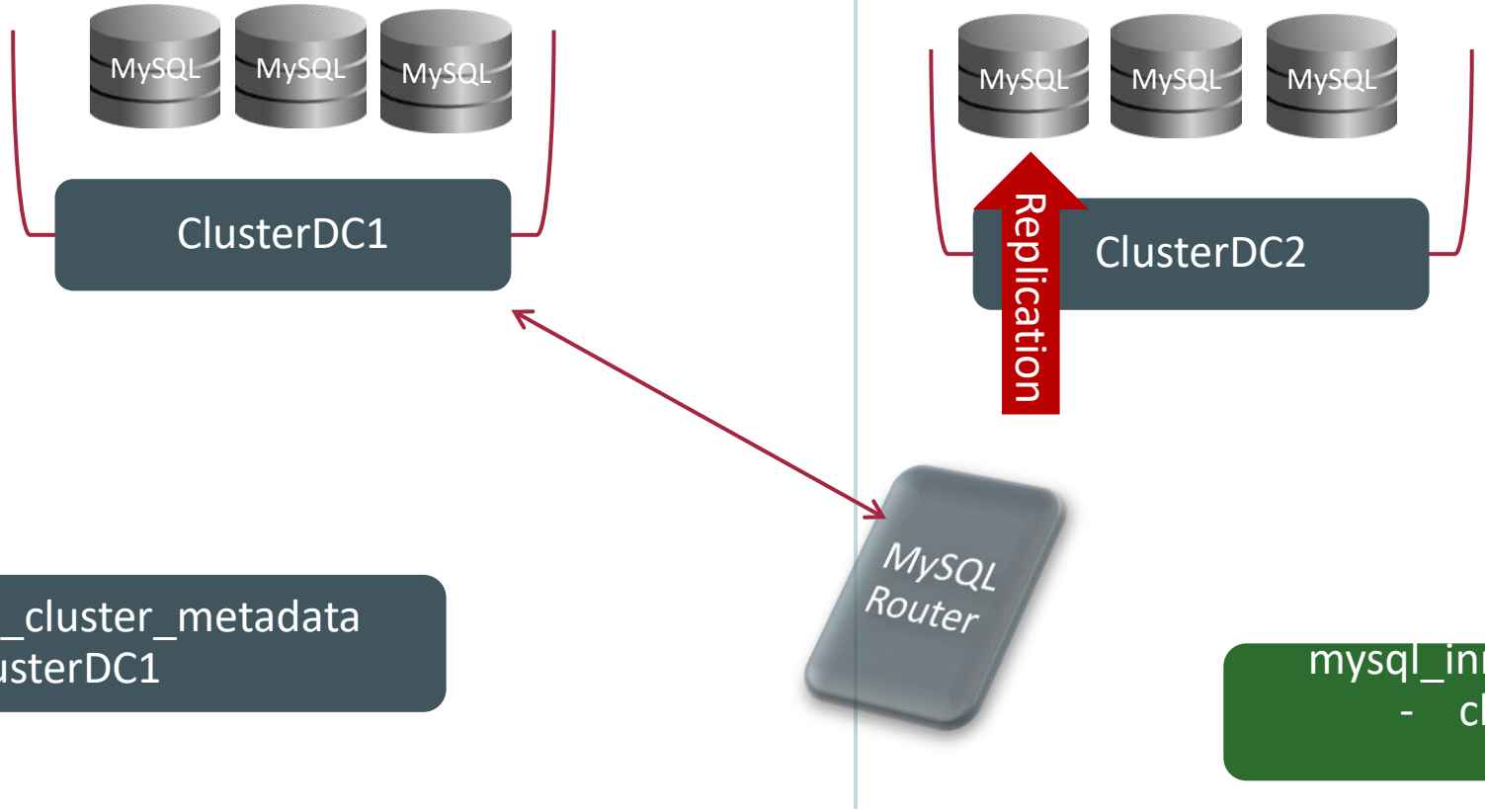
MySQL InnoDB Cluster - 异地复制场景

- DC1
- DC2



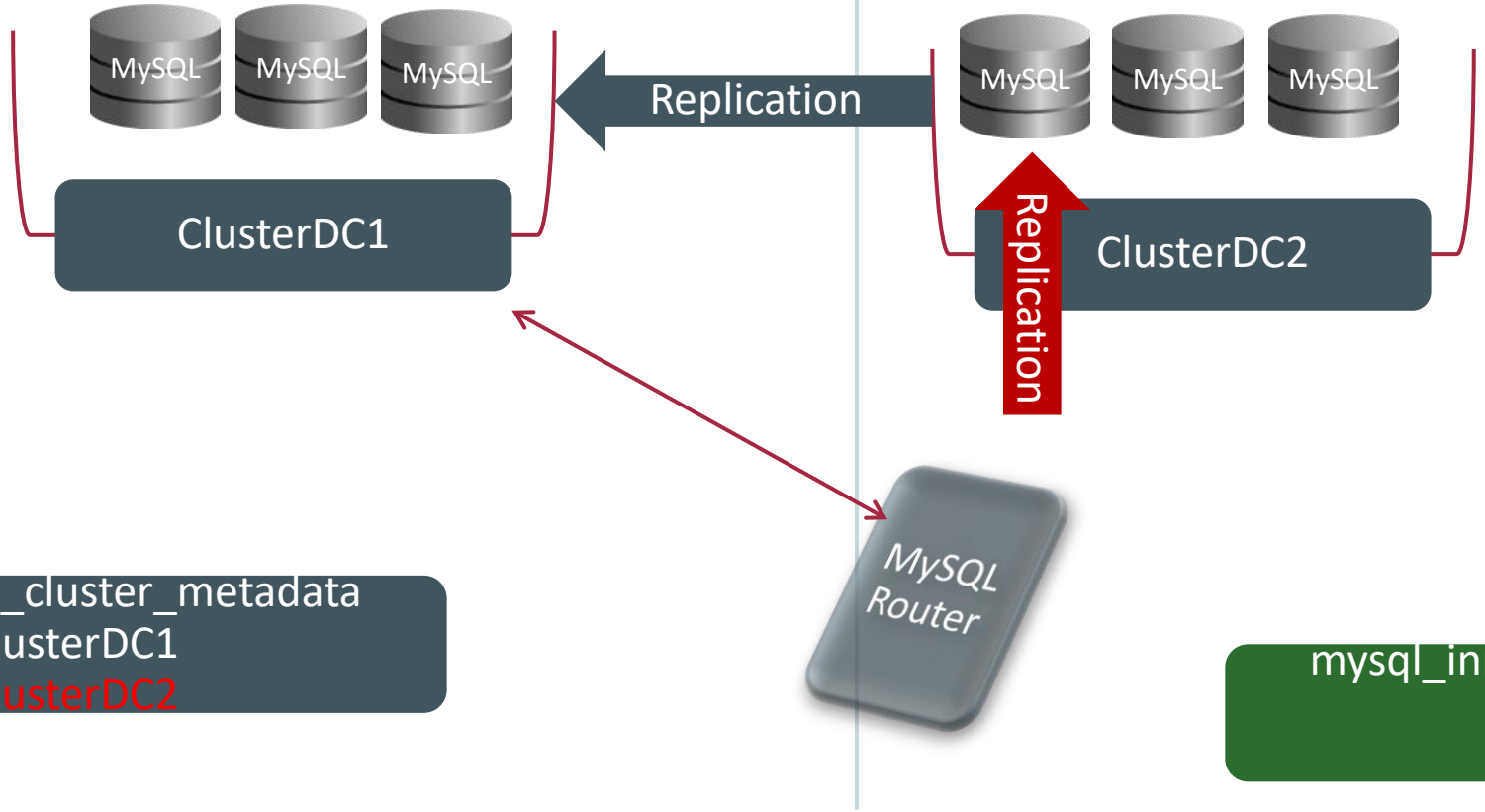
MySQL InnoDB Cluster - 异地复制场景

- DC1
- DC2



MySQL InnoDB Cluster - 异地复制场景

- DC1
- DC2



mysql_innodb_cluster_metadata
- clusterDC1
- clusterDC2

mysql_innodb_cluster_metadata
- clusterDC1
- clusterDC2

总结

- Oracle commits to MySQL and delivered Quality Product and Supporting Open Source.
- HA solutions to MySQL – SIMPLE, EASY and Perform!
- MySQL 8.0 新功能 – 更好用，更易于使用，高可用更方便，更可靠！
- Q &A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