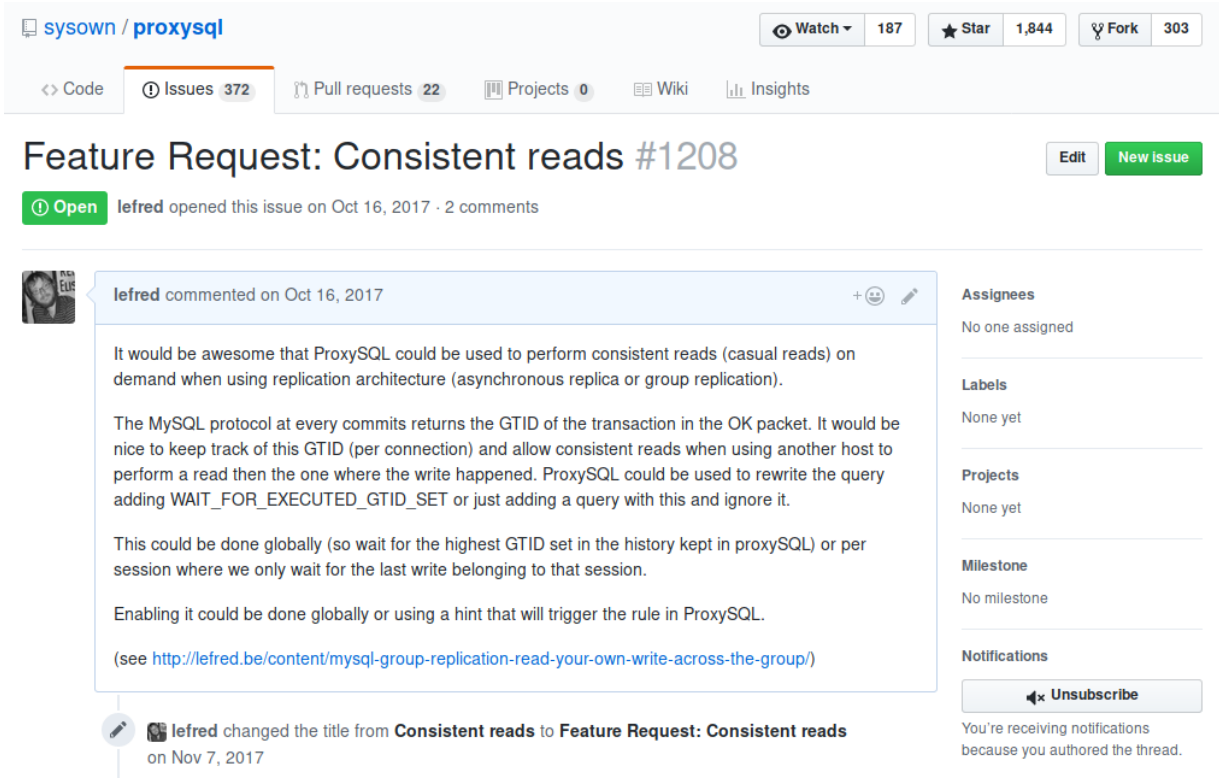
Consistent Reads Using ProxySQL and GTID

Santa Clara, California | April 23th – 25th, 2018

Disclaimer

- I am
  - not René Cannaò
  - @lefred – MySQL Community Manager / Oracle
  - the one who provided a hint for this
  - not the one writing these slides (credit to René and Nik Vyzas)



What is ProxySQL?

A brief introduction to ProxySQL

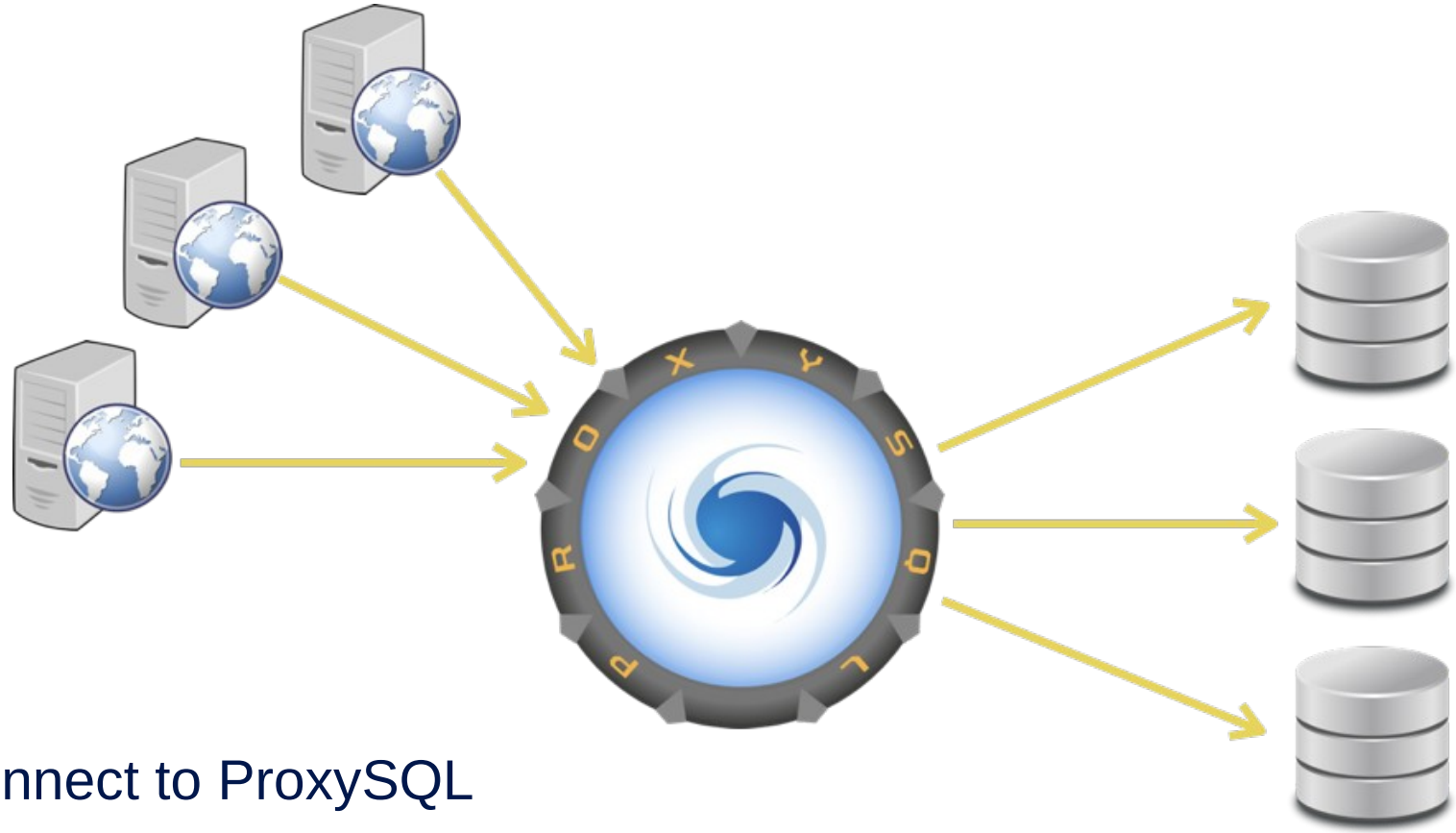
What is ProxySQL?

- The winner of a MySQL Community Award 2018 !!

What is ProxySQL?

- A "Layer 7" database proxy
- MySQL / ClickHouse protocol aware
- High Performance
- High Availability
- Feature Rich

ProxySQL Overview



- Clients connect to ProxySQL
- Requests are evaluated
- Actions are performed (e.g. RW Split / Sharding / etc.)

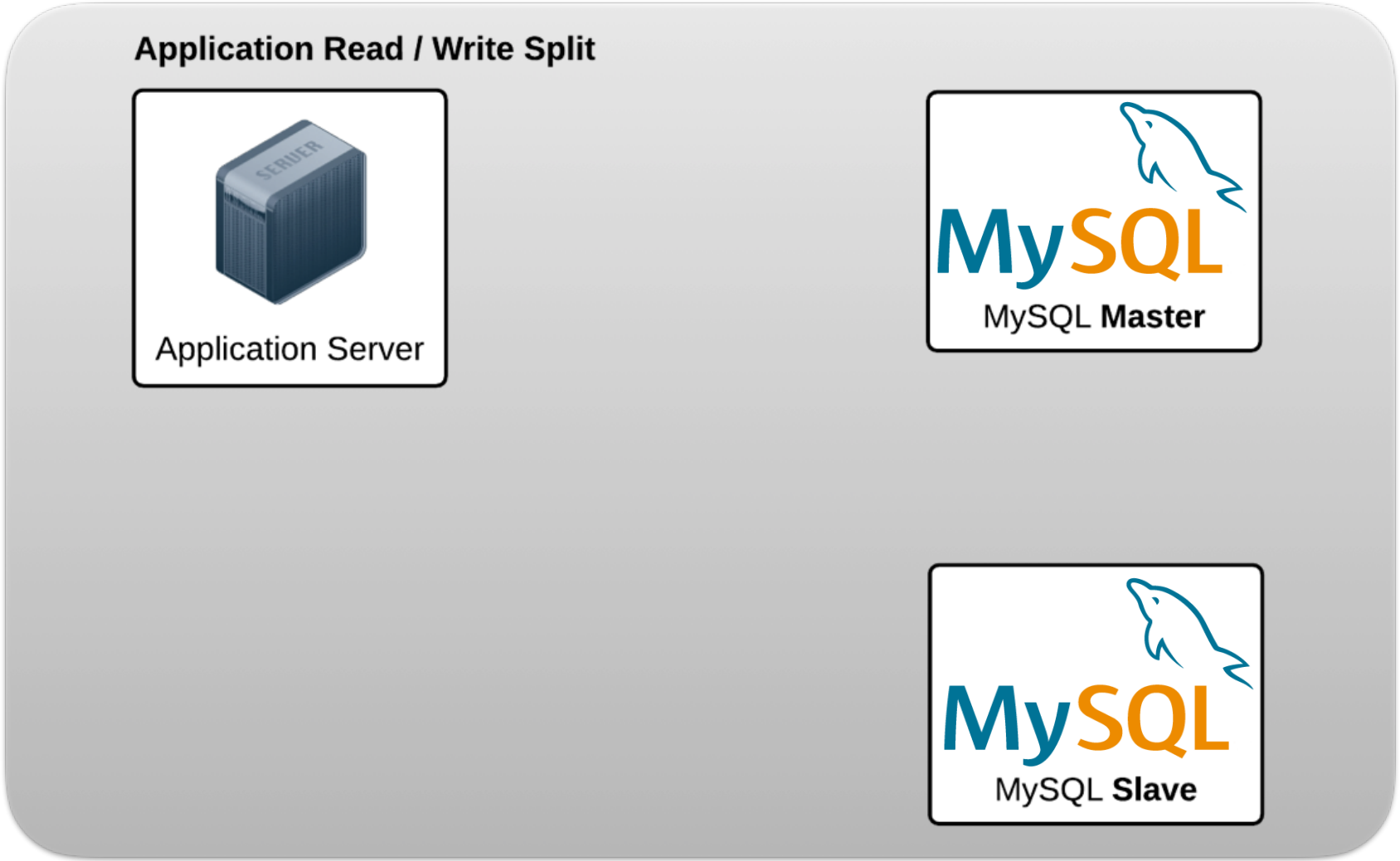
Master - Slave Replication Pain Points

- Asynchronous replication
  - Replication lag is the **major challenge**
- Semi-synchronous replication
  - Completion time for a transaction depends on availability of slave(s)
  - The time taken to complete the transaction can still cause stale data
  - To avoid stale data applications / client connections must be aware if there is replication delay

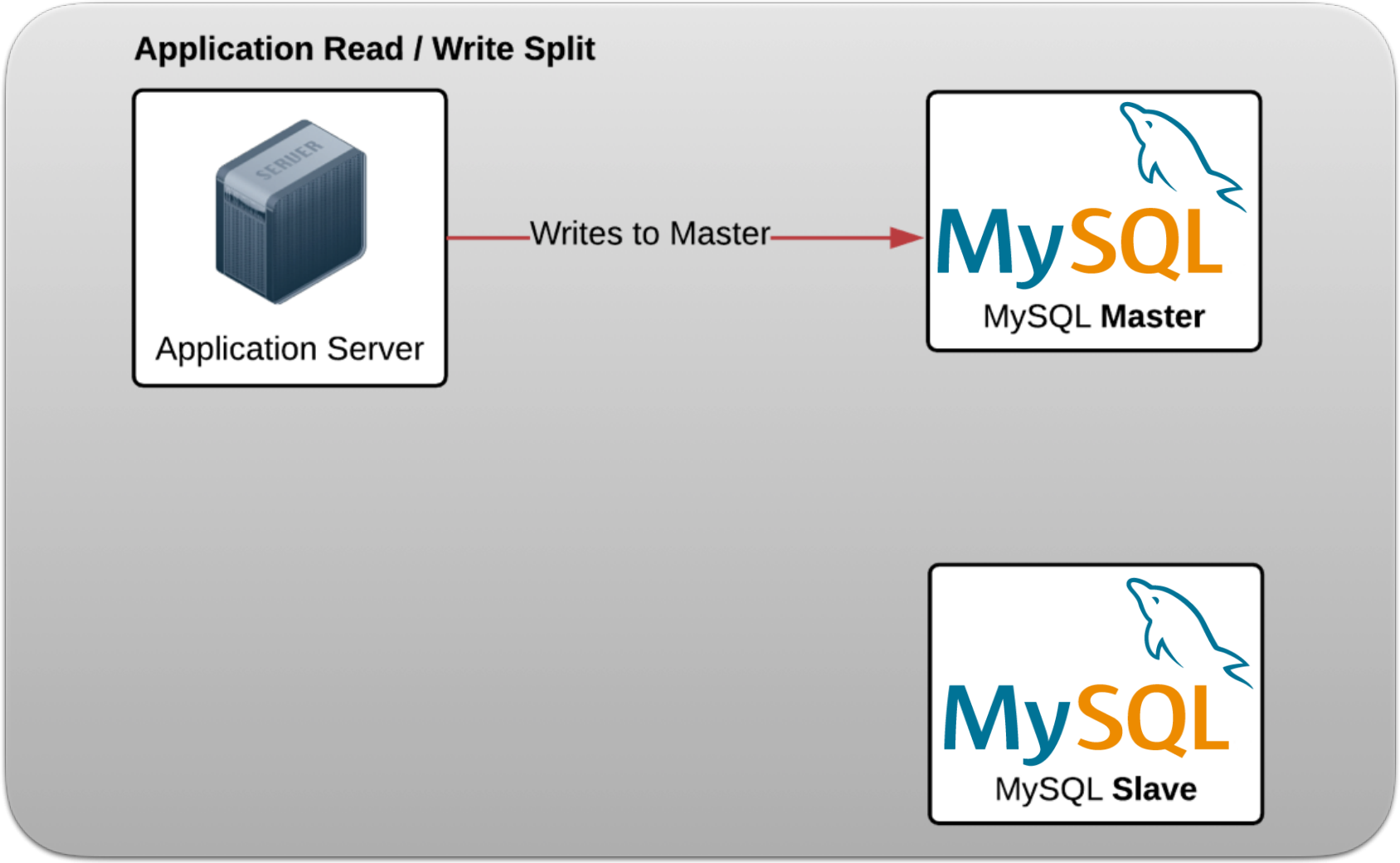
RW Split and MySQL Replication

A few slides about read / write load balancing across MySQL masters and slaves

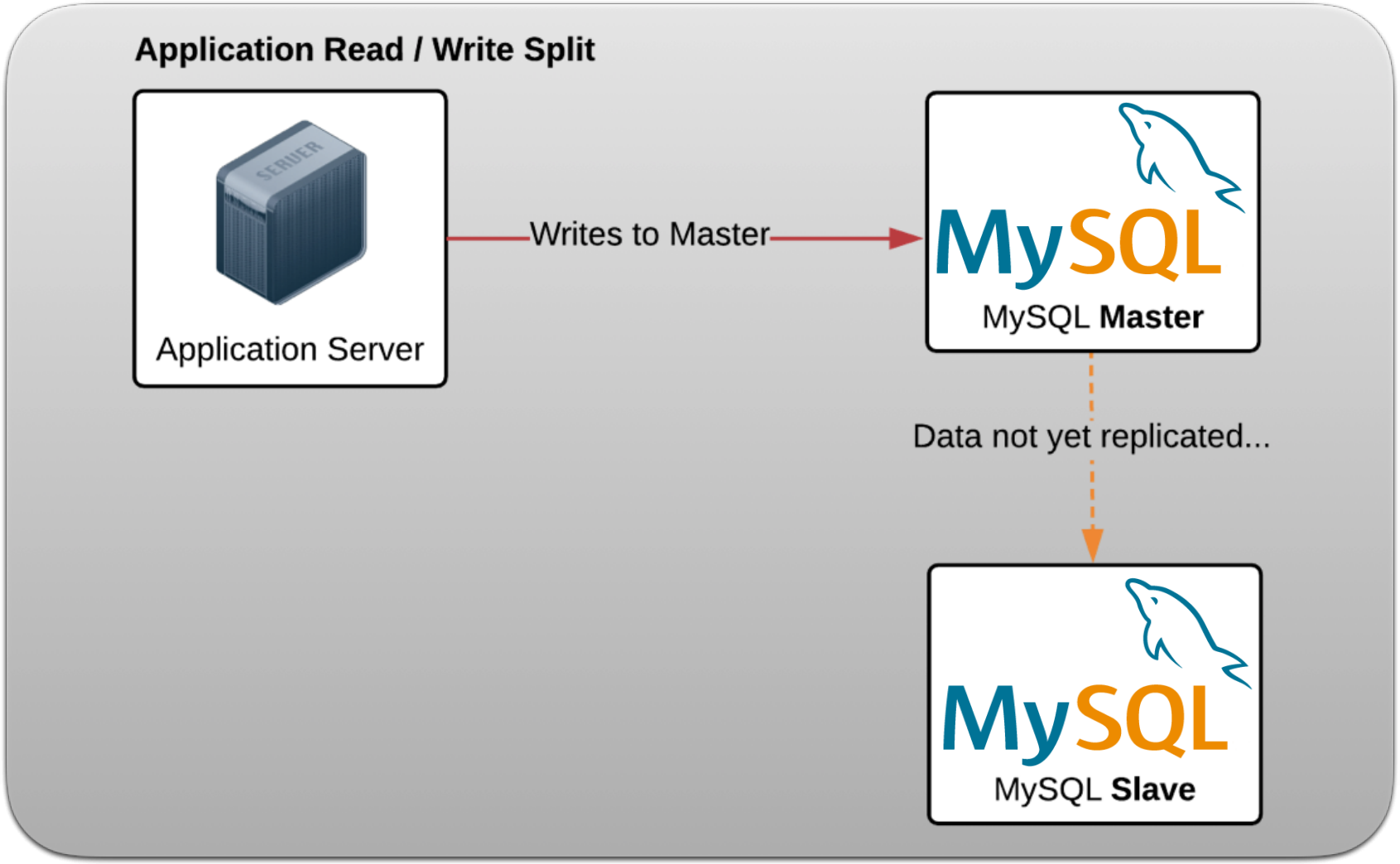
Application Read / Write Split



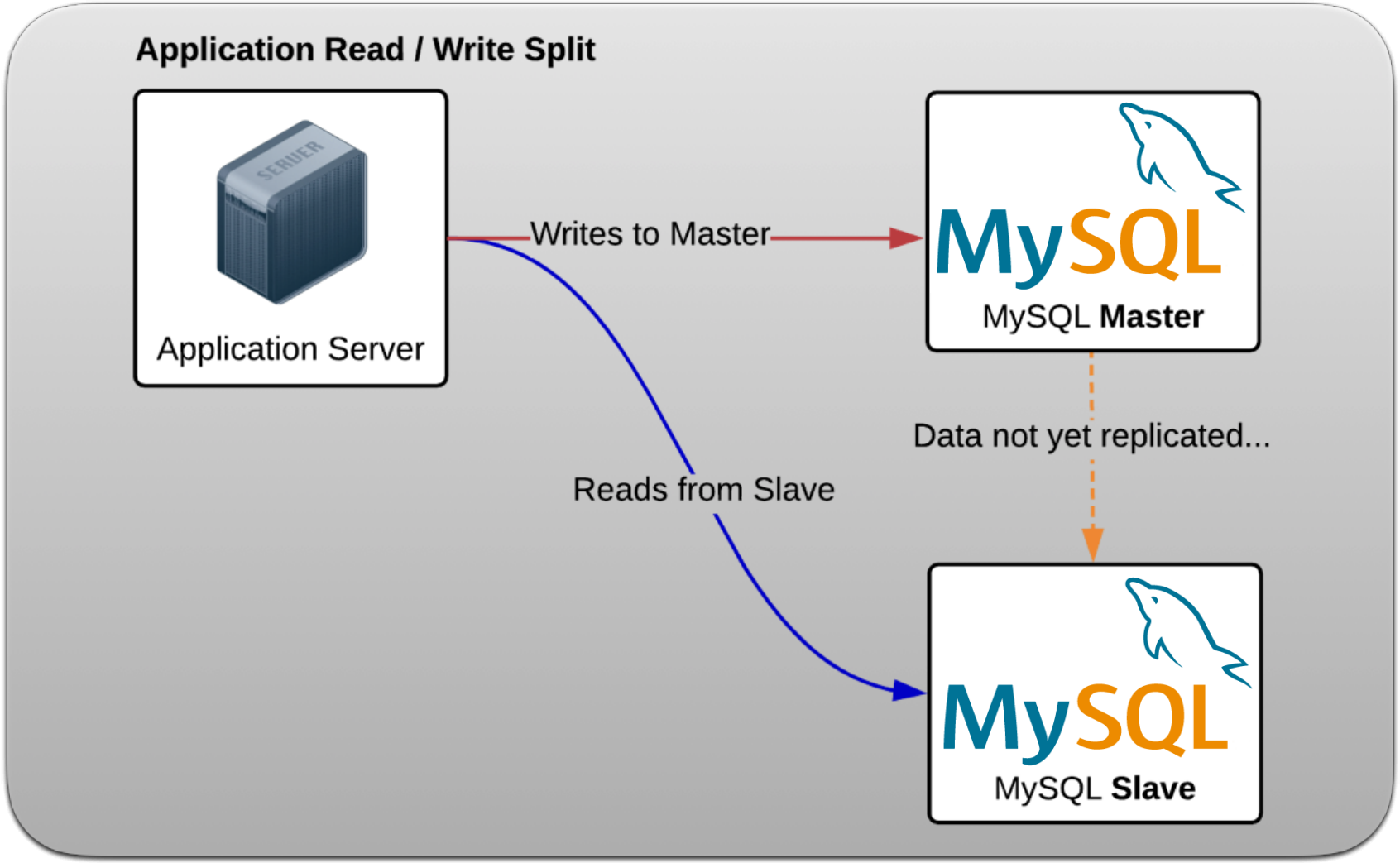
Application Read / Write Split



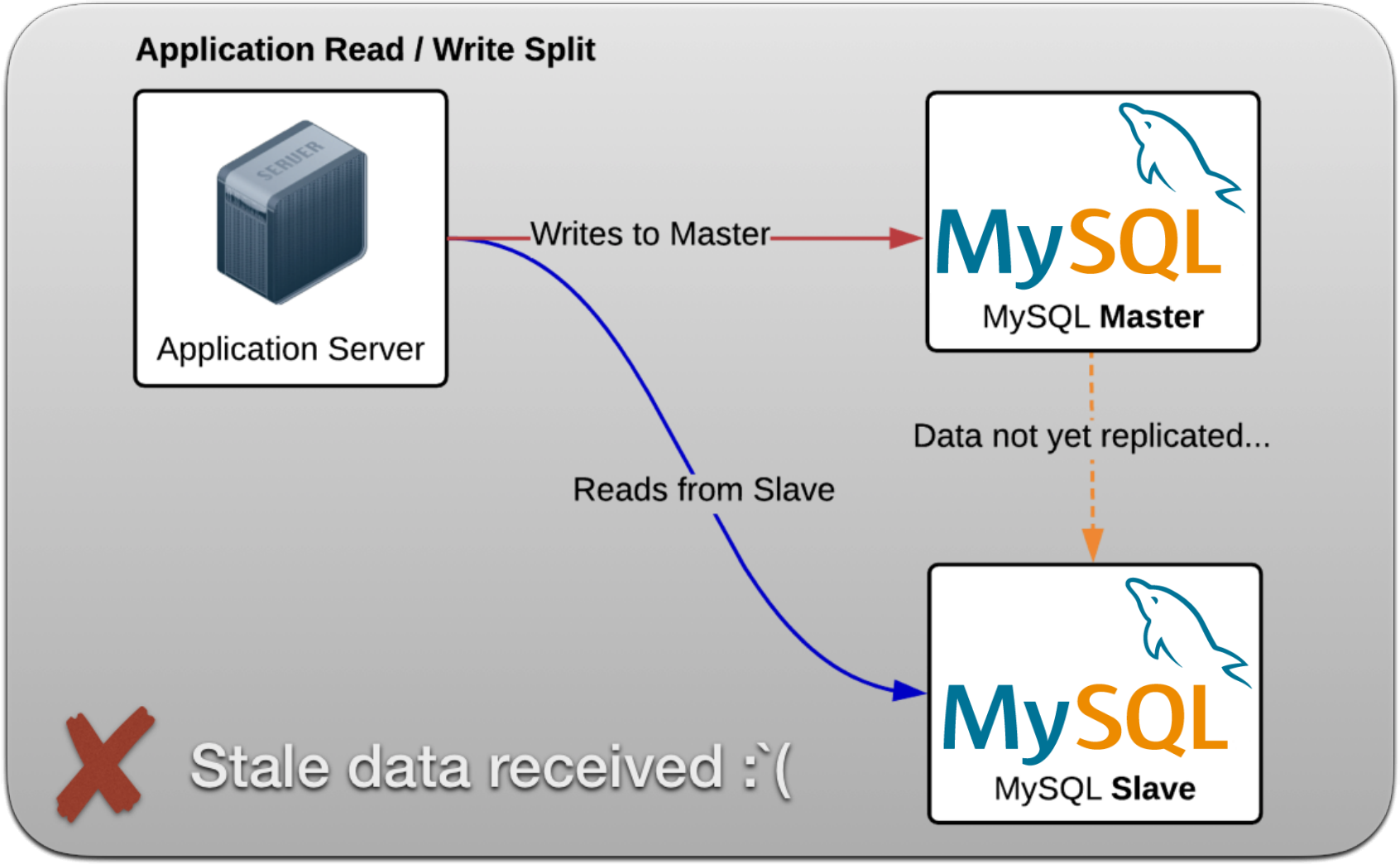
Application Read / Write Split



Application Read / Write Split

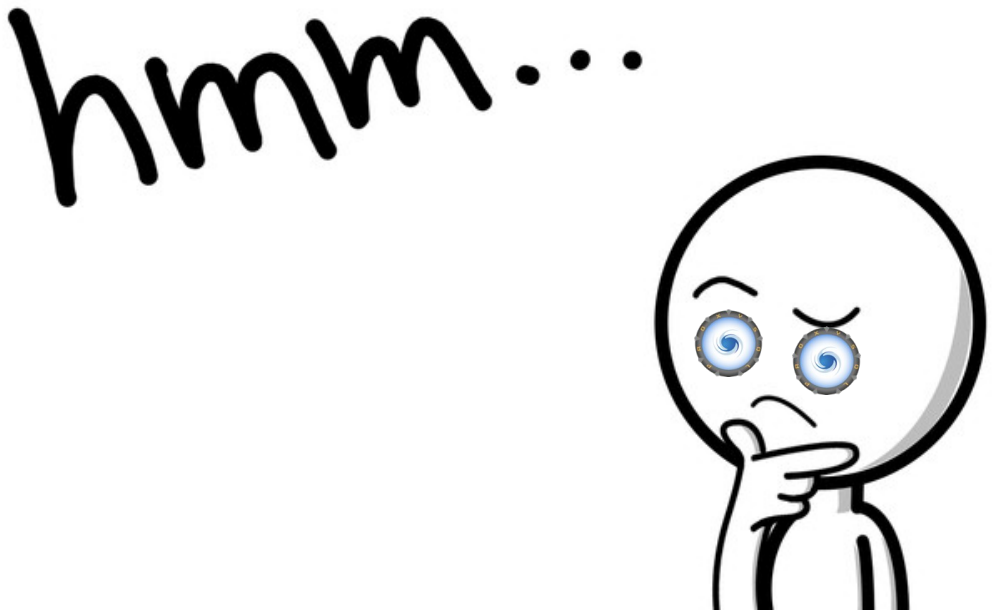


Application Read / Write Split

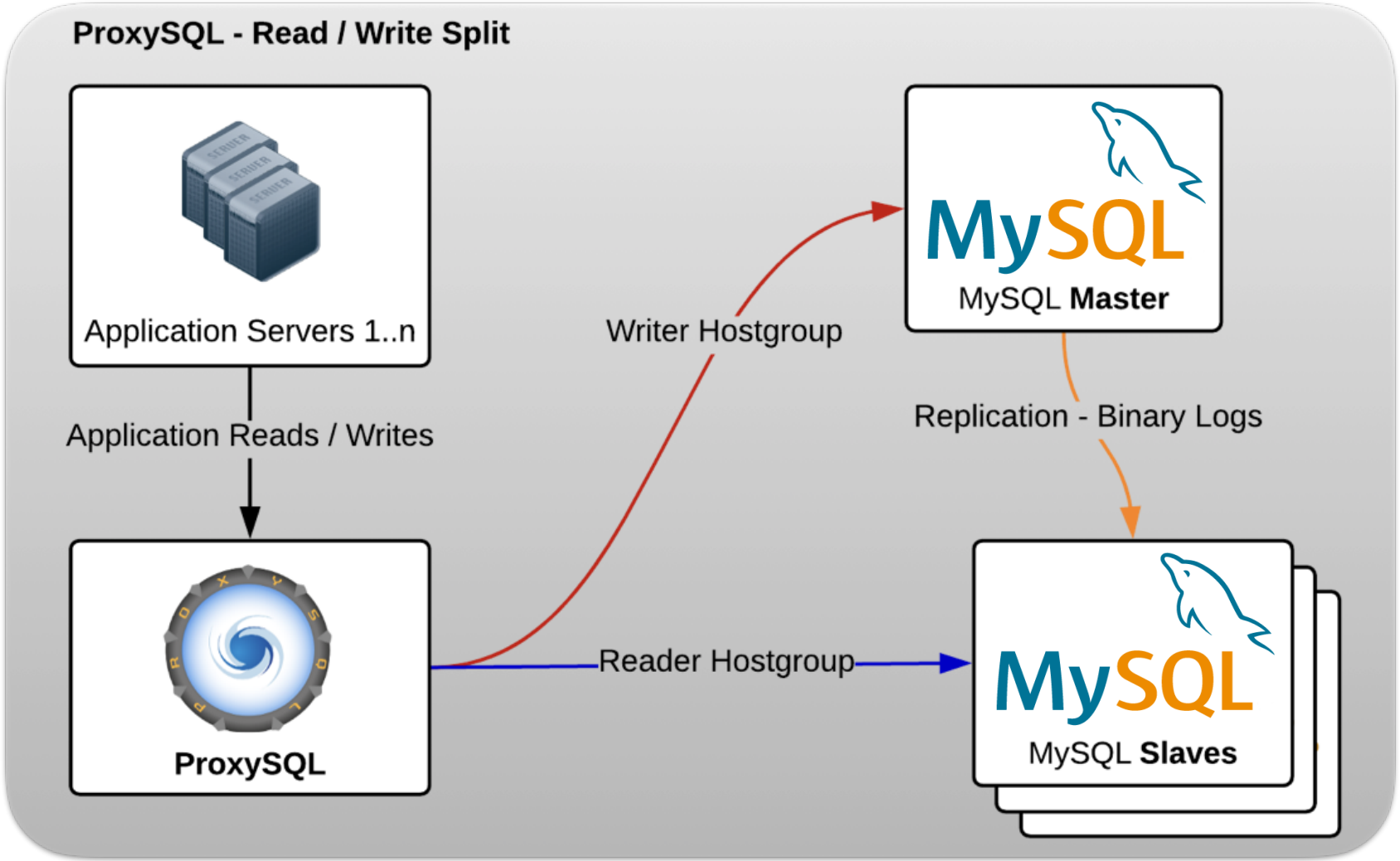


ProxSQL Read / Write Split

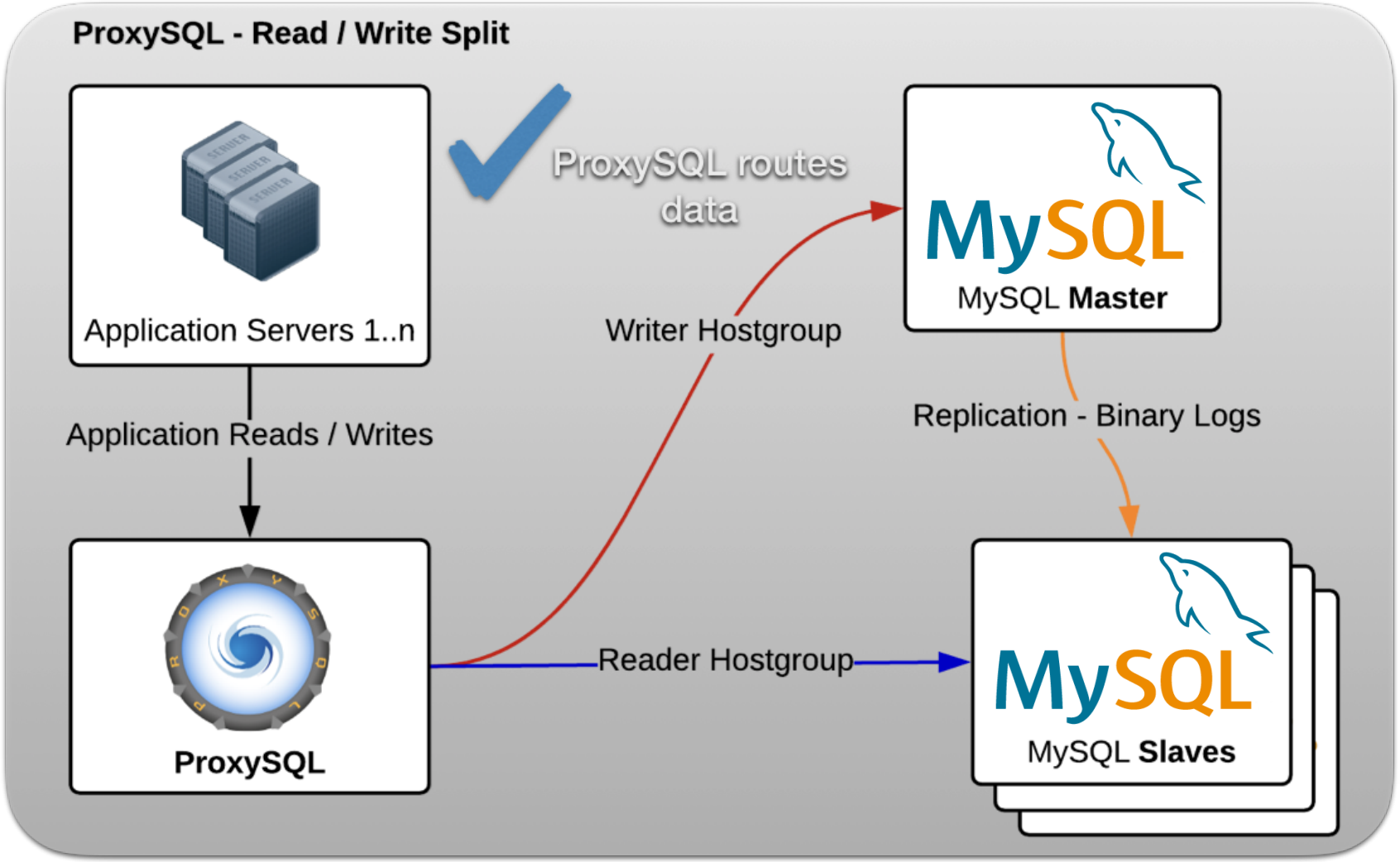
- How are these problems solved with ProxySQL…?



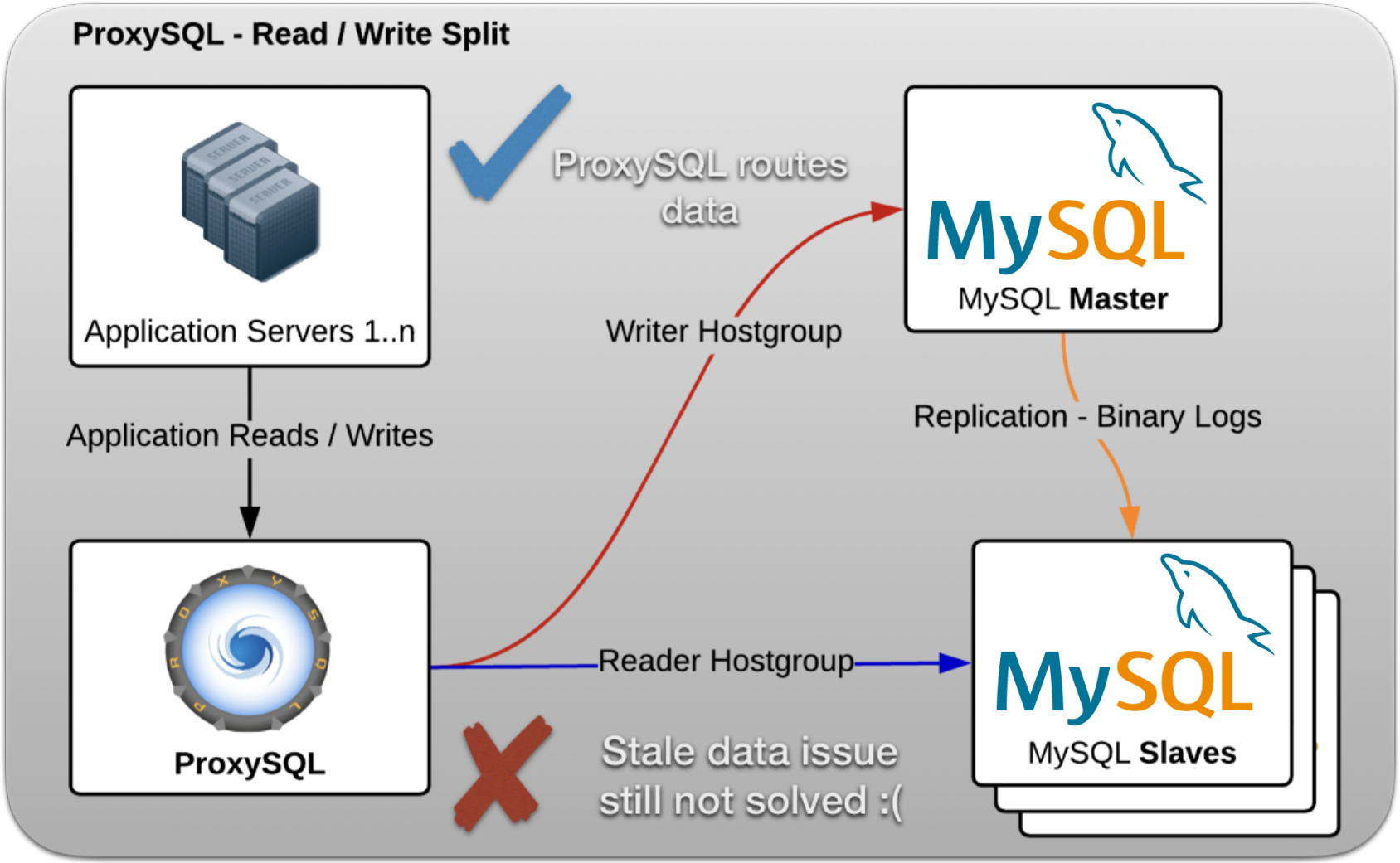
ProxSQL Read / Write Split



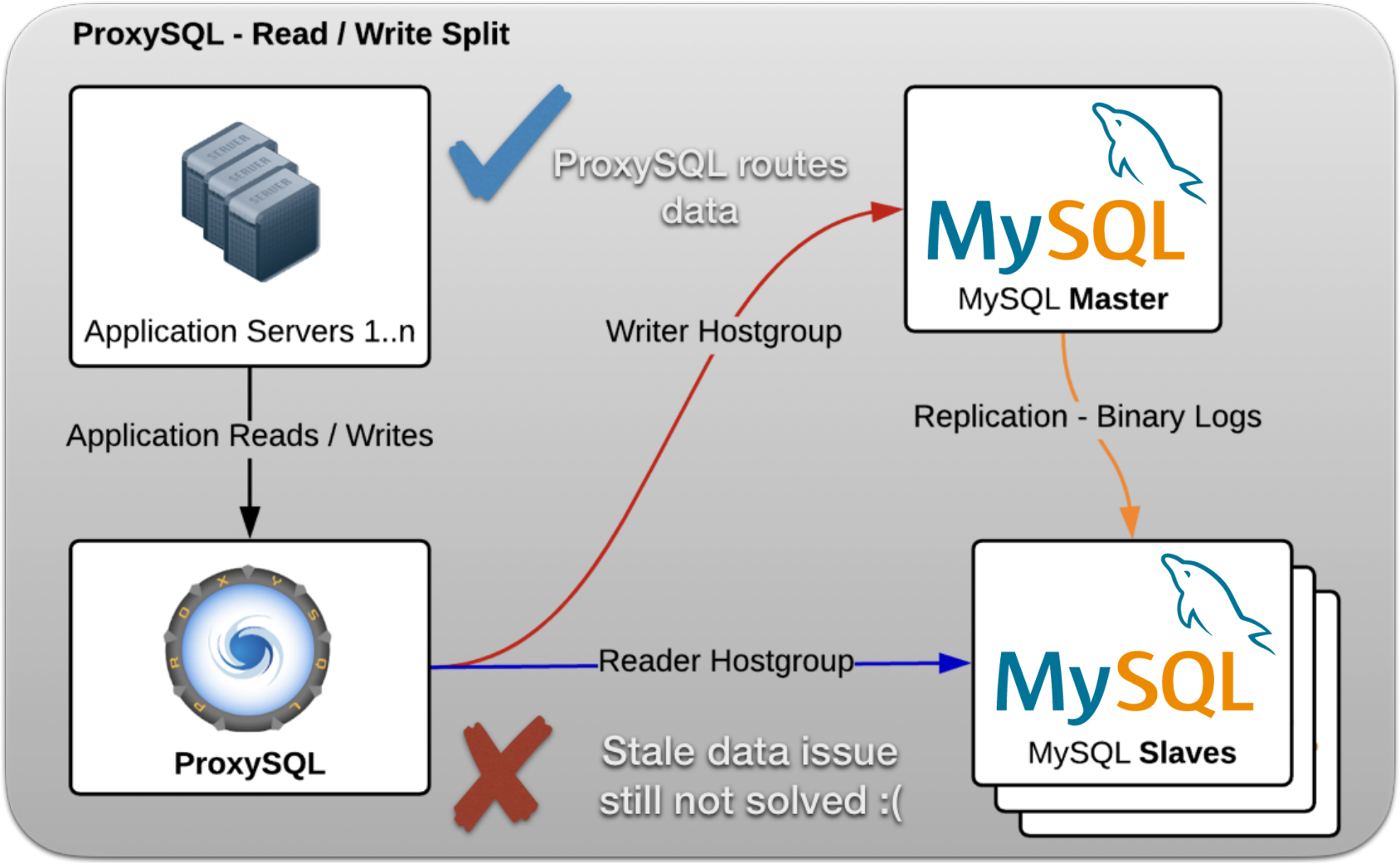
ProxSQL Read / Write Split



ProxSQL Read / Write Split



ProxSQL Read / Write Split



Benefits of ProxySQL's Read / Write Split

- Query rules defined in ProxySQL can dynamically route queries to READER or WRITER hostgroups
- Seamless for an application connecting and no application changes are required
- All traffic is served from a single listening port
- Slaves can be dynamically added / removed from a hostgroup to scale or perform maintenance

Challenges of R/W Split

- Susceptible to serve stale data due to replication lag
- Replication lag can be monitored and the reads can be routed to the master if a threshold is breached
- Threshold is configurable in increments of 1 second
- Replication lag is determined by polling at regular intervals

Replication in MySQL

A few slides about replication in MySQL historically as well as current features

Traditional binlog replication

- Traditional replication requires master & slave binary log file / position to be 100% synchronised
- Binary log events must be processed sequentially
- Binary log events can be missed or re-executed if replication is started from the wrong binlog file / position
- During failover replication should be stopped at the same position on all slaves to ensure data consistency after promotion

What is GTID?

- GTID is an acronym for "global transaction identifier"
- Unique identifier for every committed transaction
- GTID is unique across all servers in a master / slave cluster
- 1-to-1 mapping between all transactions and all GTIDs
- Represented as a colon separated pair of coordinates:

```
GTID = source_id:transaction_id
```

Why is GTID important?

- GTID guarantees consistency by detecting missing transactions from the set of GTIDs executed on a slave
- Supports auto-positioning making failover simpler, safer and quicker as slaves can be repointed to masters at any level of the a replication hierarchy
- SELECT WAIT_UNTIL_SQL_THREAD_AFTER_GTIDS() was introduced in 5.6.9 obsoleting WAIT_FOR_EXECUTED_GTID_SET() from MySQL 5.6.5.
  - Allows "SELECT" to wait until all GTIDs in a specified set have executed
  - You need to have the GTID prior to executing
  - Better approach however queries may be delayed

An important enhancement in MySQL 5.7

- In MySQL 5.7 & Percona Server 5.7 an important feature was added which allows sending the GTID for a transaction on the OK packet for a transaction
- Enabled explicitly by setting **--session-track-gtids** to one of the following values:
  - "OWN_GTID": collect GTIDs generated for committed R/W transactions
  - "ALL_GTIDS": collect ALL GTIDs in gtid_executed when a R/W or R/O transaction commits

Note: This feature is **NOT** available in MariaDB

Leveraging GTID in ProxySQL 2.0

New features / components introduced in ProxySQL 2.0 to leverage GTID

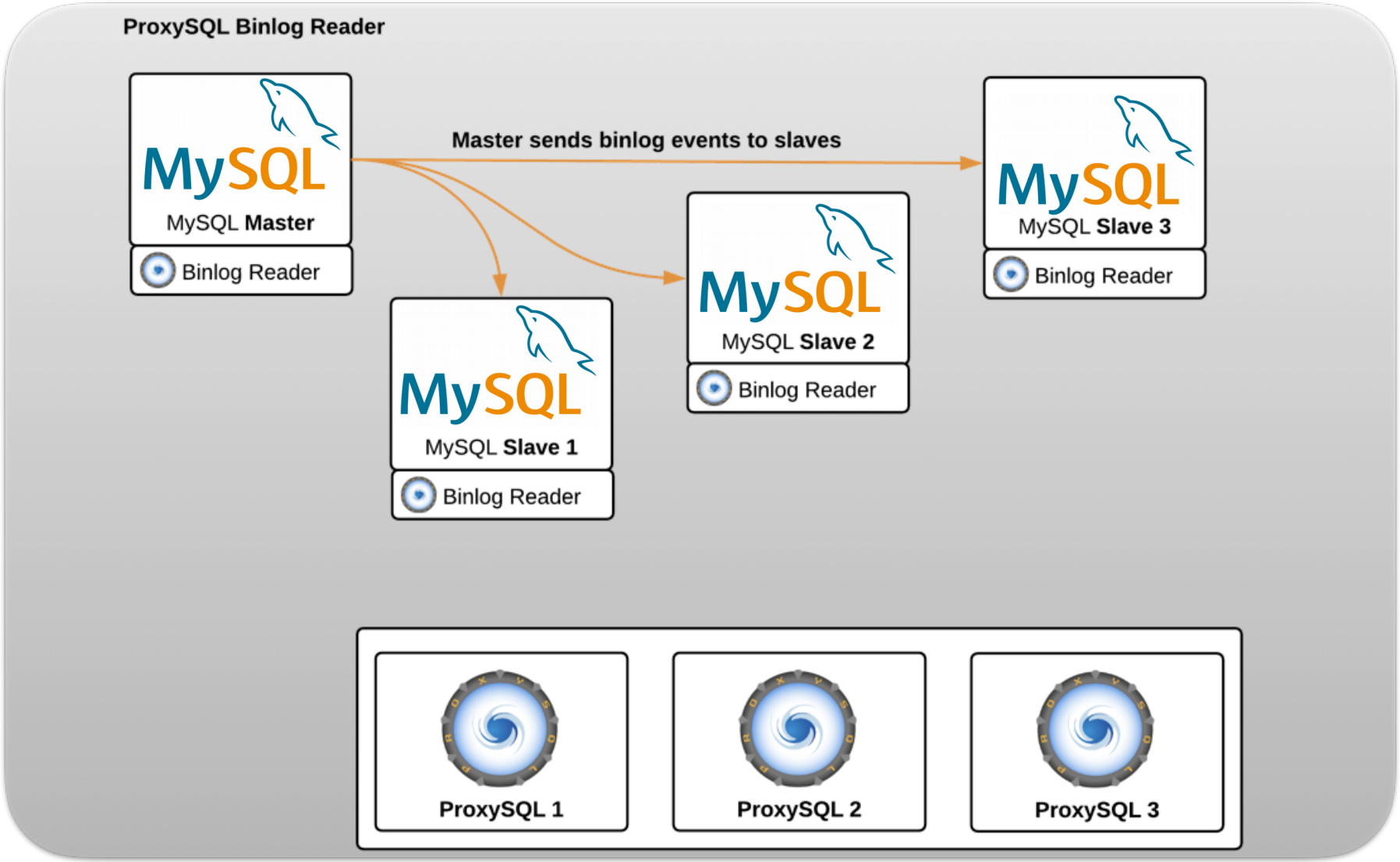
GTID tracking in ProxySQL

- Since GTIDs can be tracked on client connections... why not track these in ProxySQL as well?
- Tracking the GTIDs executed on a MySQL server can be done in one of two ways:
  - pull method: ProxySQL can query each MySQL server to fetch the last executed GTID
  - push method: Parse the binlog events "***as a slave***" and send the GTIDs processed to ProxySQL
- The "push method" is far more efficient and results in **less requests** and **lower latency**
  - Especially important in large scale deployments

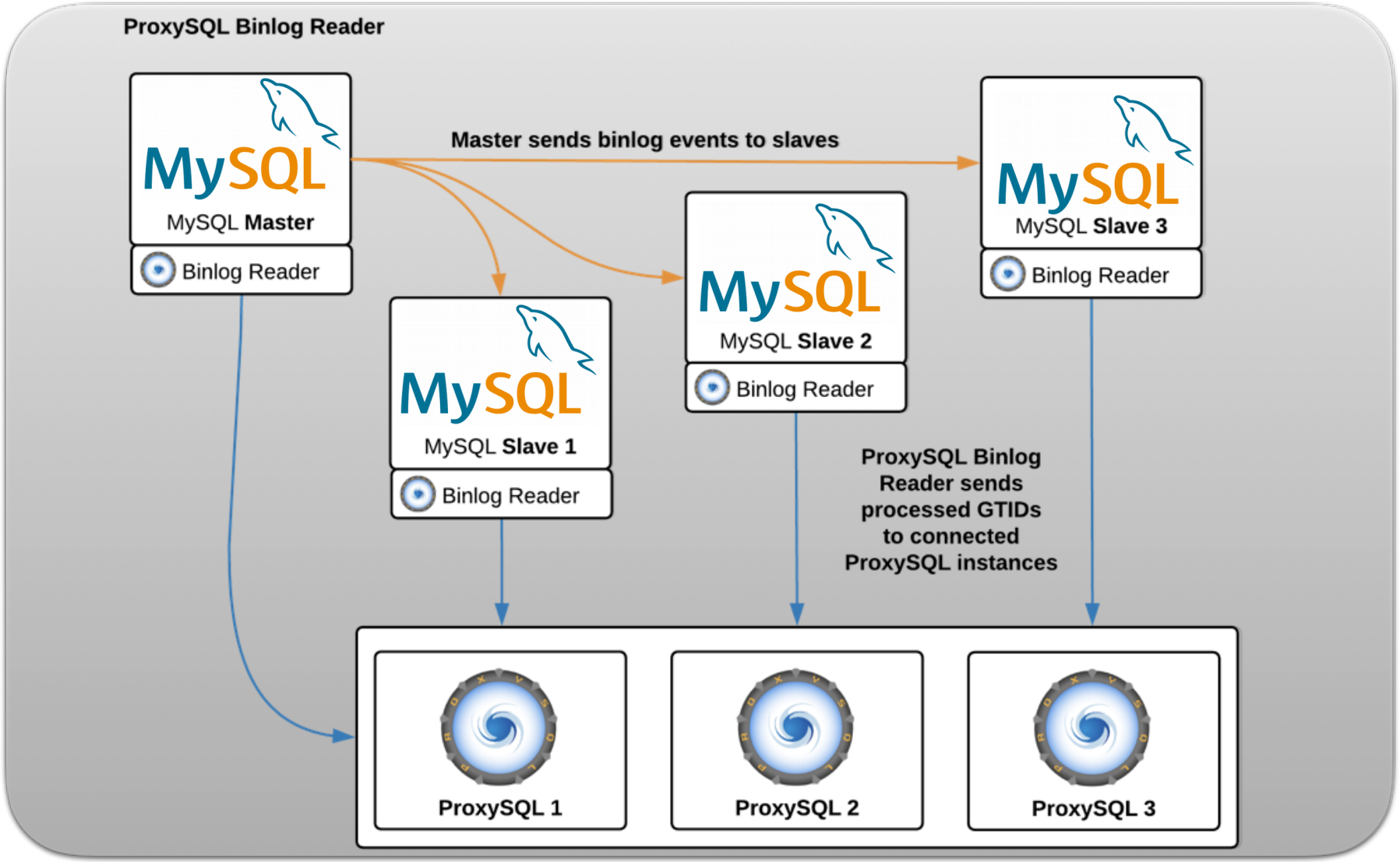
ProxySQL Binlog Reader

- A lightweight process that runs on the MySQL server
- Primary task is to provide GTID information about a MySQL server to all connected ProxySQL instances
- Designed to be robust and efficient while keeping CPU and network I/O to an absolute minimum for supporting hundreds
- Features an auto-restart mechanism in case of failure and a client side reconnect

ProxySQL Binlog Reader



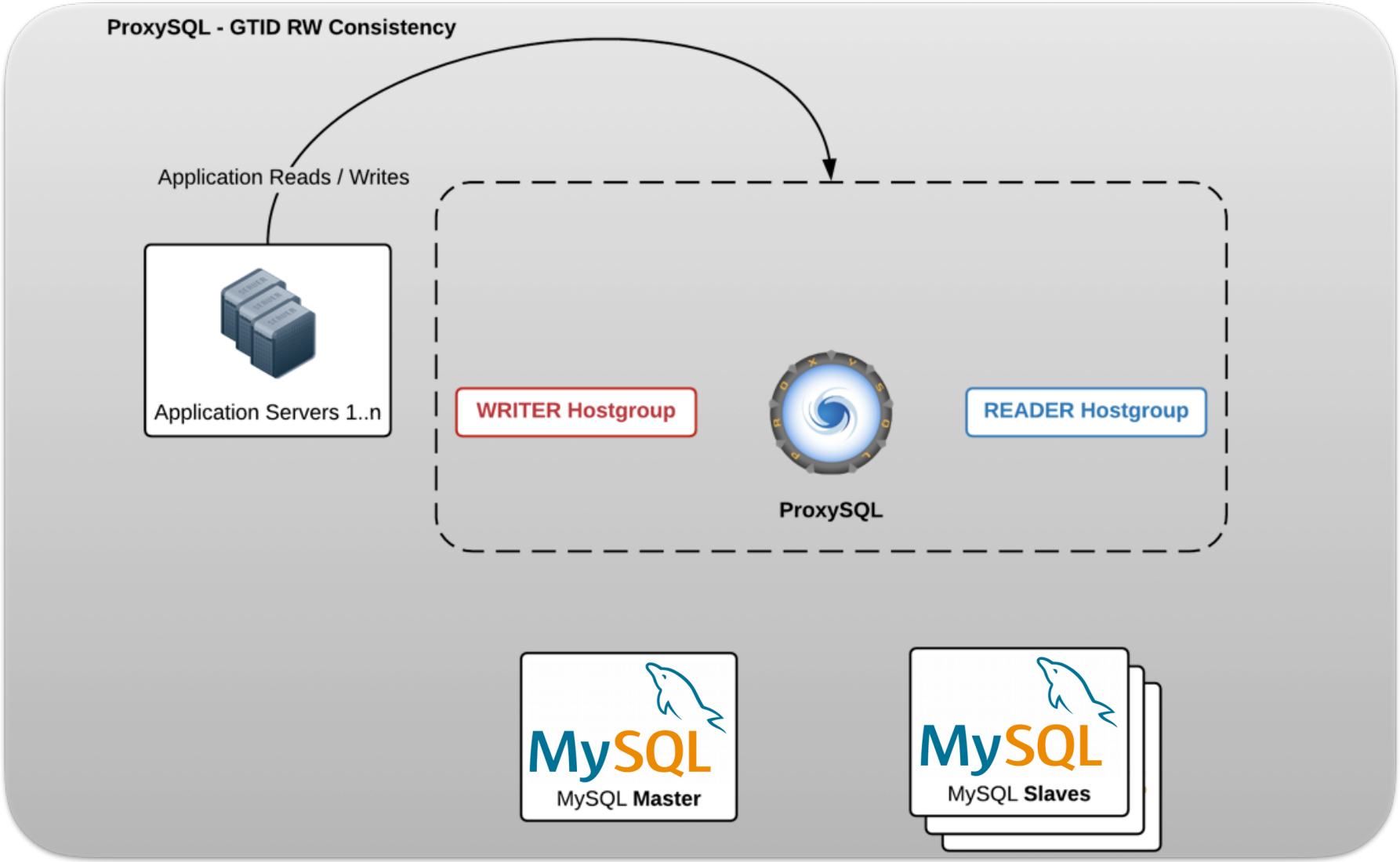
ProxySQL Binlog Reader



How does ProxySQL achieve GTID R/W Consistency?

- ProxySQL can be configured to enforce GTID consistency for reads on any hostgroup / replication hostgroup
- The hostgroup will ensure that any subsequent DQL:
  - Will be routed only to hosts which have executed the previous transaction's GTID for the connection
  - Since the MASTER host will be part of the hostgroup / READER replication hostgroup (with a lower weight) there is always a node available to serve the DQL statement

ProxySQL Binlog Reader



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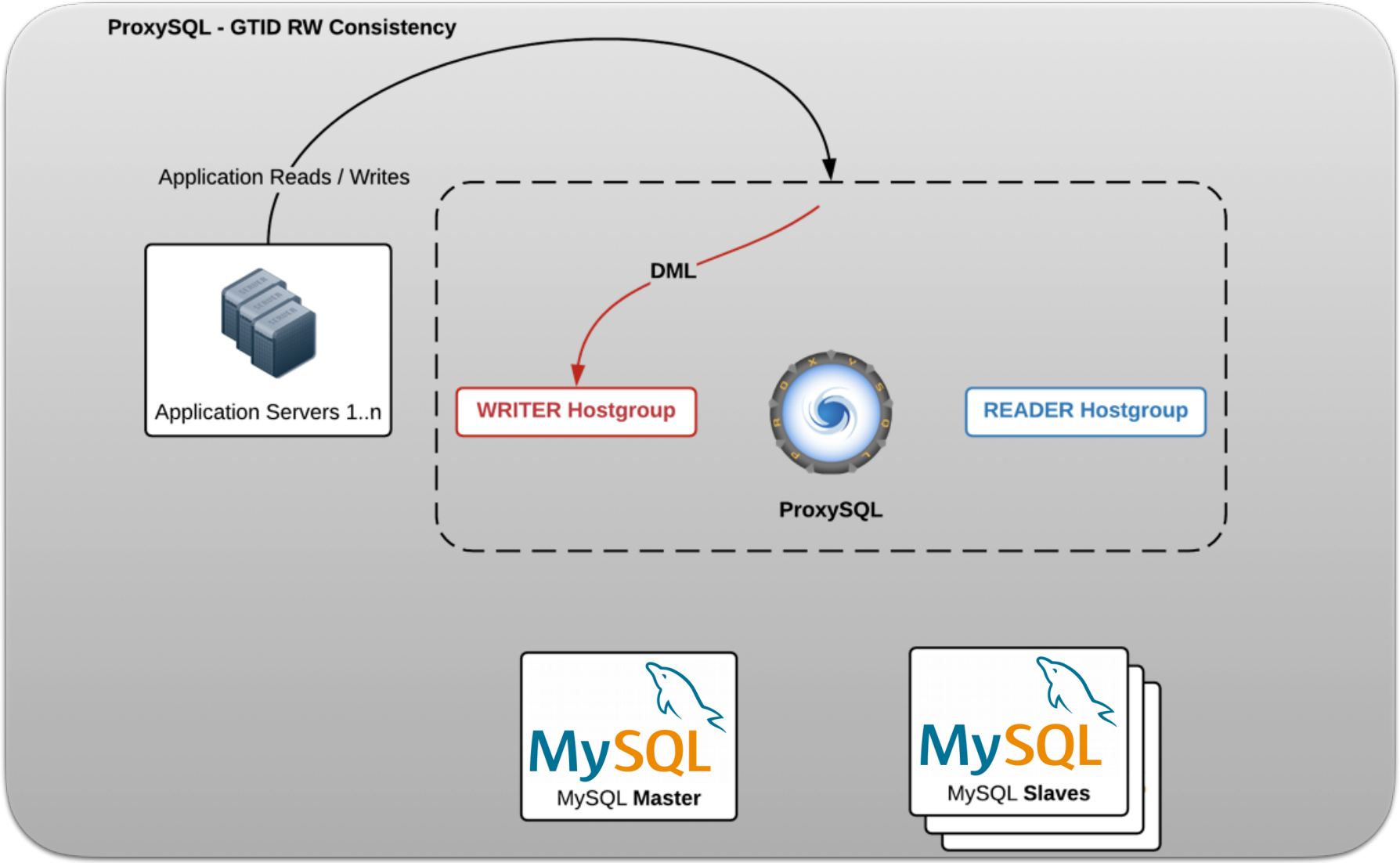

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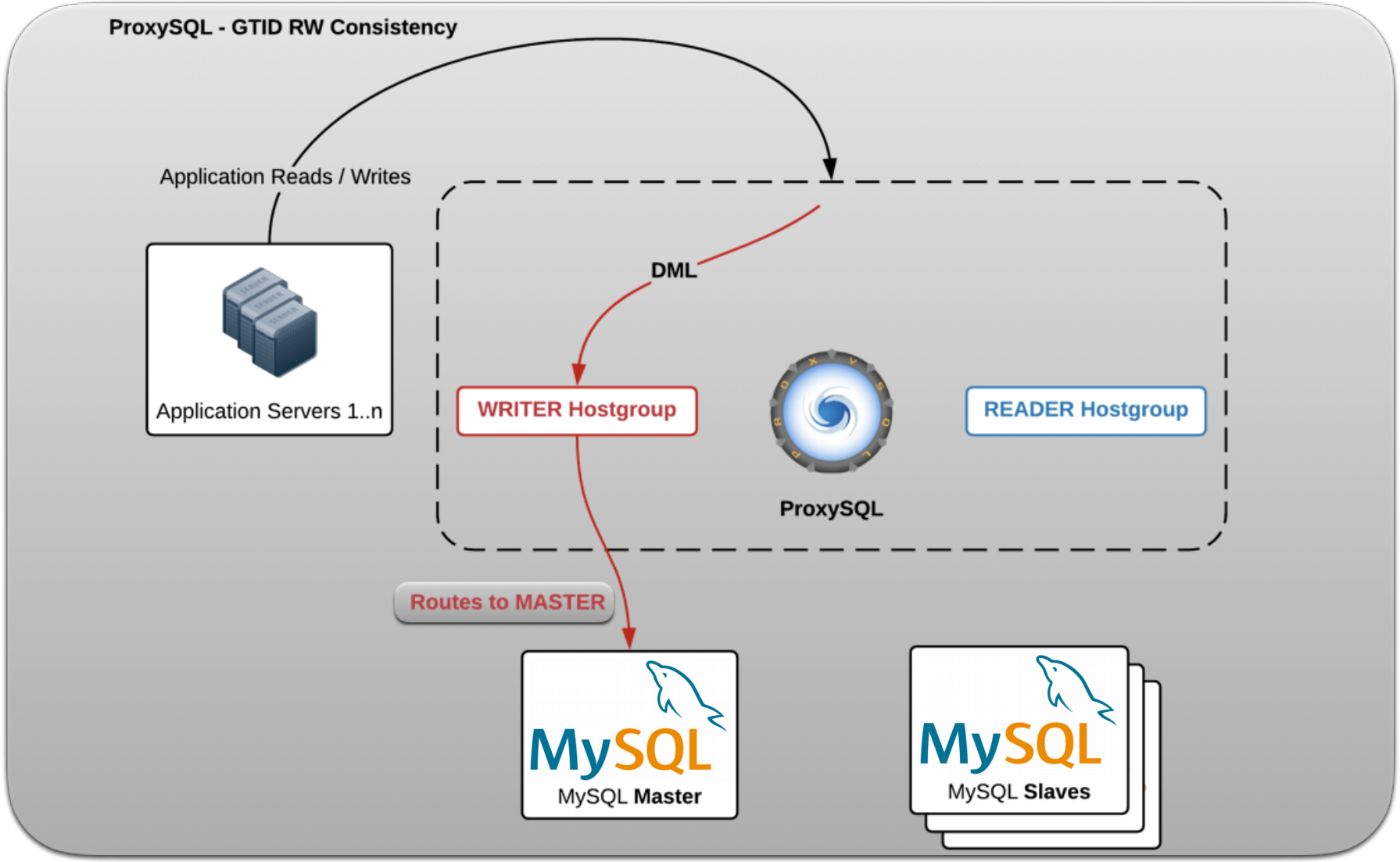

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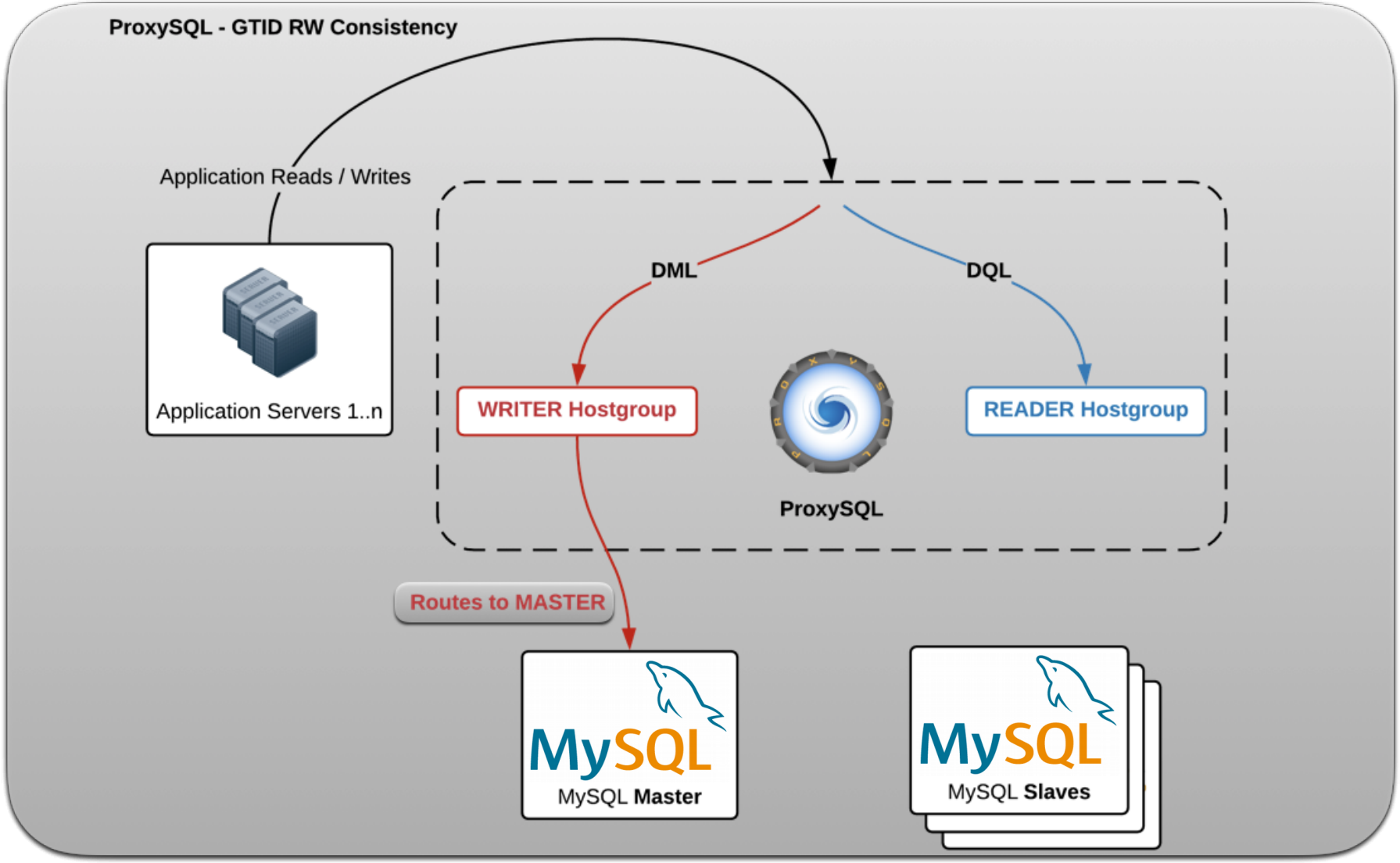

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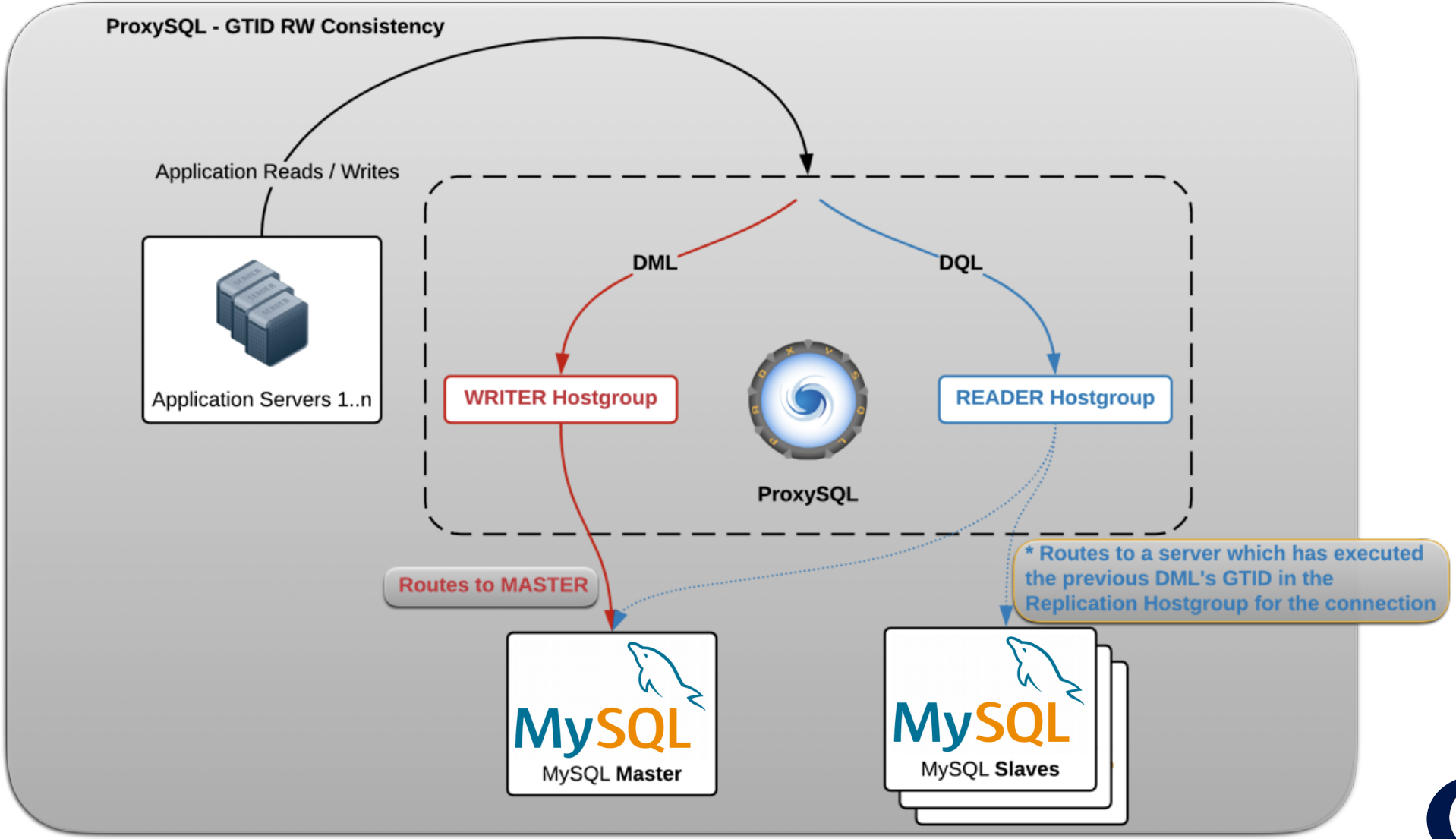

Supported Replication Models

- Master - Slave:
  - Asynchronous Replication
  - Semi-Synchronous Replication
- Multi - Master:
  - InnoDB Cluster / Group Replication
- Additional requirements:
  - **GTID** is required for all servers in the hostgroup which routes **GTID consistent queries**
  - The **binlog_format** must be configured to **ROW**

Live Demo

A demonstration of consistent reads with GTID and the components discussed in this presentation

Demo Configuration

- 1x ProxySQL 2.0 instance
  - Proxysql1
- 3x MySQL 5.7 instances
  - Mysql1: Read / Write Master
  - Mysql2: Read Only Slave
  - Mysql3: Read Only Slave
- Python test script: “`bin/gtid-tester`”
  - Creates a “user” table and starts 4x threads (separate connections)
  - Each thread does 1000 iterations performing an INSERT followed by a COUNT(*) on the table

Demo MySQL Configuration

- Specific my.cnf variables of interest:
  - `binlog_format=ROW`
  - `gtid_mode=ON`
  - `enforce_gtid_consistency=true`
  - `session_track_gtids=OWN_GTID`

Demo MySQL Configuration

Processes running in the MySQL Docker container

- MySQL (port 3306):
  - `mysqld`
- ProxySQL Binlog Reader (port 999):
  -
```
proxysql_binlog_reader \
-h 127.0.0.1 -u root -p xxxx -P 3306 \
-l 999 -L /var/log/binlog_reader.log
```

Demo ProxySQL Configuration

ProxySQL “mysql_servers” configuration:

```
ProxySQL Admin> select hostgroup_id, hostname, port, gtid_port,
status from runtime_mysql_servers;
+--------------+----------+------+-----------+--------+
| hostgroup_id | hostname | port | gtid_port | status |
+--------------+----------+------+-----------+--------+
| 0            | mysql1   | 3306 | 999       | ONLINE |
| 1            | mysql3   | 3306 | 999       | ONLINE |
| 1            | mysql2   | 3306 | 999       | ONLINE |
| 1            | mysql1   | 3306 | 999       | ONLINE |
+--------------+----------+------+-----------+--------+
```

Demo ProxySQL Configuration

ProxySQL “mysql_query_rules” configuration (“gtid_from_hostgroup” defines which hostgroup determines the required GTID for a session):

```
ProxySQL Admin> select match_digest, destination_hostgroup,
gtid_from_hostgroup from mysql_query_rules\G
*************************** 1. row ***************************
        match_digest: ^SELECT.*FOR UPDATE
destination_hostgroup: 0
  gtid_from_hostgroup: NULL
*************************** 2. row ***************************
        match_digest: ^SELECT
destination_hostgroup: 1
  gtid_from_hostgroup: 0
```

Demo ProxySQL GTID Statistics

ProxySQL “stats_mysql_gtid_executed” to view status of GTID tracking:

```
ProxySQL Admin> select * from stats_mysql_gtid_executed where
hostname='mysql1’\G
*************************** 1. row ***************************
     hostname: mysql1
         port: 3306
gtid_executed: 85c17137-4258-11e8-8090-0242ac130002:1-65588
       events: 65581
```

Demo ProxySQL GTID Statistics

```
ProxySQL Admin> select hostname,gtid_executed from stats_mysql_gtid_executed
order by hostname\G
*************************** 1. row ***************************
     hostname: mysql1
gtid_executed: 85c17137-4258-11e8-8090-0242ac130002:1-146301
*************************** 2. row ***************************
     hostname: mysql2
gtid_executed: 85c17137-4258-11e8-8090-0242ac130002:1-146300,8a093f5f-4258-
11e8-8037-0242ac130004:1-5
*************************** 3. row ***************************
     hostname: mysql3
gtid_executed: 85c17137-4258-11e8-8090-0242ac130002:1-146301,8a0ac961-4258-
11e8-8003-0242ac130003:1-5
```

Demo ProxySQL GTID Statistics

ProxySQL “stats_mysql_connection_pool” shows how many queries were executed using GTID causal reads in the “Queries_GTID_sync” column:

```
ProxySQL Admin> select hostgroup, srv_host, queries, queries_gtid_sync
from stats_mysql_connection_pool;
+-----------+----------+---------+--------------------+
| hostgroup | srv_host | Queries | Queries_GTID_sync |
+-----------+----------+---------+--------------------+
| 0         | mysql1   | 603677  | 0                  |
| 1         | mysql1   | 480665  | 8270               |
| 1         | mysql2   | 638147  | 8570               |
| 1         | mysql3   | 631756  | 8387               |
+-----------+----------+---------+--------------------+
```

Sample ProxySQL Binlog Reader Logfile

```
$ cat /var/log/binlog_reader.log
Starting ProxySQL MySQL Binlog
Sucessfully started
Angel process started ProxySQL MySQL Binlog process 242
2018-04-17 16:04:05 [INFO] Initializing client...
8a093f5f-4258-11e8-8037-0242ac130004:1-5,85c17137-4258-11e8-8090-
0242ac130002:1-7
2018-04-17 16:04:05 [INFO] Reading binlogs...
```

Sample ProxySQL Binlog Reader Stream

SourceID is only sent when it changes, other the bare minimum TransactionID is sent (on client initialisation full GTID history available is sent), for example:

```
ST=85c17137-4258-11e8-8090-0242ac130002:1-209419
I1=85c17137425811e880900242ac130002:209420
I2=209421
I2=209422
I2=209423
I2=209424
I2=209425
```

Thank You!

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