PERCONA

New Replication Features In MySQL 5.6

Stéphane Combaudon
October 23rd, 2013

Agenda

- Introduction
- Binlog checksums
- Crash safe replication
- Multi threaded slaves
- Global Transactions IDs

Introduction

Why using replication?

- Scaling out
  - Offload some of the reads to slaves
- High availability
  - If master fails, you can promote a slave
- Backups
  - Impact of backups is less problematic on slaves
- Tests & Upgrades
  - Run the application load on a slave first

High-level description

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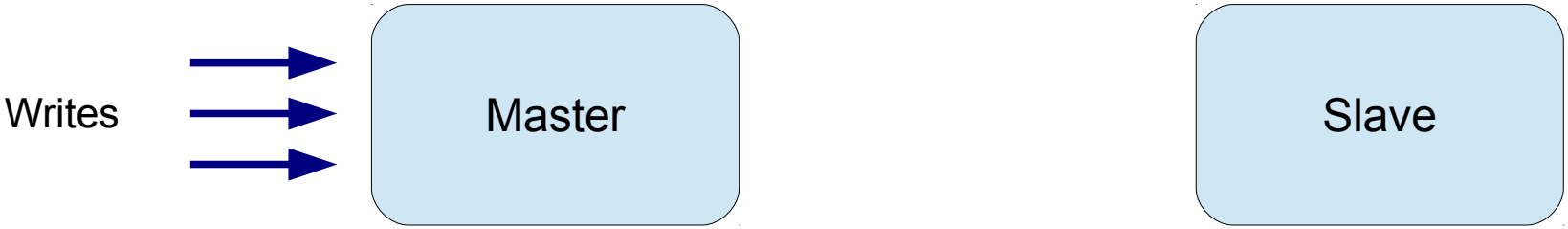

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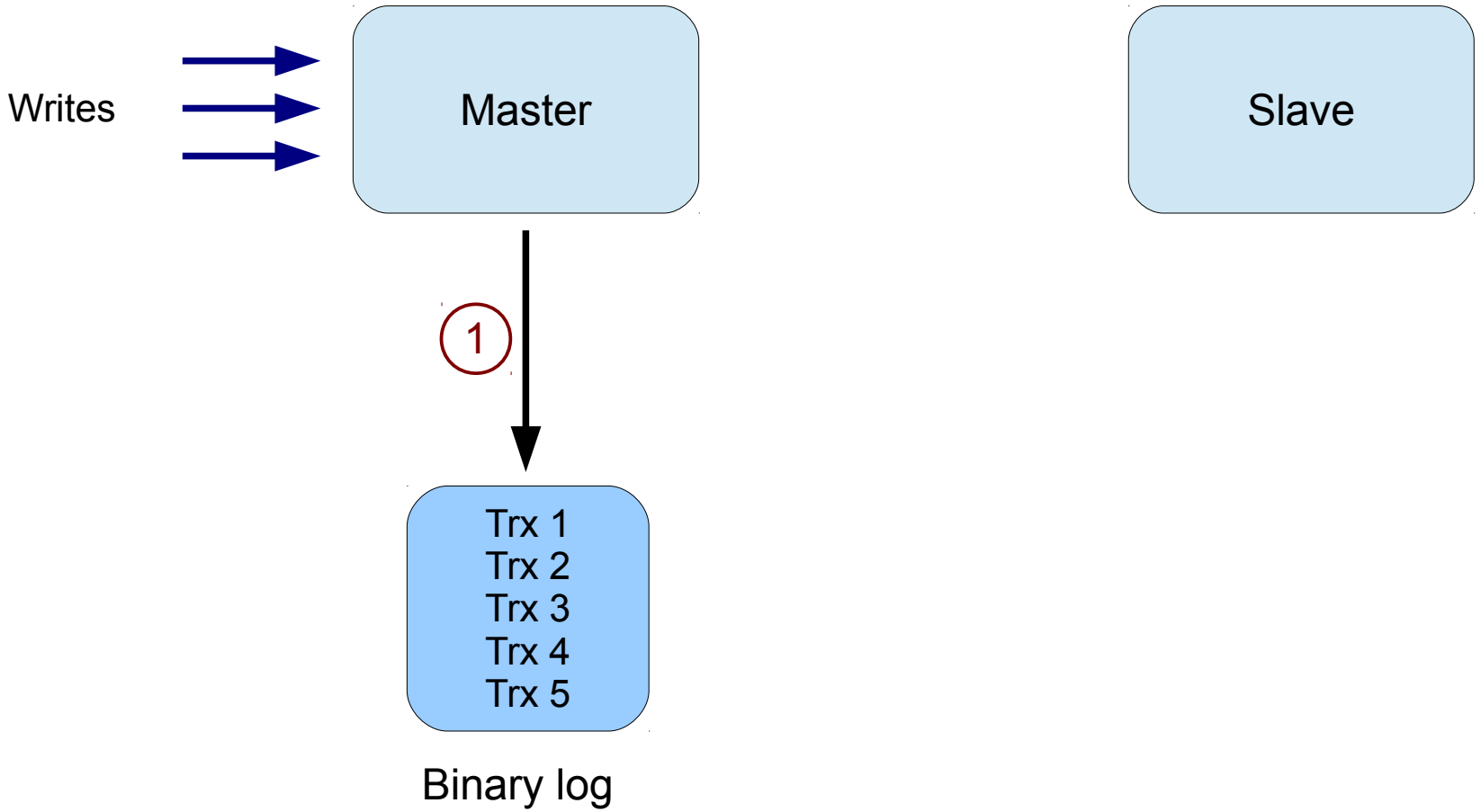

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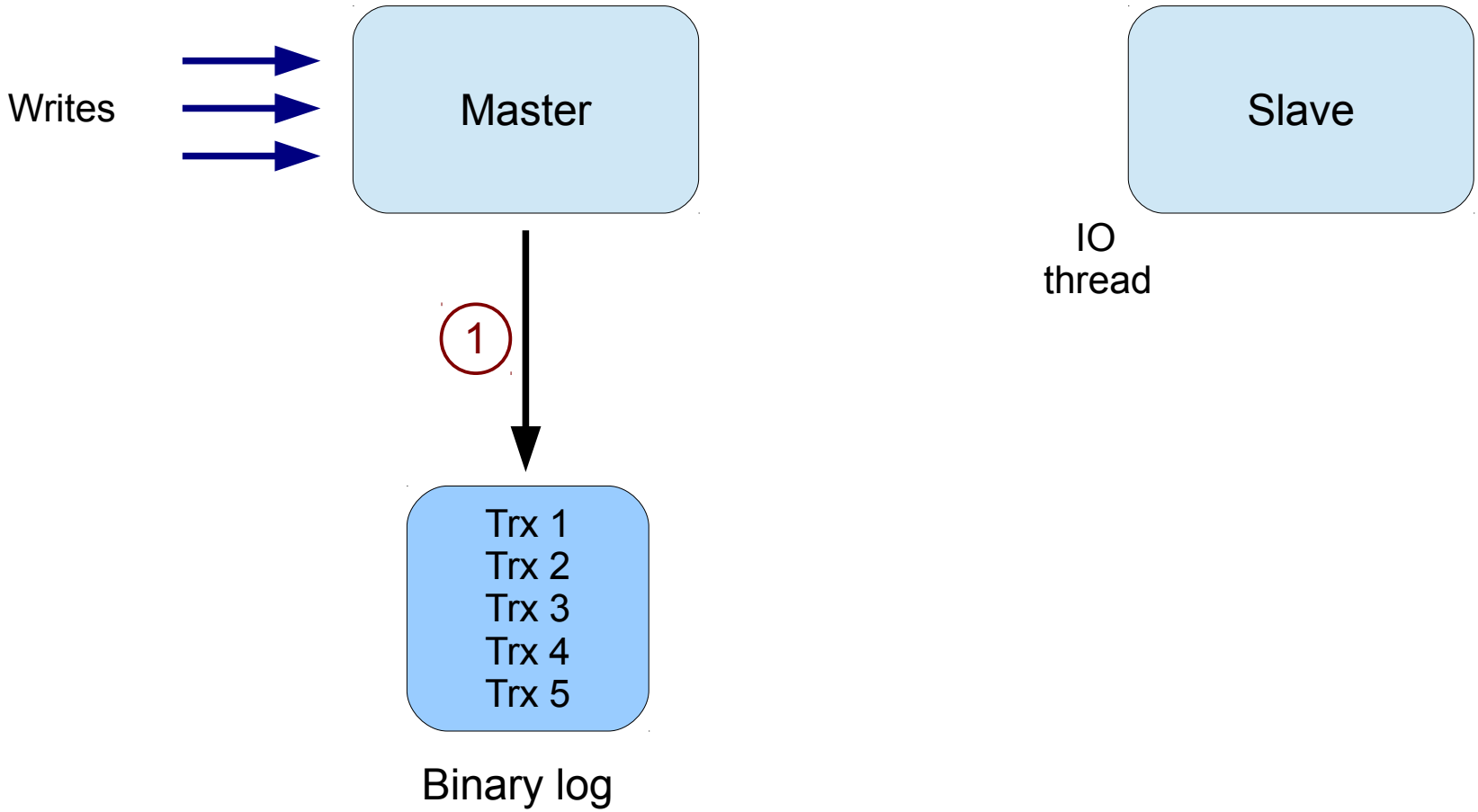

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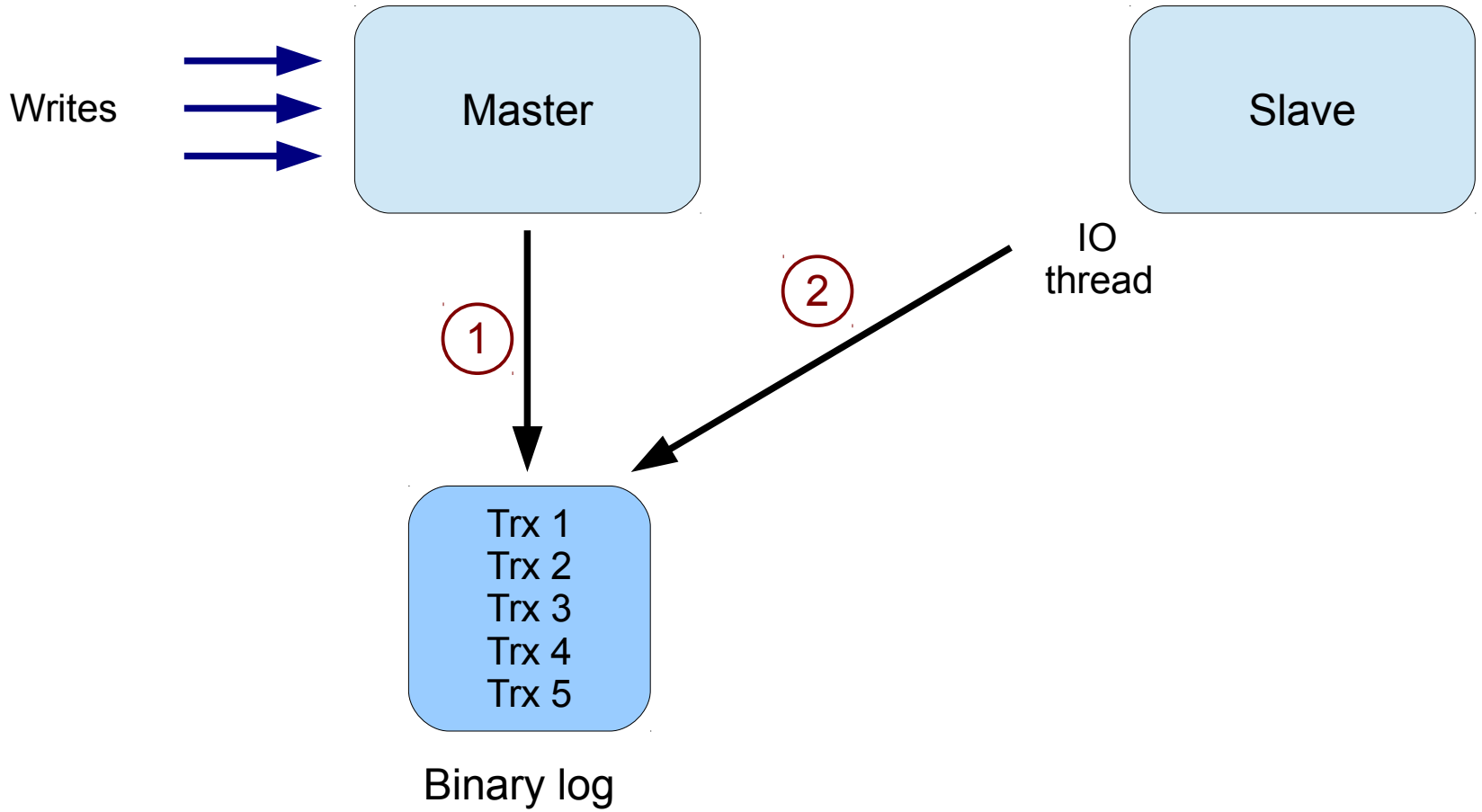

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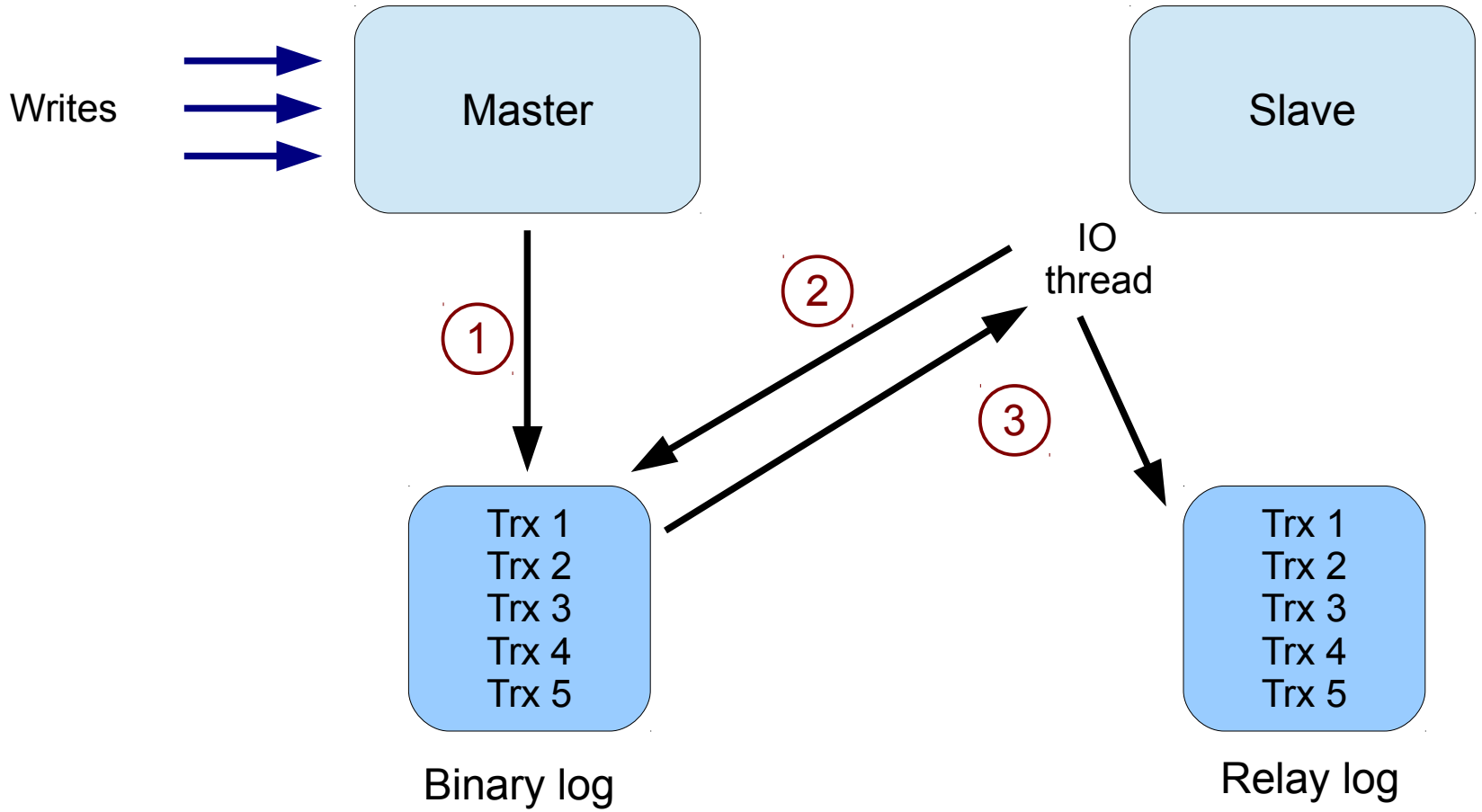

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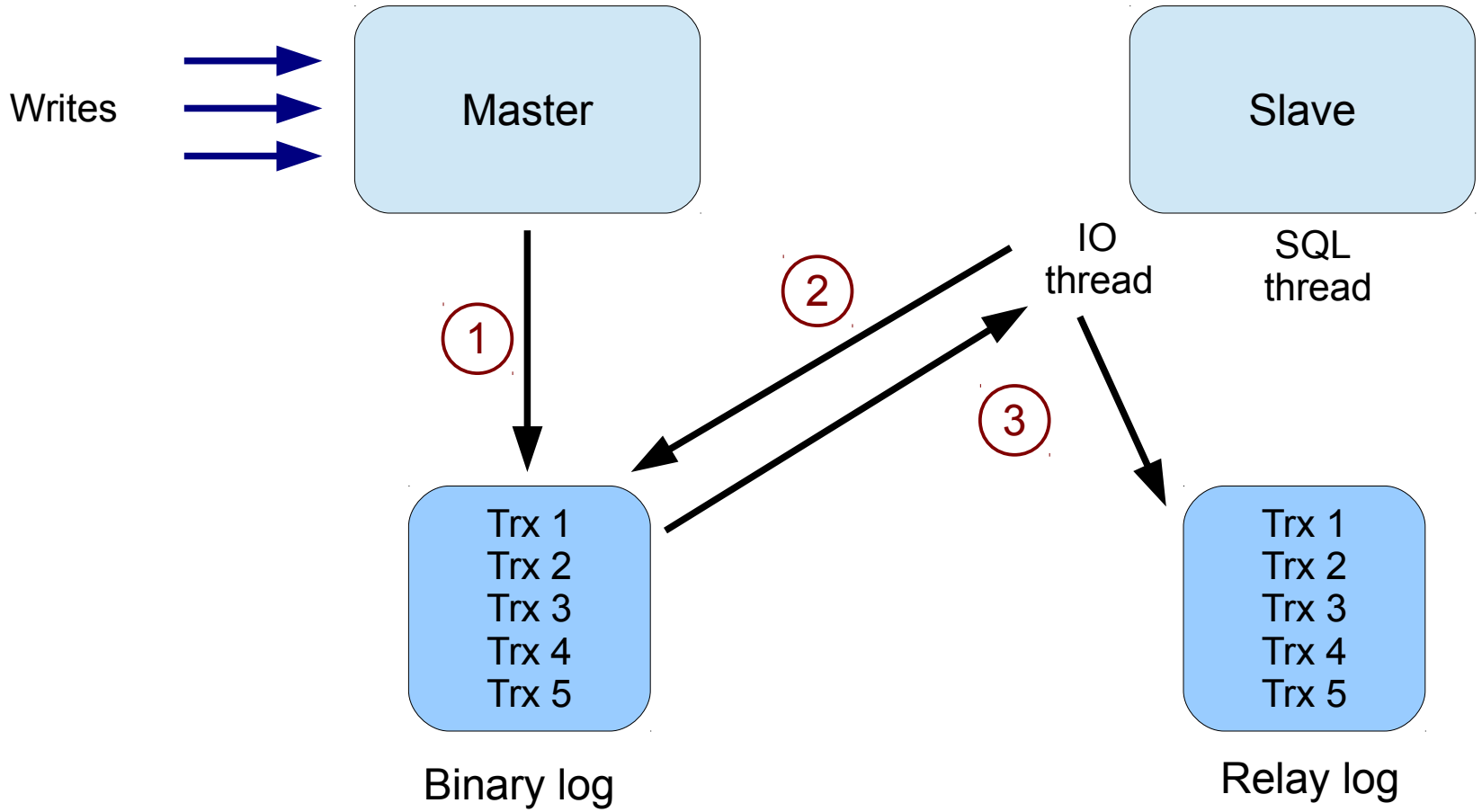

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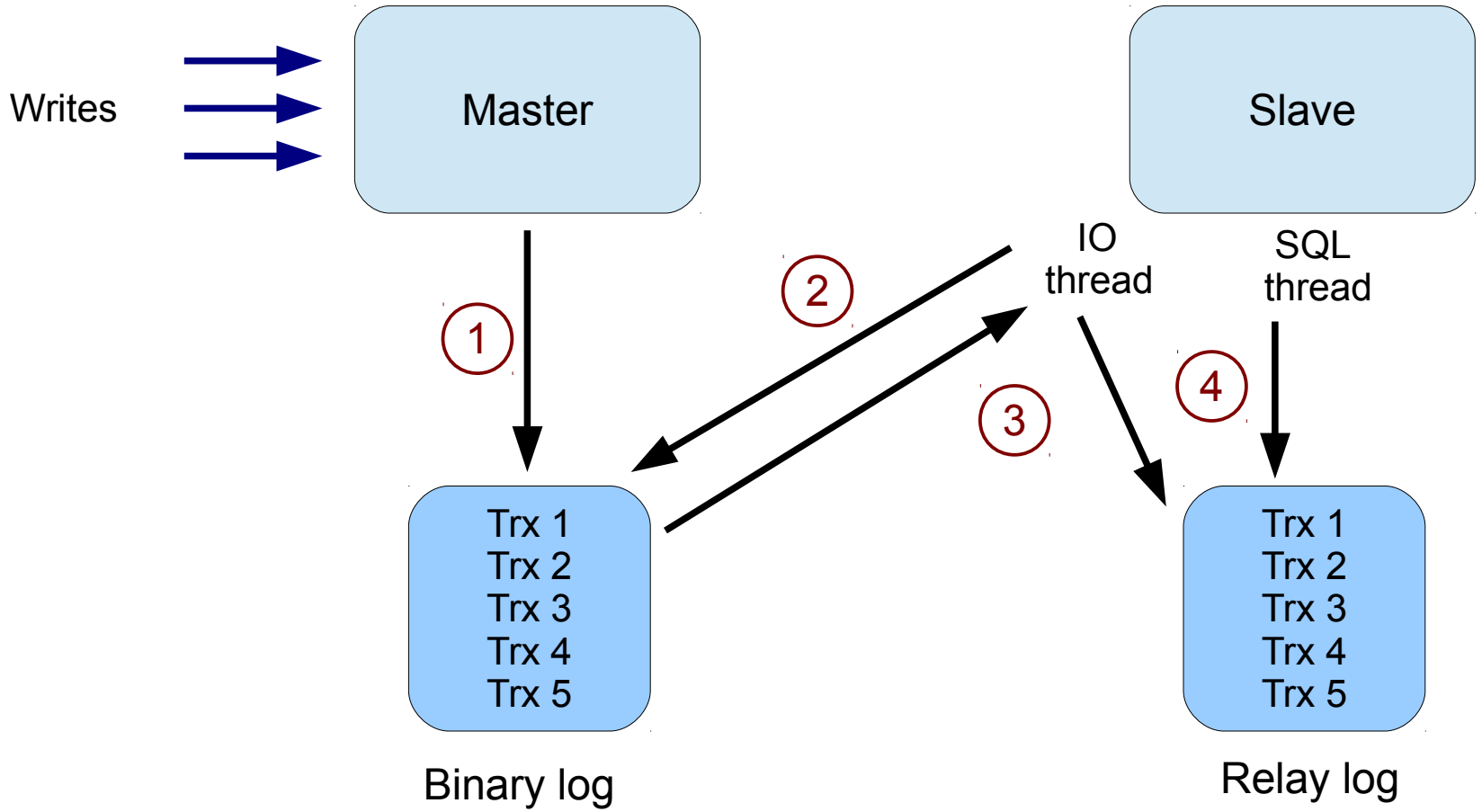

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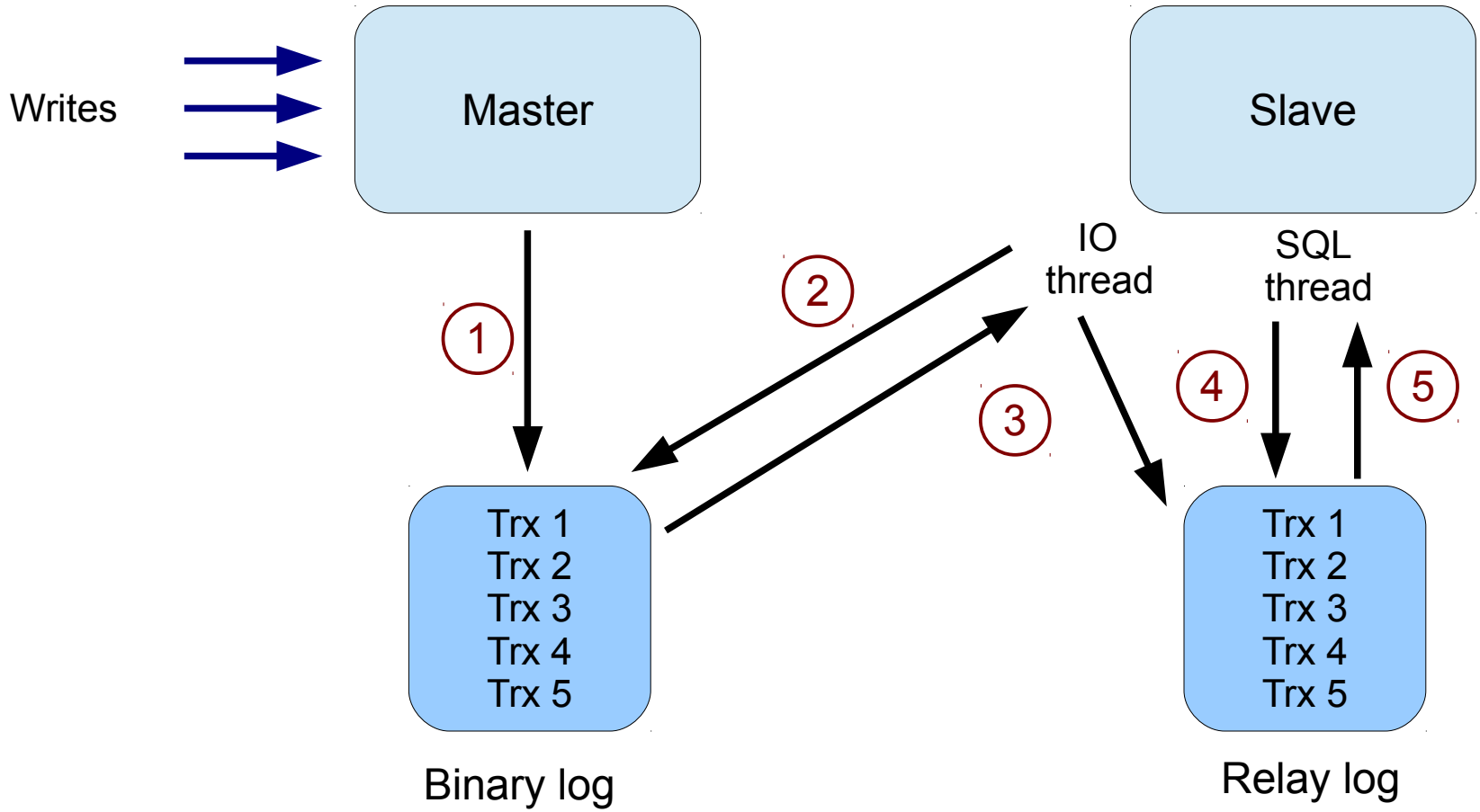

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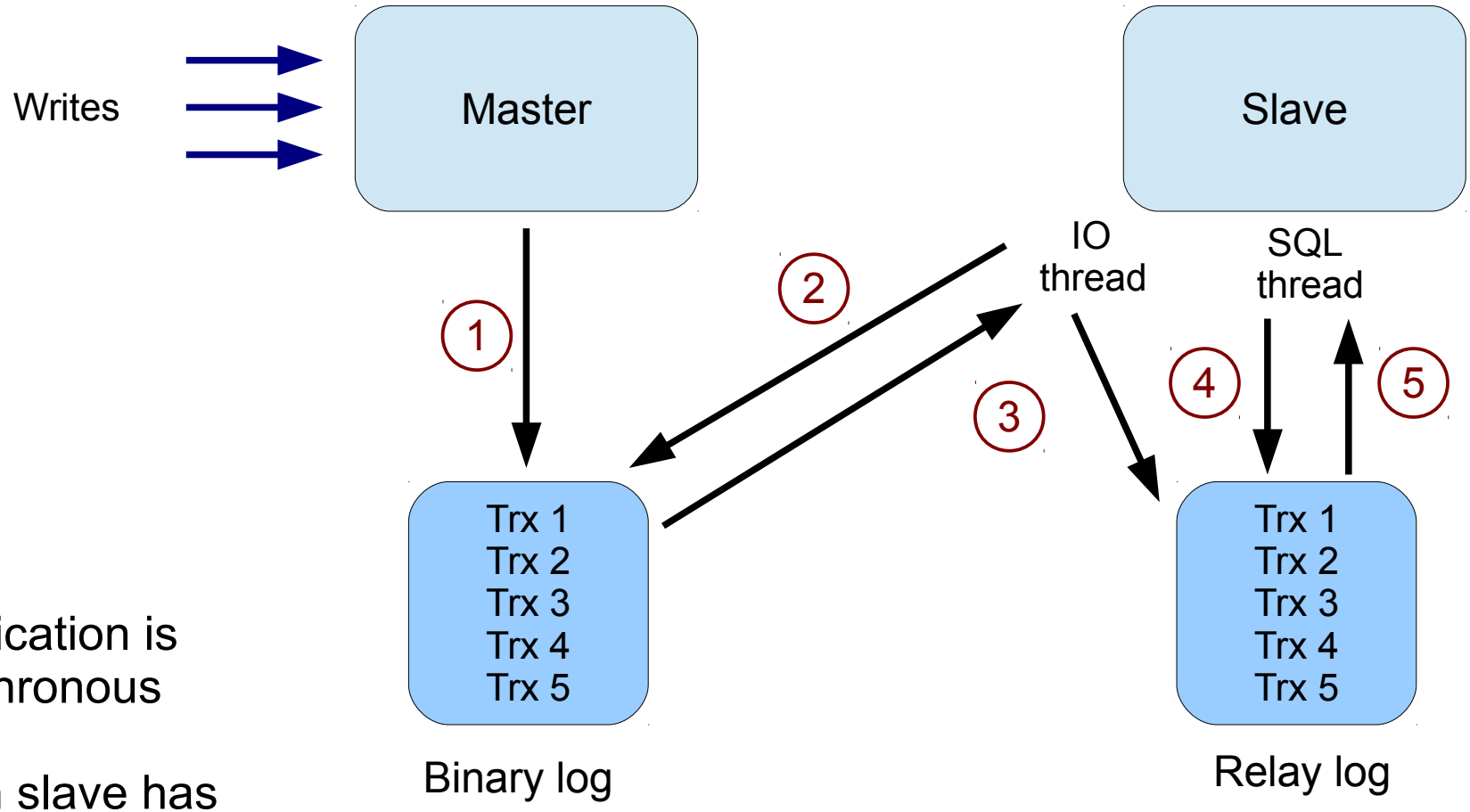

- Replication is asynchronous
- Each slave has its own relay log

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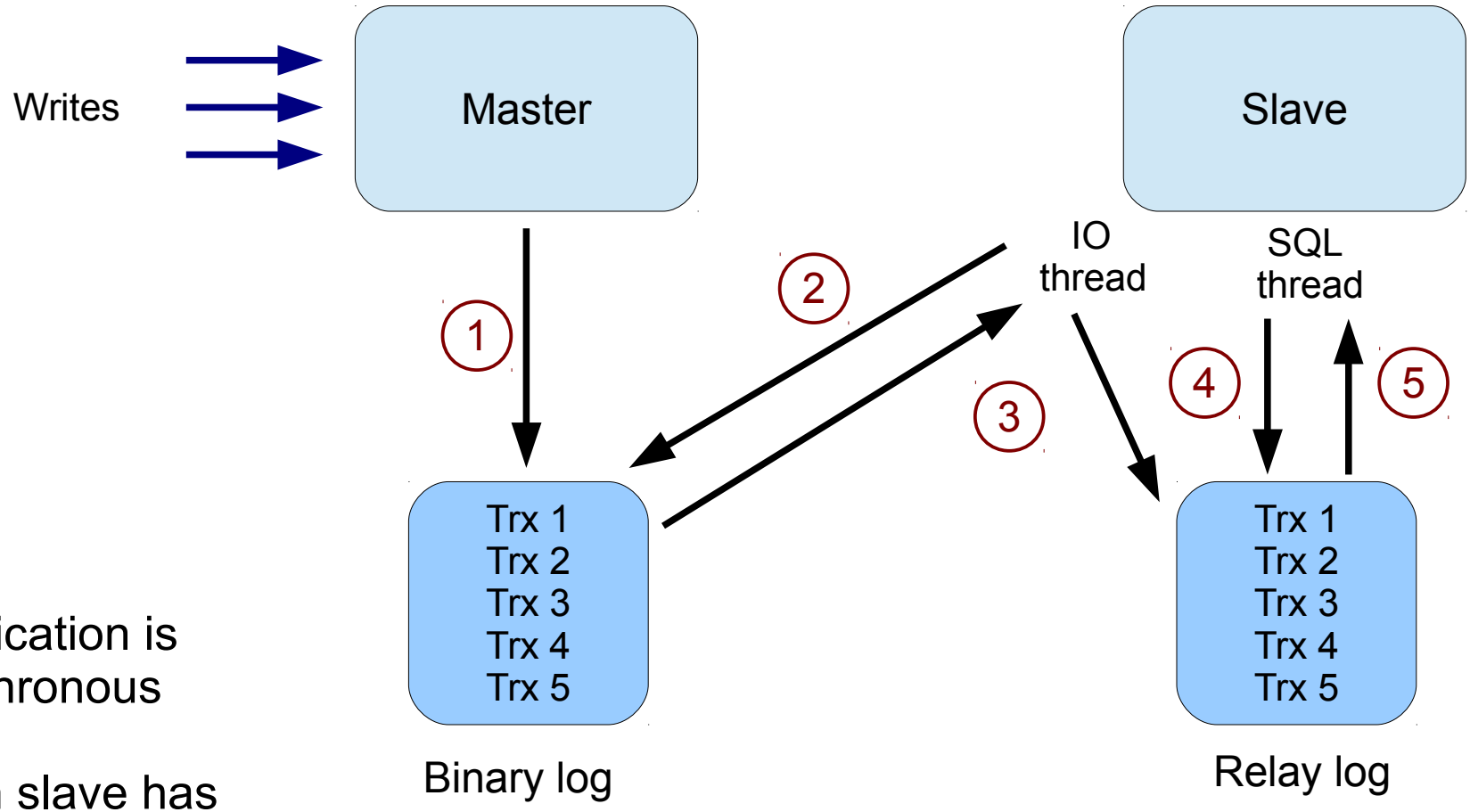

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Binlog checksums

What is the problem?

- Master and slaves can have different data
- Even when replication runs without error. Why?
  - Non deterministic queries
  - Writes executed on slaves outside of replication
  - Wrong usage of replication filters
  - Using a non transactional storage engine
  - Binlog or relay log corruption
  - ...

How to check?

- Before 5.6, nothing was provided by the server
- Your best bet was to use pt-table-checksum
  - http://www.percona.com/doc/percona-toolkit/2.2/pt-table-checksum.html

```
[stephane@centos2 ~]$ pt-table-checksum --empty-replicate-table -d sakila h=127.0.0.1,P=22585
            TS ERRORS  DIFFS     ROWS  CHUNKS SKIPPED    TIME TABLE
04-03T15:39:37      0      0      200       1       0   0.281 sakila.actor
04-03T15:39:38      0      0      603       1       0   0.299 sakila.address
04-03T15:39:38      0      0       16       1       0   0.047 sakila.category
04-03T15:39:38      0      0      600       1       0   0.049 sakila.city
04-03T15:39:38      0      0      109       1       0   0.049 sakila.country
04-03T15:39:38      0      0      599       1       0   0.302 sakila.customer
04-03T15:39:38      0      0     1000       1       0   0.292 sakila.film
04-03T15:39:39      0      0     5462       1       0   0.307 sakila.film_actor
04-03T15:39:39      0      0     1000       1       0   0.300 sakila.film_category
04-03T15:39:39      0      0     1000       1       0   0.048 sakila.film_text
04-03T15:39:39      0      0     4581       1       0   0.301 sakila.inventory
04-03T15:39:39      0      0        6       1       0   0.083 sakila.language
04-03T15:39:40      0      1    16049       1       0   0.381 sakila.payment
04-03T15:39:40      0      0    16044       1       0   0.355 sakila.rental
04-03T15:39:40      0      0        2       1       0   0.034 sakila.staff
04-03T15:39:40      0      0        2       1       0   0.056 sakila.store
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Checksums on slaves

- Step #1: enable checksums on master
  - `binlog_checksum = CRC32;`
- Step #2: enable checks on slaves
  - `slave_sql_verify_checksum = ON;`
- Both are enabled by default

In case of relay log corruption

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```
mysql> show slave status\G

               [...]
 Slave_IO_Running: Yes
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           [...]
       Last_Errno: 1594
       Last_Error: Relay log read failure: Could not parse relay log event entry.
The possible reasons are: the master's binary log is corrupted (you can check this
by running 'mysqlbinlog' on the binary log), the slave's relay log is corrupted (you
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- For a more meaningful error message, use mysqlbinlog

```
# mysqlbinlog --verify-binlog-checksum mysql_sandbox18676-relay-bin.000002
[...]
ERROR: Error in Log_event::read_log_event(): 'Event crc check failed! Most likely
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Checksums on the master

- `master_verify_checksum = ON;`

- But... this setting won't prevent you from writing to a corrupted binlog file!

- You will have to test manually

```
mysql> SHOW BINLOG EVENTS IN 'mysql-bin.000006';

ERROR 1220 (HY000): Error when executing command SHOW
BINLOG EVENTS: Wrong offset or I/O error
```

Limitations

- Back to the 'What can go wrong' list
  - Non deterministic queries
  - Writes executed on slaves outside of replication
  - Wrong usage of replication filters
  - Using a non transactional storage engine
  - Binlog or relay log corruption
  - ...

Checksums only help here!

- CPU overhead

- Relay log corruption was already often detected

Crash safe slaves

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- Replication information is stored in files by default (relay-log.info and master.info)
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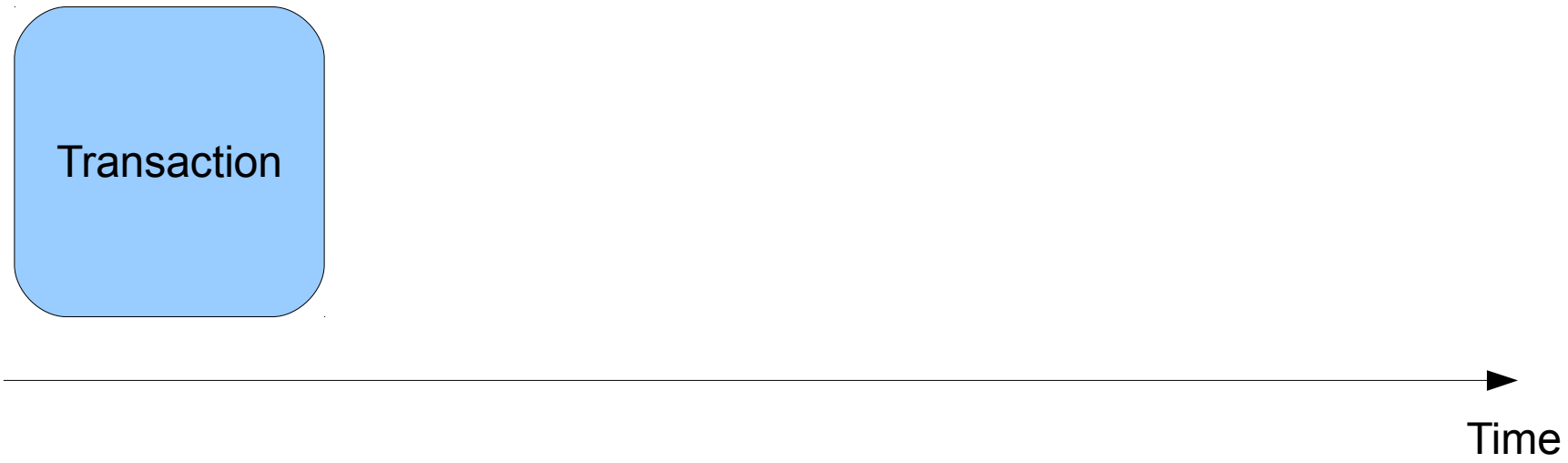

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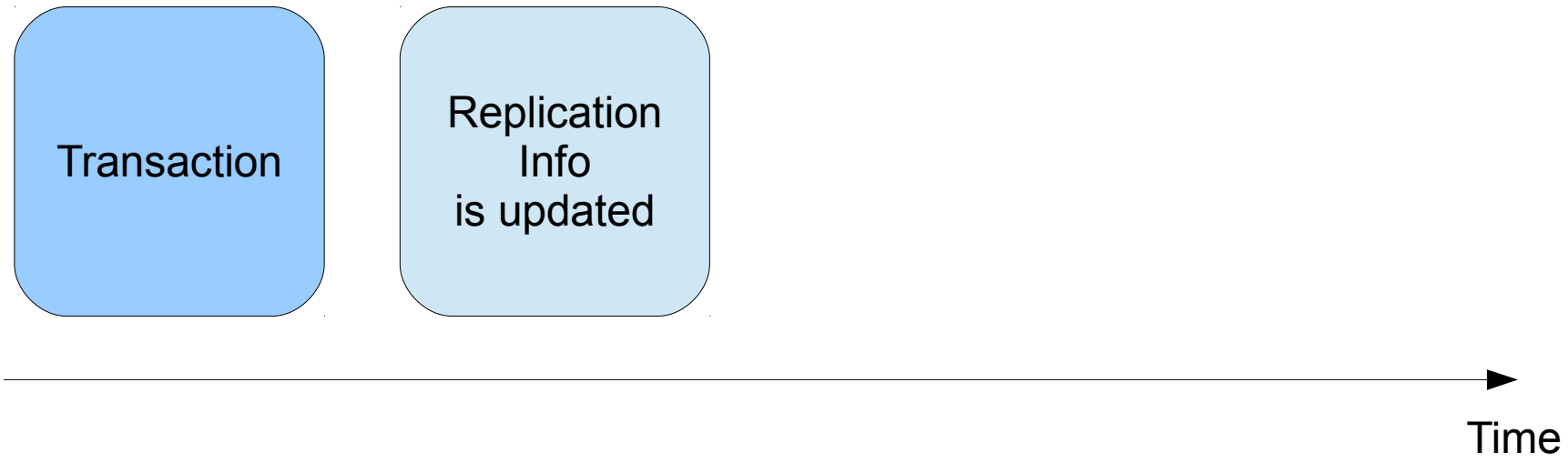

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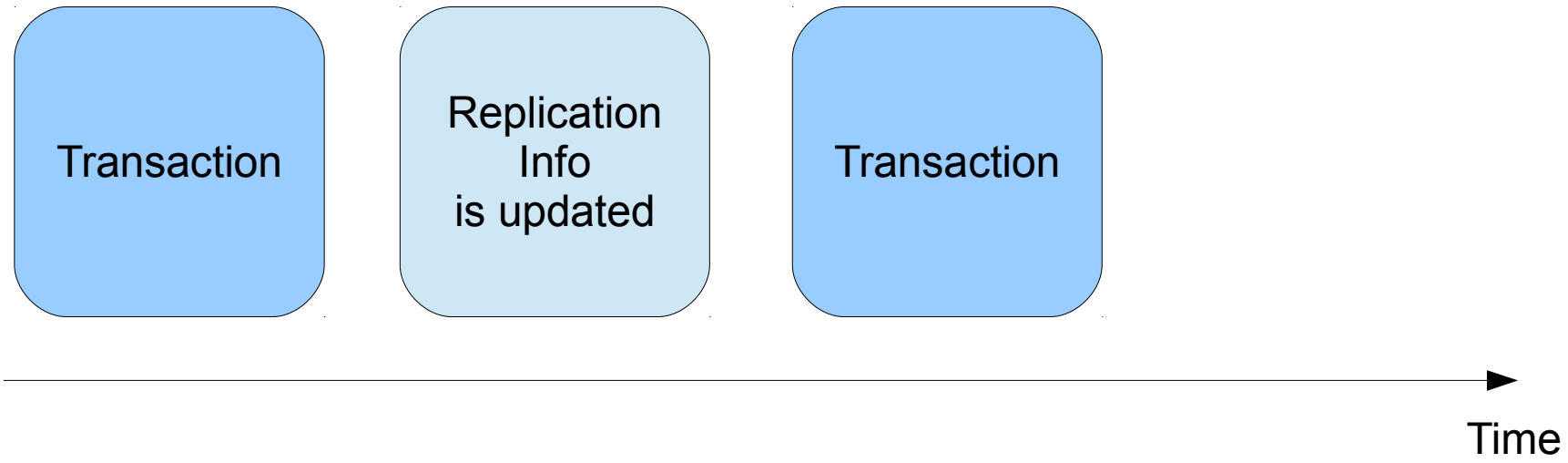

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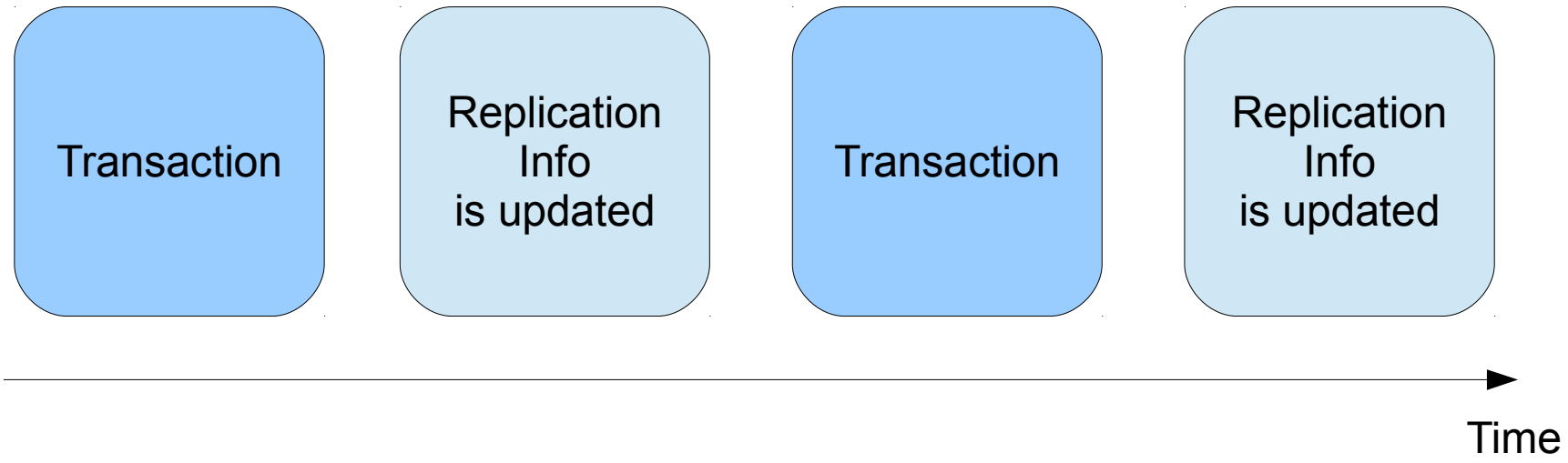

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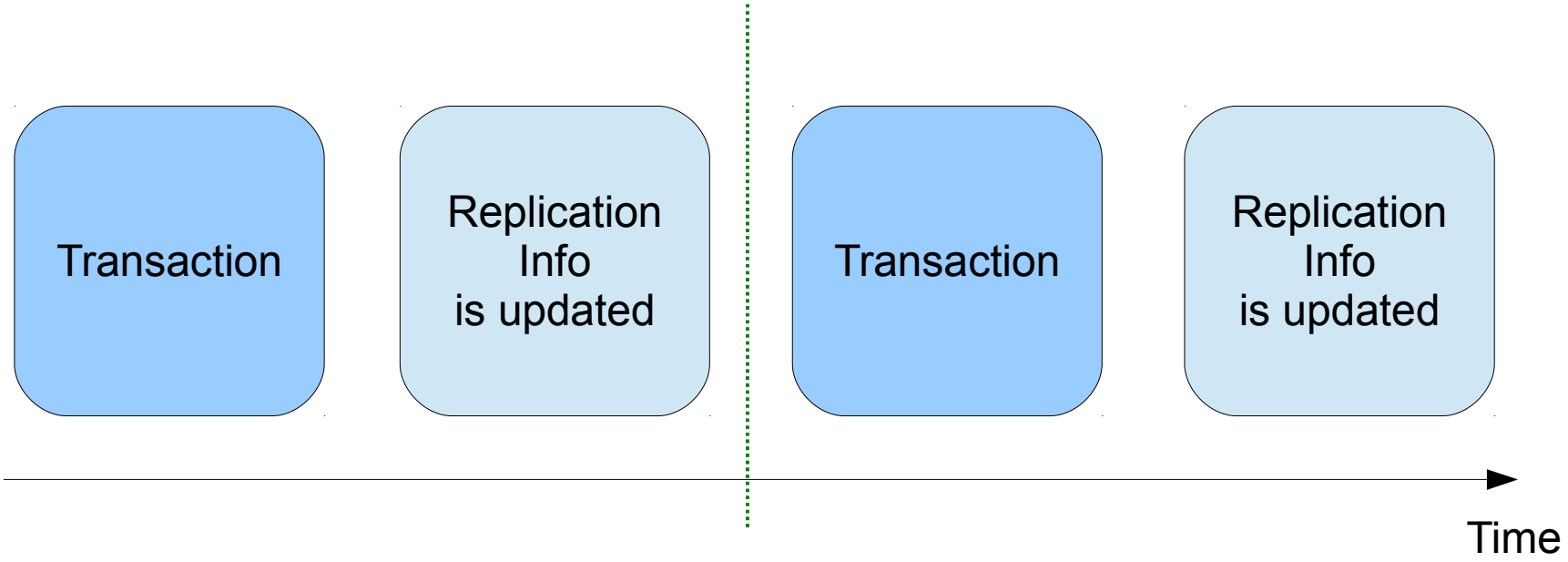

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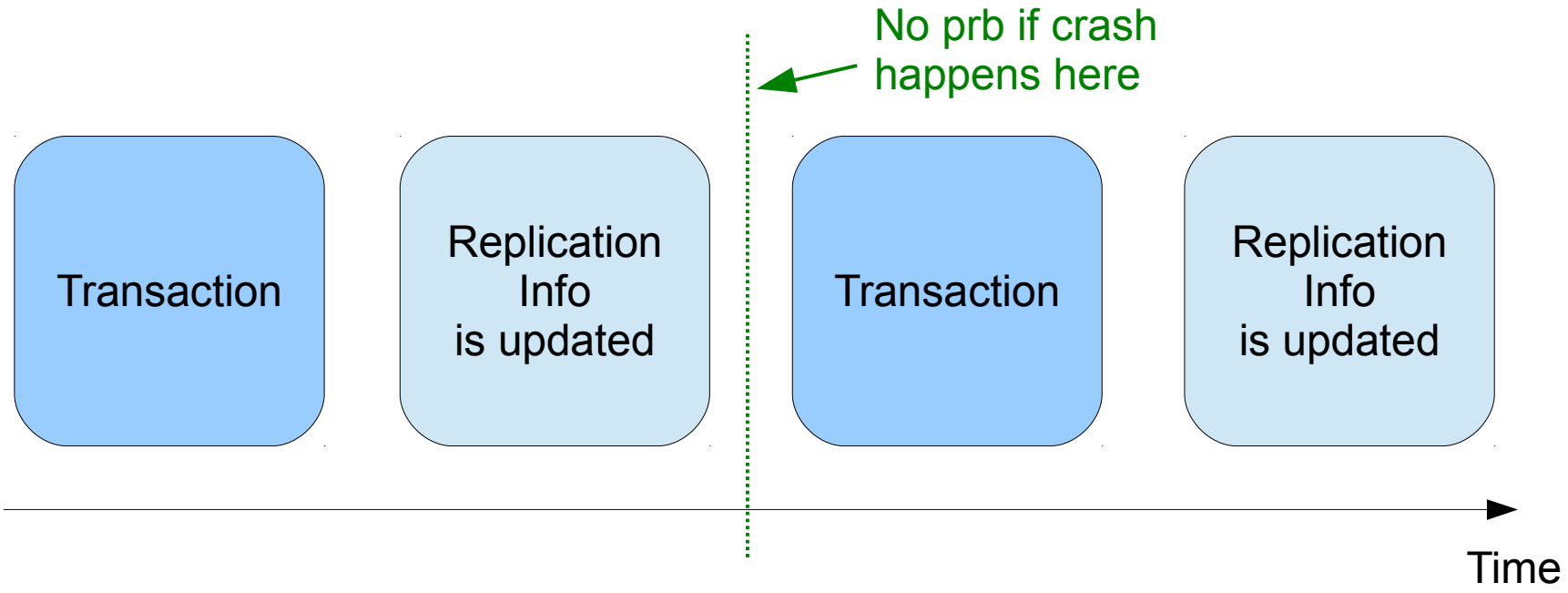

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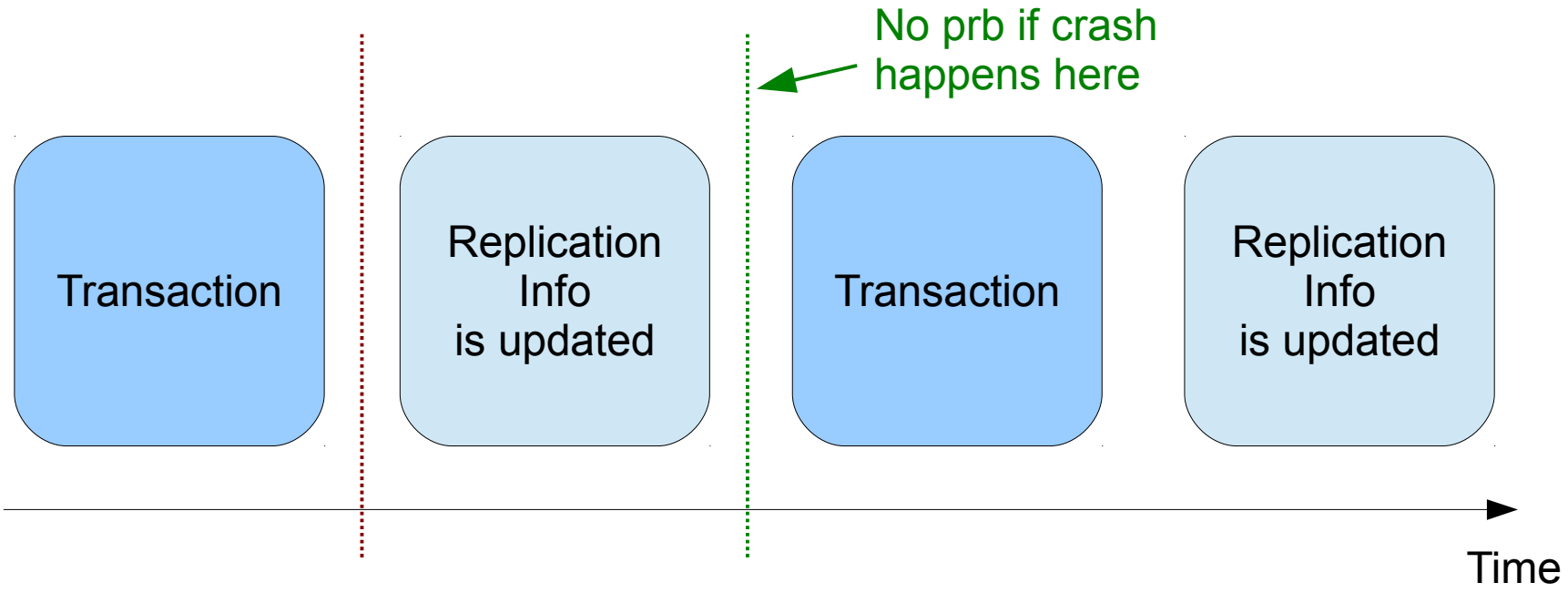

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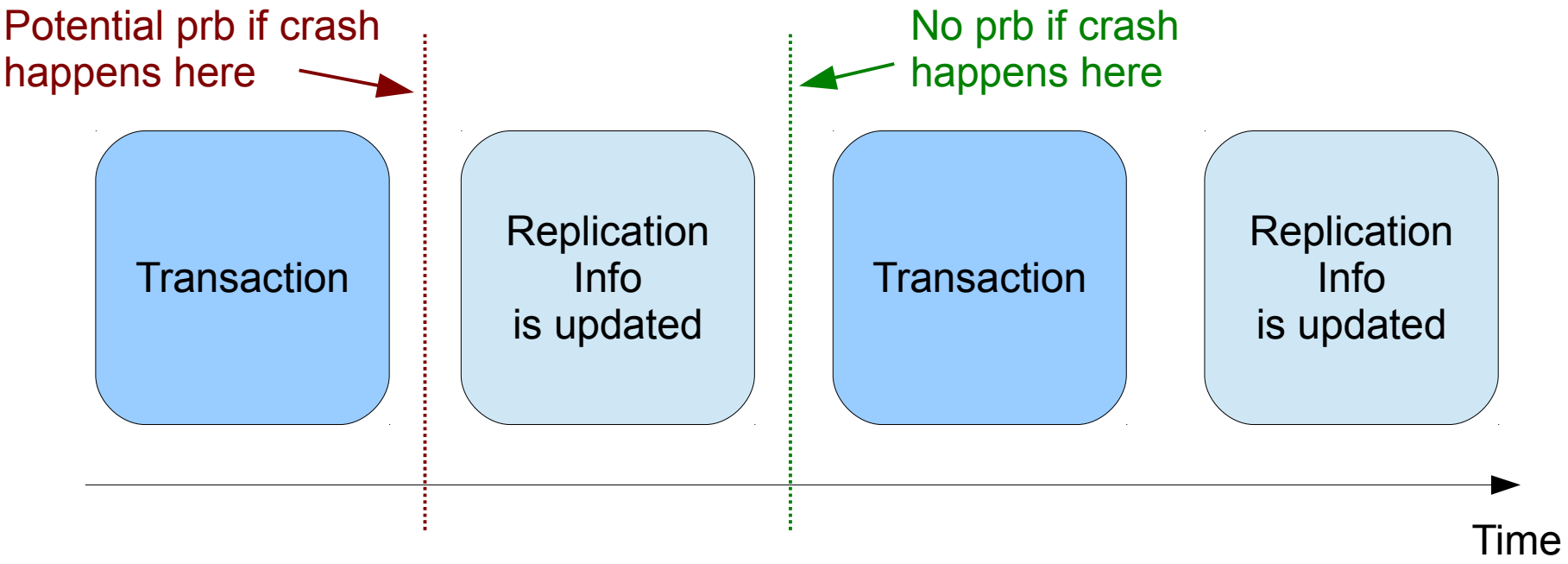

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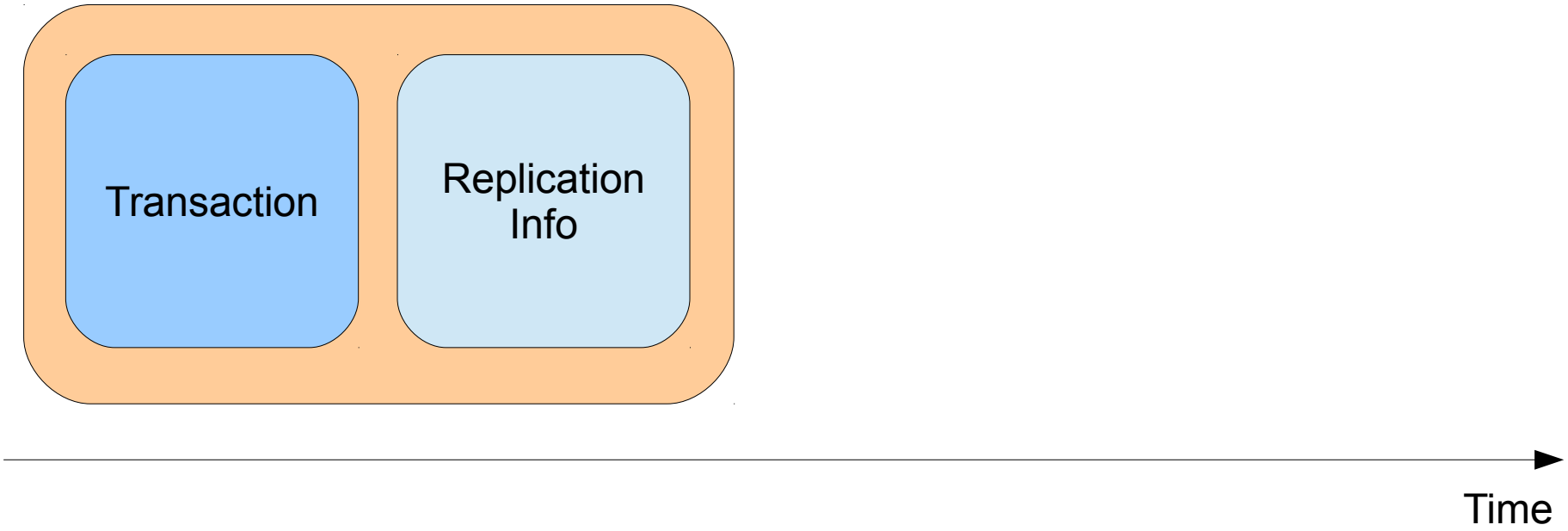

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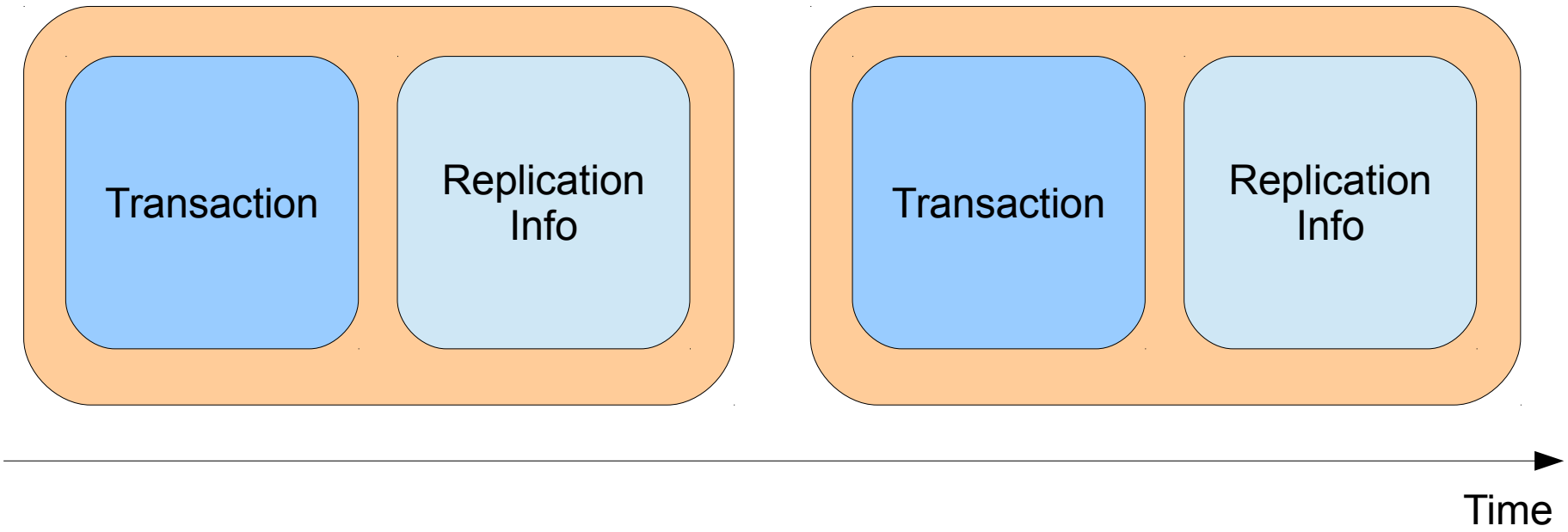

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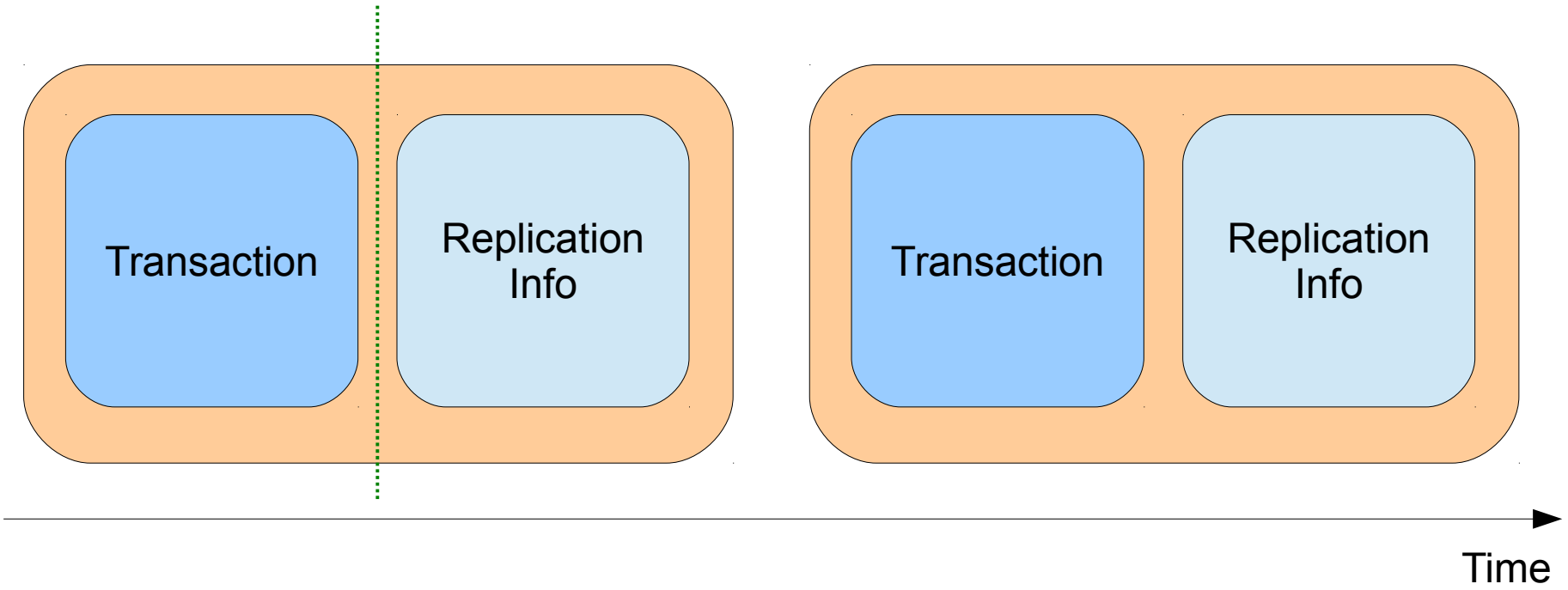

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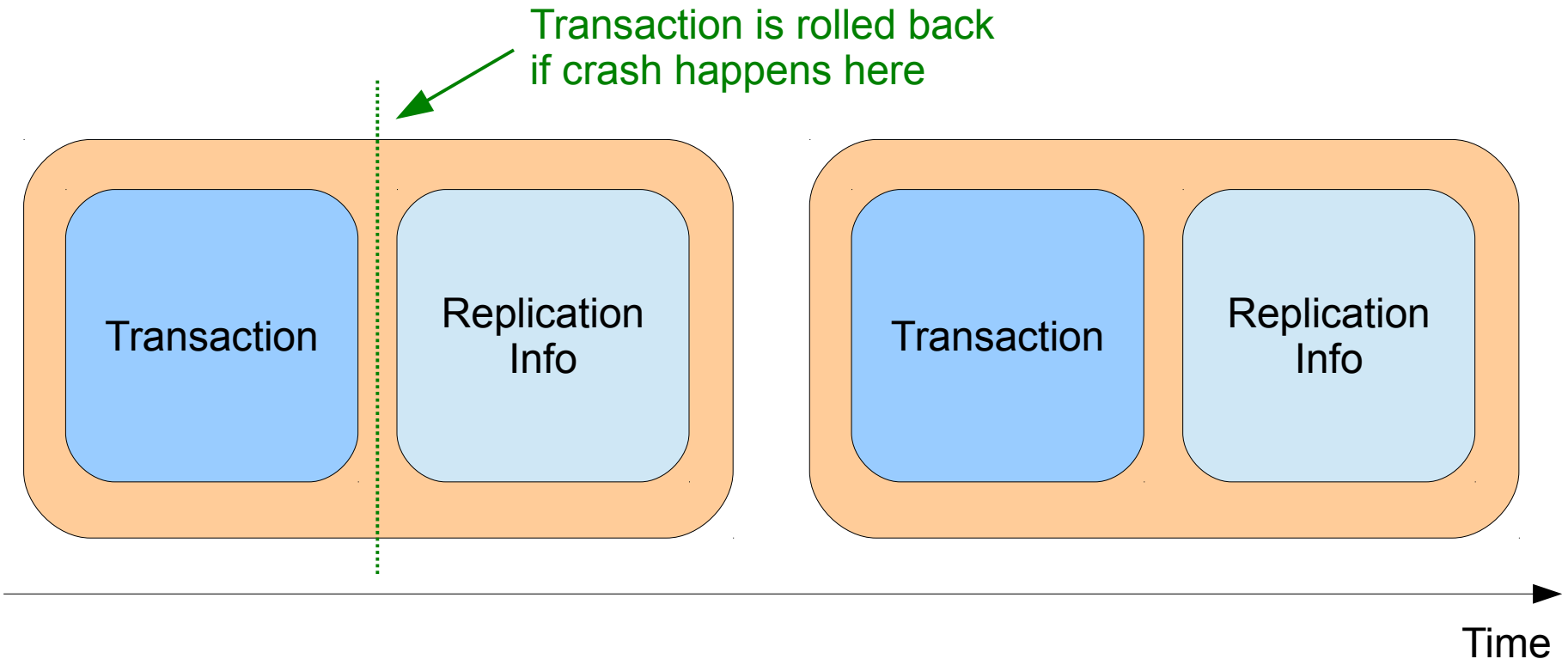

Settings to change

- You will need
  - `relay_log_info_repository = TABLE (*)`
  - `master_info_repository = TABLE (*)`
  - `relay_log_recovery = ON (+)`
- (*) Needs to run `STOP SLAVE` first
- (+) Needs to restart MySQL

relay_log_recovery

- By default, slave_master_info table is not updated at each transaction
  - Except if you set sync_master_info = 1
  - But it can have a performance impact
- With relay_log_recovery, at server startup
  - All unprocessed relay logs are discarded
  - Replication coordinates are recovered from the slave_relay_log_info table
  - It removes the need to have sync_master_info = 1

For users of Percona Server

- A similar feature exists in Percona Server
  - Turn on `innodb_recovery_update_relay_log` (5.5)
  - Turn on `innodb_overwrite_relay_log_info` (5.1)

- Oracle's crash safe slaves obsoletes this feature in Percona Server 5.6

Multi-threaded slaves

What is the problem?

- On the slave, replication uses 1 thread to run queries (the SQL thread)
- But on the master writes can be done in parallel
- A moderately loaded master can easily make your slaves lag
- Common workarounds: SSDs, relaxed durability, prefetcher tools

Adding parallelism

- Data must be partitioned across N databases
- Set `slave_parallel_workers = N`
- Use crash-safe replication setting to be able to correctly recover from crash

- The regular SQL_thread acts as a coordinator
- The other threads can execute trx in parallel if they come from different databases

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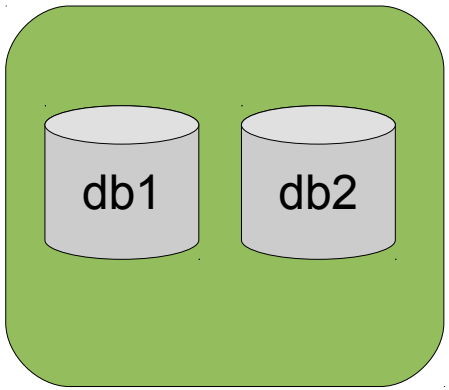

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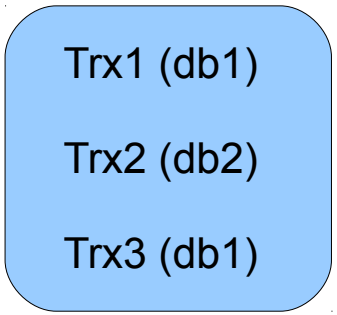
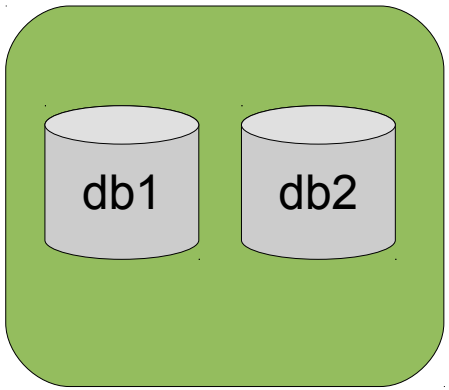


Relay log



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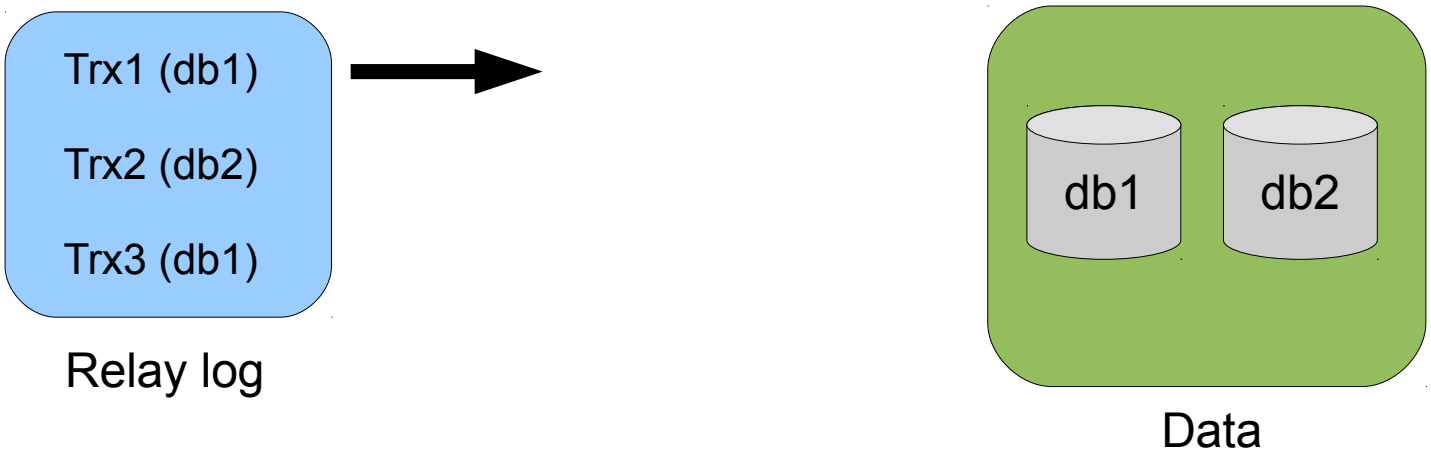

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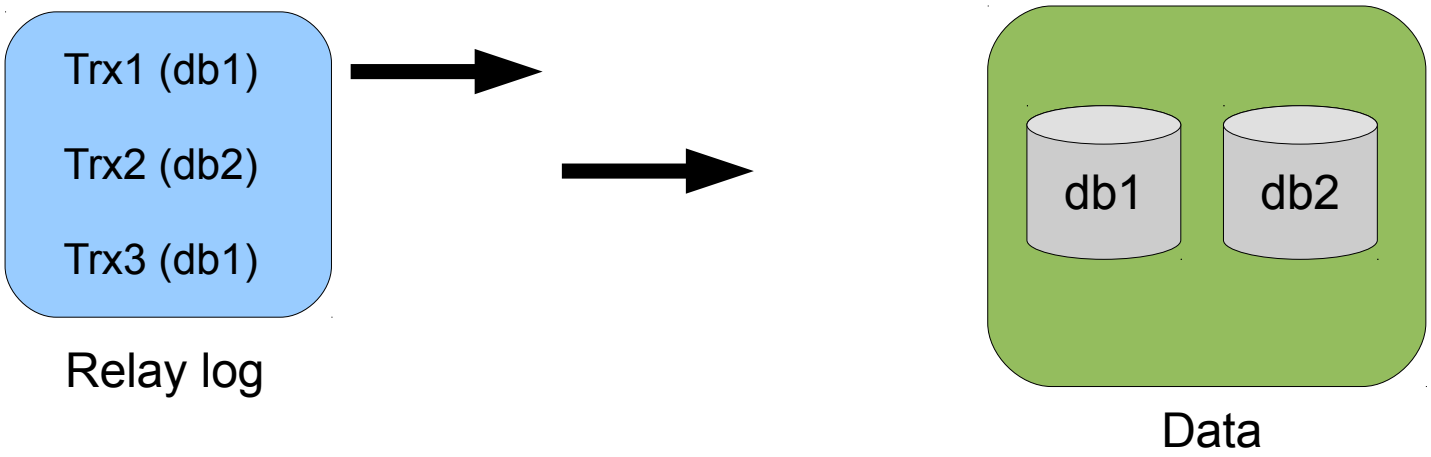

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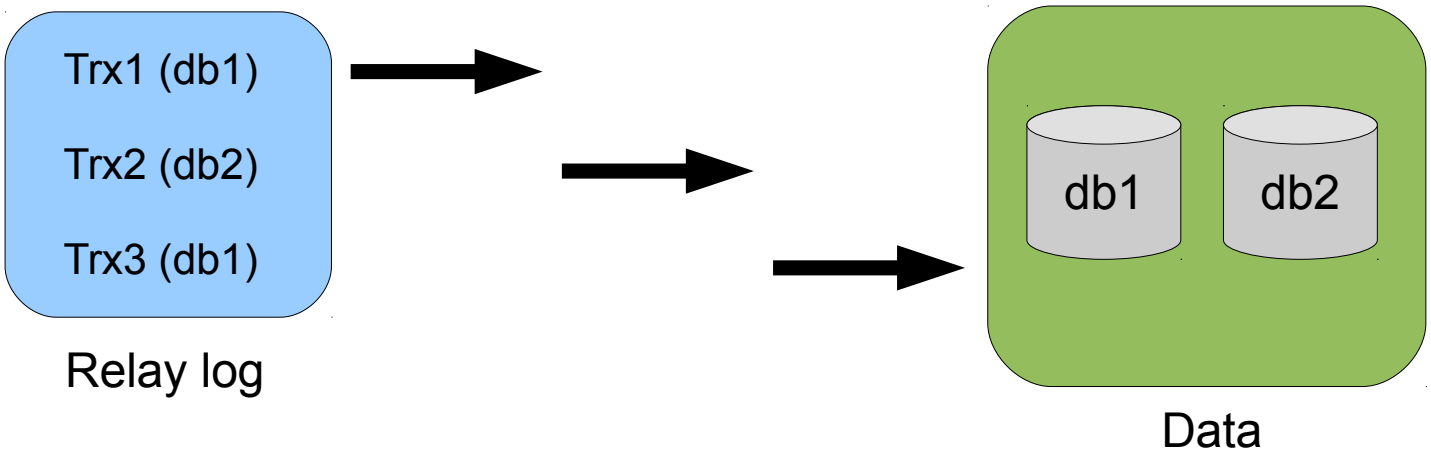
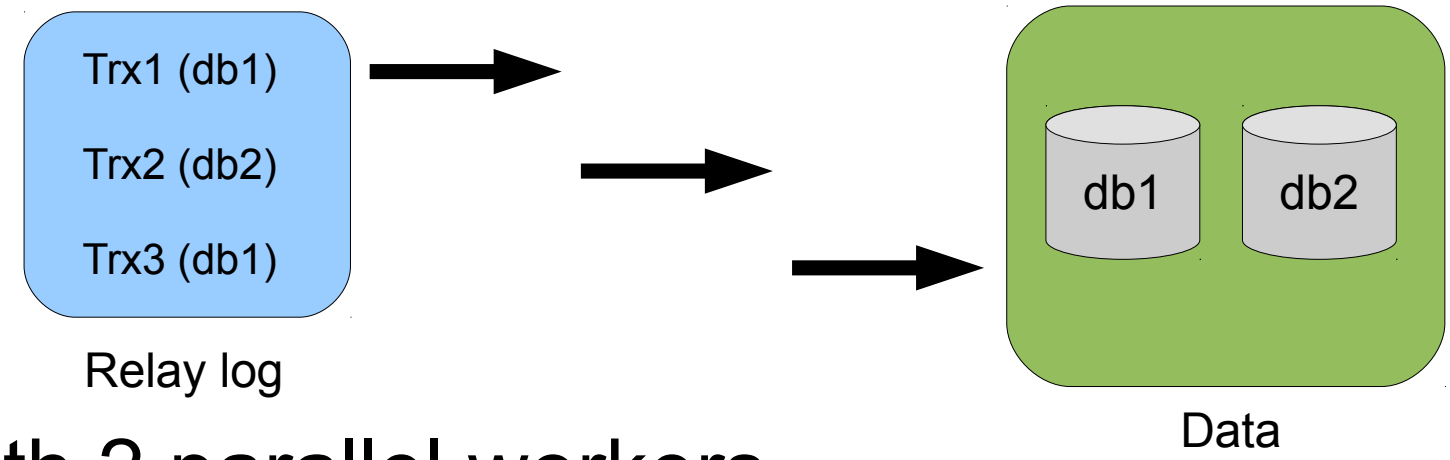


Visual explanation

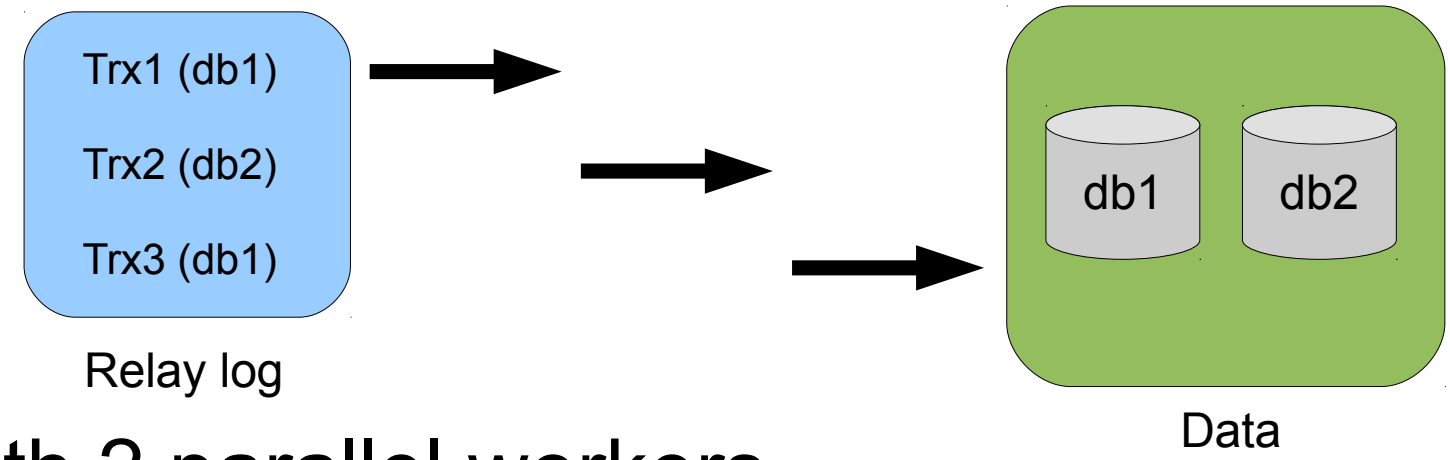
- Standard replication



- With 2 parallel workers

Visual explanation

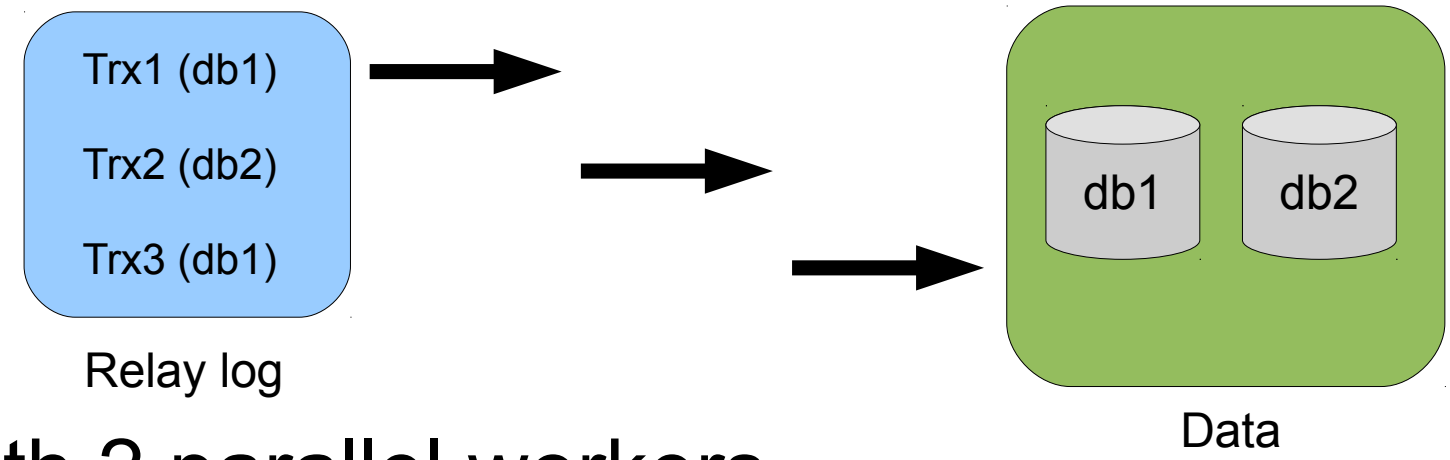
- Standard replication



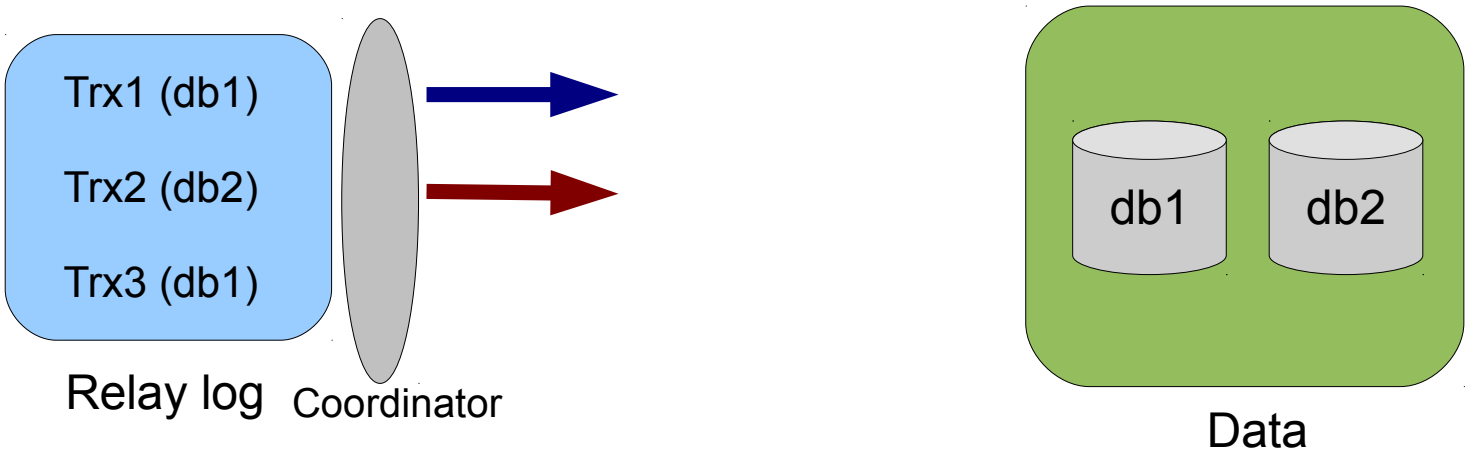
- With 2 parallel workers

Visual explanation

- Standard replication

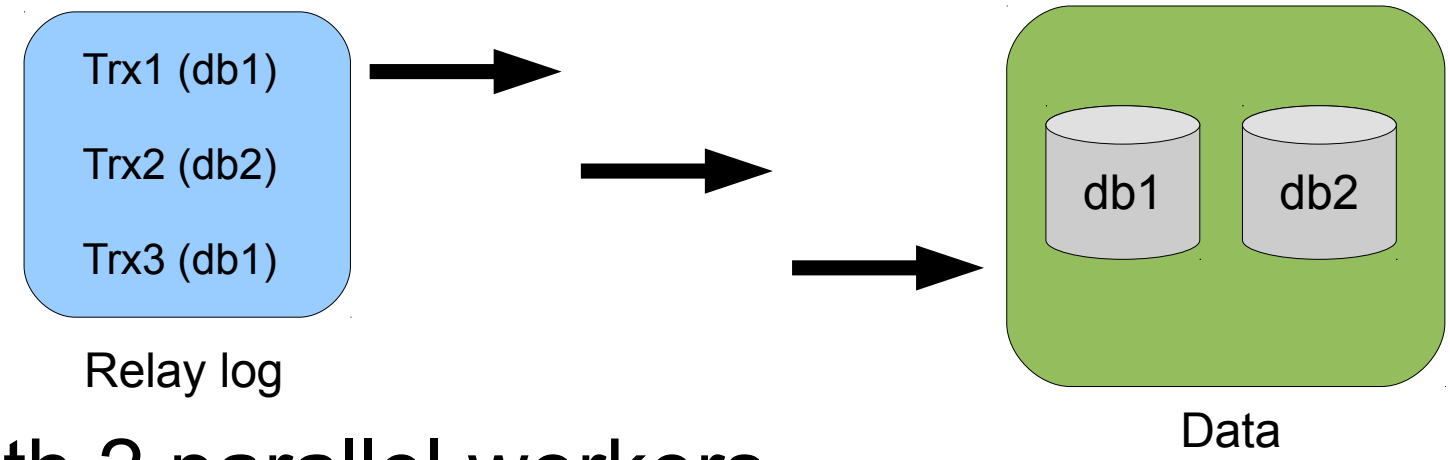


- With 2 parallel workers

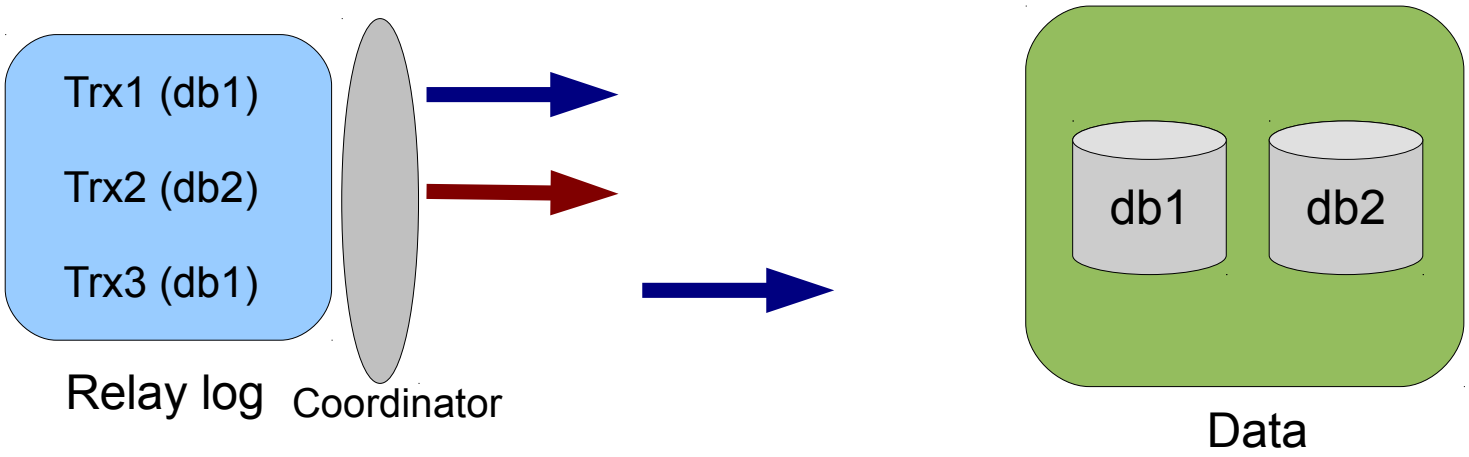


Visual explanation

- Standard replication



- With 2 parallel workers



Administrative table

```
 mysql> select * from mysql.slave_worker_info\G
****************** 2. row ***************
                          Id: 2
               Relay_log_name:
./mysql_sandbox19279-relay-bin.000034
                Relay_log_pos: 1038
              Master_log_name: mysql-bin.000005
               Master_log_pos: 1107
 Checkpoint_relay_log_name:
./mysql_sandbox19279-relay-bin.000034
  Checkpoint_relay_log_pos: 790
Checkpoint_master_log_name: mysql-bin.000005
 Checkpoint_master_log_pos: 859
             Checkpoint_seqno: 0
     Checkpoint_group_size: 64
   Checkpoint_group_bitmap:
```

Positions

- Transactions are not guaranteed to be executed in the order of the binlog
  - Not a problem as transactions are independent
  - Slave keeps track of such execution gaps
- The position reported by `SHOW SLAVE STATUS` is not accurate
  - It is a low-water mark corresponding to the latest checkpoint (see `slave_checkpoint_period` setting)
  - Executed transactions since latest checkpoint are recorded for recovery

Limitations

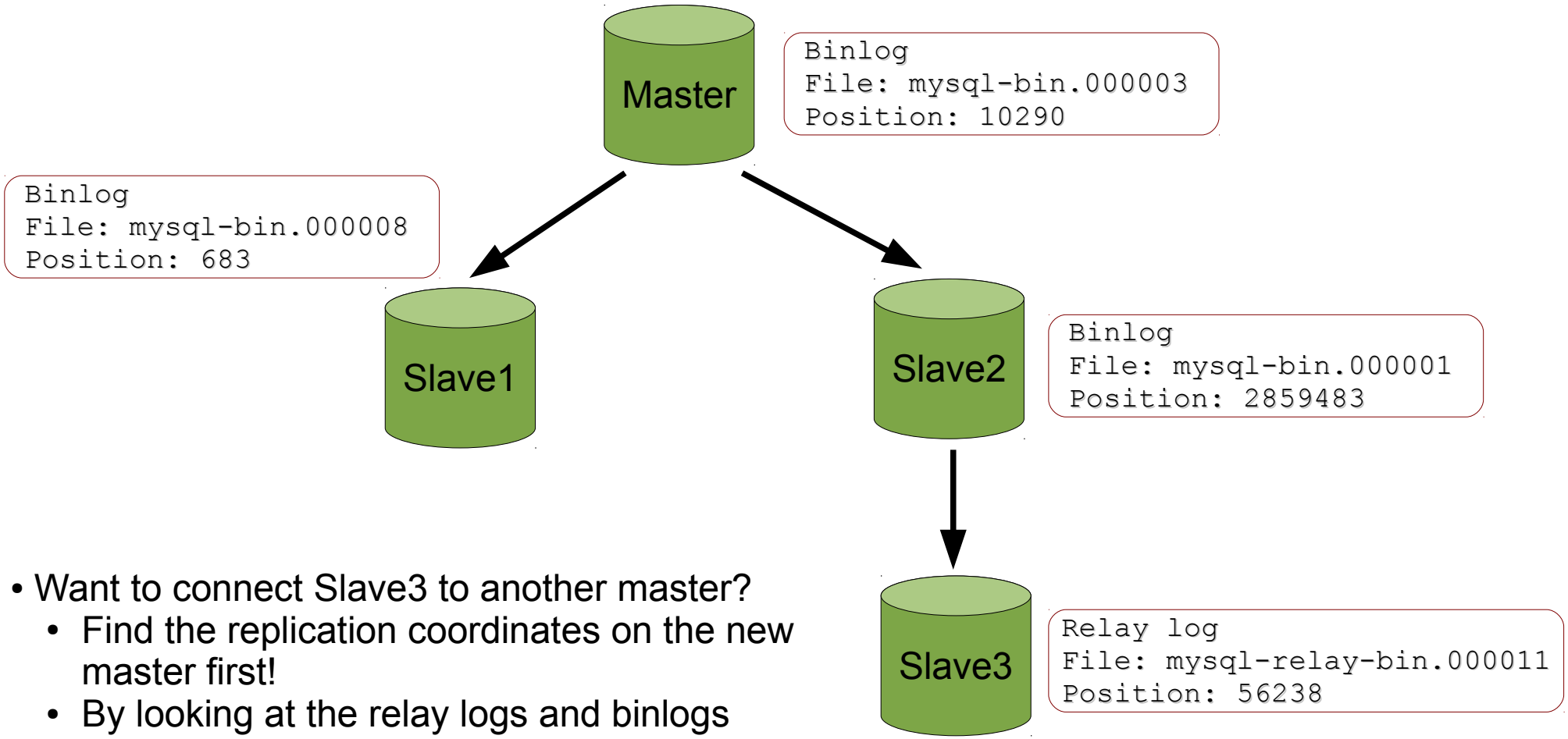
- Only useful if data is partitioned across N dbs
- And if there are only cross-db transactions
- If N is too high, you're likely to hit bottlenecks (CPU, disks, internal implementation)
- `SHOW SLAVE STATUS` output must be taken with care

Global Transactions IDs

What is the problem?

- The same event is very likely to have different binary log file and binary log position on 2 separate servers
- That makes it hard and error-prone to reconfigure replication

Position-based replication

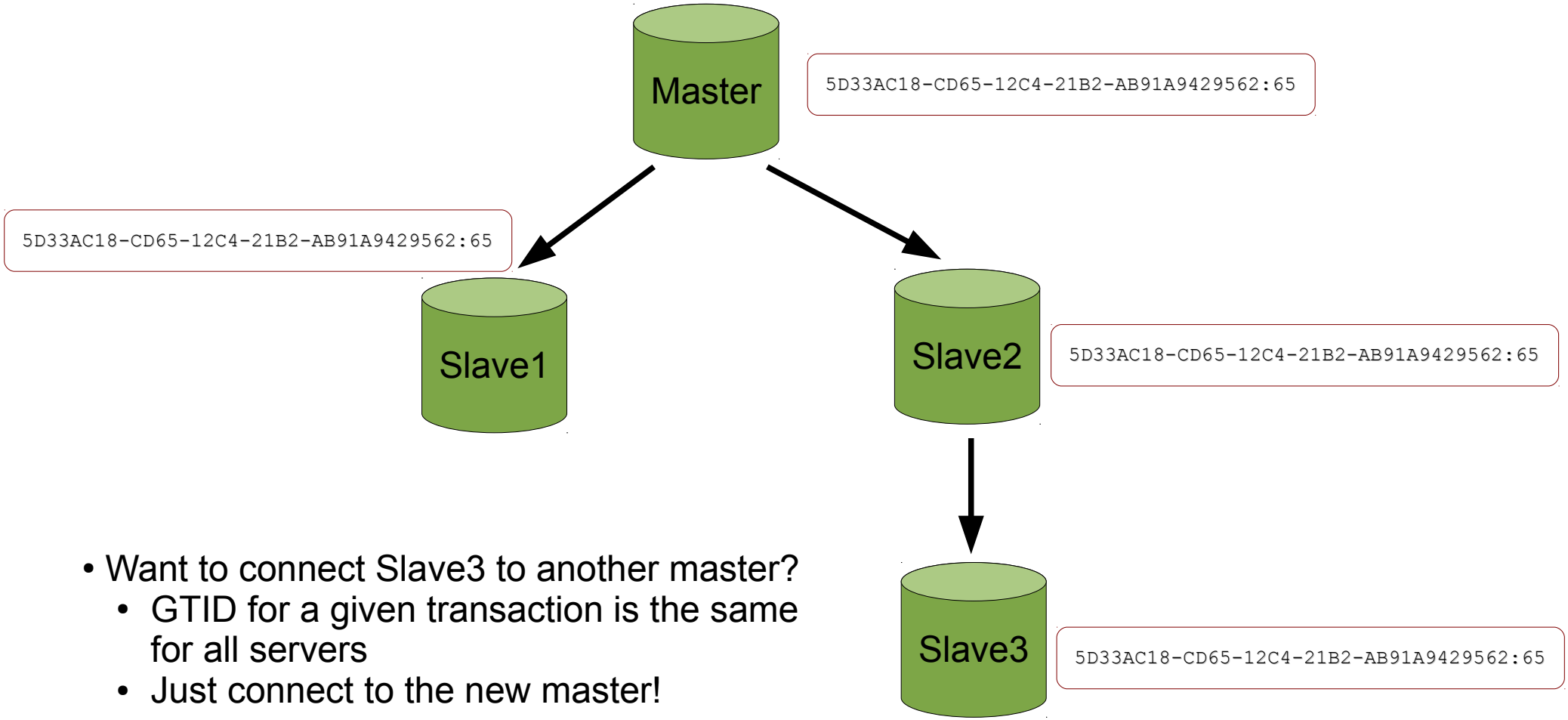


- Want to connect Slave3 to another master?
  - Find the replication coordinates on the new master first!
  - By looking at the relay logs and binlogs
  - Tedious and error-prone

What is a GTID?

- It is the unique identifier of a transaction across all servers of a replication setup
- A GTID has 2 parts
  - source_id:transaction_id
- A sequence of GTIDs is simply
  - source_id:trx_start-trx_stop
  - Eg `3E11FA47-71CA-11E1-9E33-C80AA9429562:1-5`

GTID-based replication



- Want to connect Slave3 to another master?
  - GTID for a given transaction is the same for all servers
  - Just connect to the new master!

GTID-based replication setup (1)

- Enable read-only mode and make sure the slaves are in sync
  - `SET GLOBAL read_only=1;`
  - Compare output of `SHOW SLAVE STATUS` with output of `SHOW MASTER STATUS`
  - Positions should be the same

GTID-based replication setup (2)

- Change configuration for all servers

```
log-bin
log-slave-updates
gtid_mode=ON
enforce-gtid-consistency
```

- Restart them
- Instruct all servers to use GTIDs
  - `CHANGE MASTER TO MASTER_AUTO_POSITION = 1;`
- Disable read-only mode

Limitations

- Downtime required when switching to GTIDs
- Binary logging should be enabled on all slaves
- Not possible to use temporary tables inside transactions
- Monitoring tables for crash-safe slaves and multi-threaded replication not ready for GTIDs

Other features

Also included in MySQL 5.6

- Binary log group commit
- Optimized row-based replication
- MySQL Utilities
  - Python CLI tools, not limited to replication
- Time-delayed replication
- Remote binlog backups

Q&A

Thanks for attending!

Feel free to contact me:
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