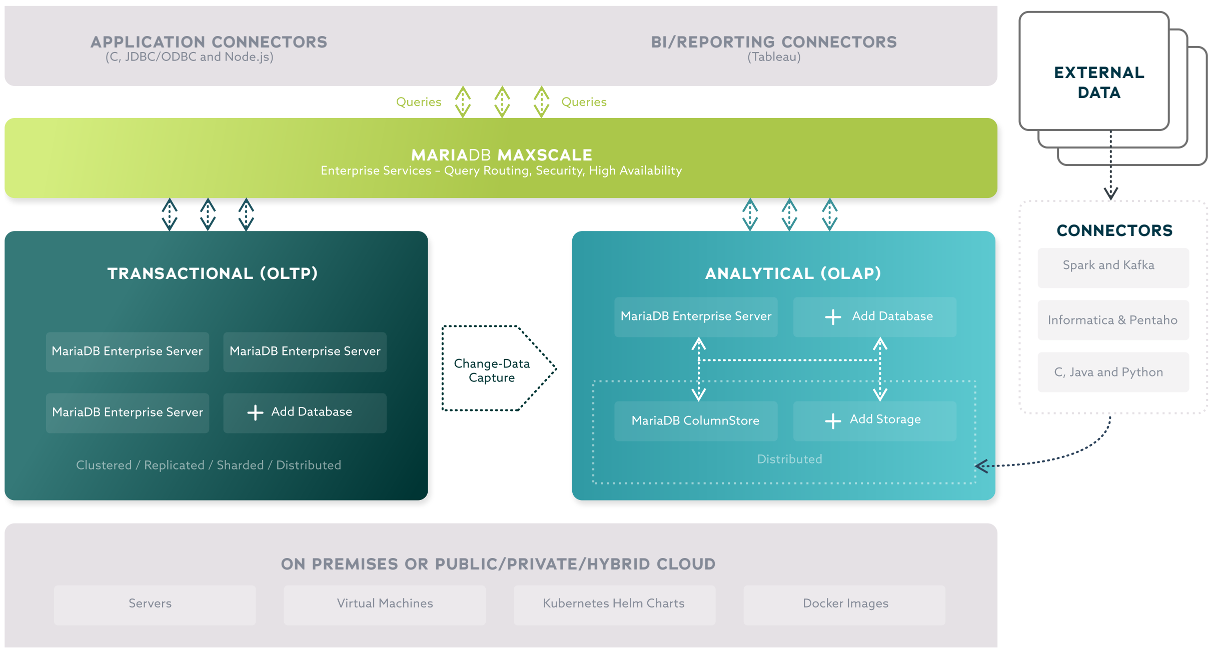
MariaDB

MARIADB ENTERPRISE: HIGH AVAILABILITY GUIDE

MARIADB ENTERPRISE

Transactions and Analytics, UNITED

MariaDB enterprise is an open source database for transactional, analytical or hybrid transactional/analytical processing at scale. By preserving historical data and optimizing for real-time analytics while continuing to process transactions, MariaDB enterprise provides businesses with the means to create competitive advantages and monetize data – everything from providing data-driven customers with actionable insight to empowering them with self-service analytics.



MariaDB Server

MariaDB Server is the foundation of the MariaDB Enterprise. It is the only open source database with the same enterprise features found in proprietary databases, including Oracle Database compatibility (e.g., PL/SQL), temporal tables, sharding, point-in-time rollback and transparent data encryption.

MariaDB ColumnStore

MariaDB ColumnStore extends MariaDB Server with distributed, columnar storage and massively parallel processing for ad hoc, interactive analytics on hundreds of billions of rows via standard SQL – with no need to create and maintain indexes, and with 10% of the disk space using high compression.

MariaDB MaxScale

MariaDB MaxScale provides MariaDB Enterprise with a set of services for modern applications, including transparent query routing and change-data-capture for hybrid transactional/analytical workloads, high availability (e.g., automatic failover) and advanced security (e.g., data masking).

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INTRODUCTION

Today, companies are undergoing a digital transformation: offline operations are becoming online operations, enterprise applications are becoming customer-facing applications, and engagement is happening anywhere and everywhere via web, mobile and Internet of Things (IoT) applications – and when it comes to customer experience, availability is not a preference, it is a requirement.

It is all about the data. It has to be available 24 hours a day, 7 days a week, 365 days a year. However, because infrastructure can and will fail, the database platform must maintain, or automatically restore, availability in the event of a failure – server, database or network.

MariaDB Enterprise uses local storage and replication (with or without clustering) to provide high availability via multiple database servers. There is no single point of failure. In fact, when MariaDB Enterprise is configured for high availability, downtime due to an unplanned infrastructure failure is all but removed.

However, when it comes to high availability, the trade-offs between performance, durability and consistency have to be considered. There are times when durability and consistency is more important than performance. There are times when performance is more important. The right trade-offs depends on the business needs, the use case and the technical requirements.

This guide explains how replication and clustering work in MariaDB Enterprise, how system variables and parameters can be set to improve performance, durability and/or consistency, important considerations when choosing between asynchronous, semi-synchronous and synchronous replication, and what the failover process looks like for different replication and clustering topologies.

This guide will detail:

- How primary/replica replication and multi-primary clustering work
- The trade-offs between asynchronous, semi- synchronous and synchronous replication
- The impact of high availability on performance, durability and consistency
- How topology detection with automatic failover improves availability

Concepts

Mean time between failures (MTBF) is a measure of reliability. It is the average elapsed time between failures (e.g., the time between database crashes). The longer, the better.

Mean time to recovery (MTTR) is a measure of maintainability. It is the average elapsed time between failure and recovery (e.g., the duration of a database failover). The shorter, the better.

Calculating availability
If the MTBF is 12 months (525,601 minutes) and the MTTR is 5 minutes, the database is available 99.999% of the time.
Availability = MTBF / (MTBF + MTTR)
525601 / (525601 + 5) = 99.999% availability

Terminology

Switchover is when the active database becomes a standby database, and a standby database becomes the active database, often in the case of planned maintenance.

Failover is when a standby database becomes the active database because the active database has failed or become unresponsive/unreachable.

Failback is when a failed active database is recovered and becomes the active database with the temporary active database reverting back to a standby database.

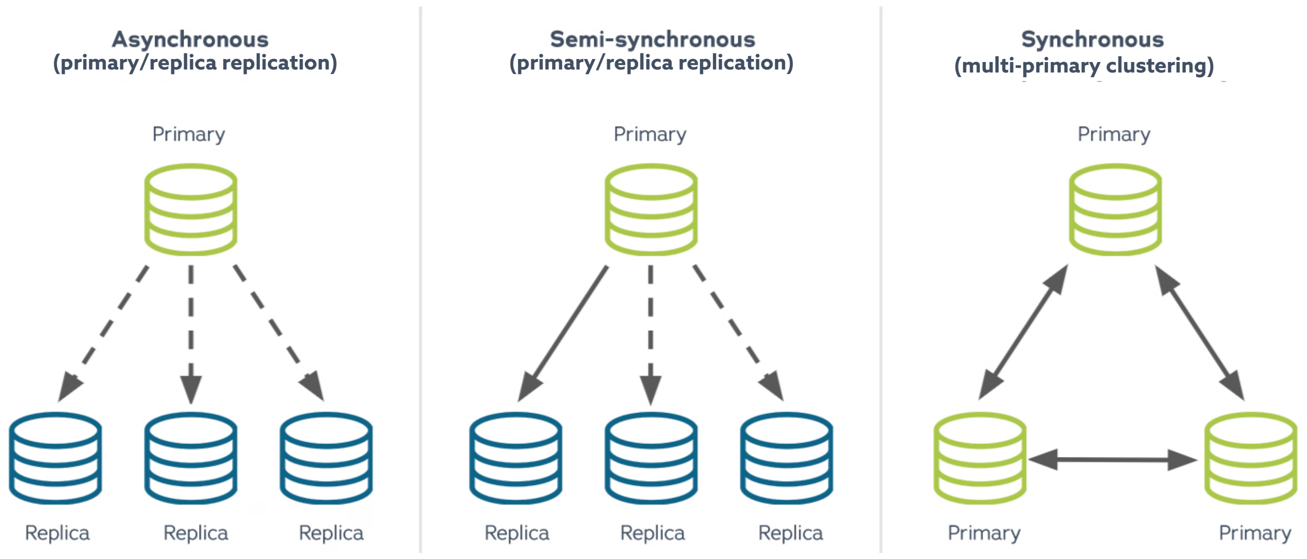
Shared-nothing architecture is when there are no shared sources (e.g., CPU, disk and/or memory) between database servers – there is no single point of failure.

Share-everything architecture is when disk and memory is shared between database servers (e.g., Oracle RAC).

Split-brain syndrome is when database servers in a single cluster form separate clusters, and each cluster is unaware of the other and continues to function as if it was the only cluster.

HIGH AVAILABILITY

MariaDB Enterprise provides high availability with multi-primary clustering (synchronous) or primary/replica replication (asynchronous or semi-synchronous) with automatic failover.

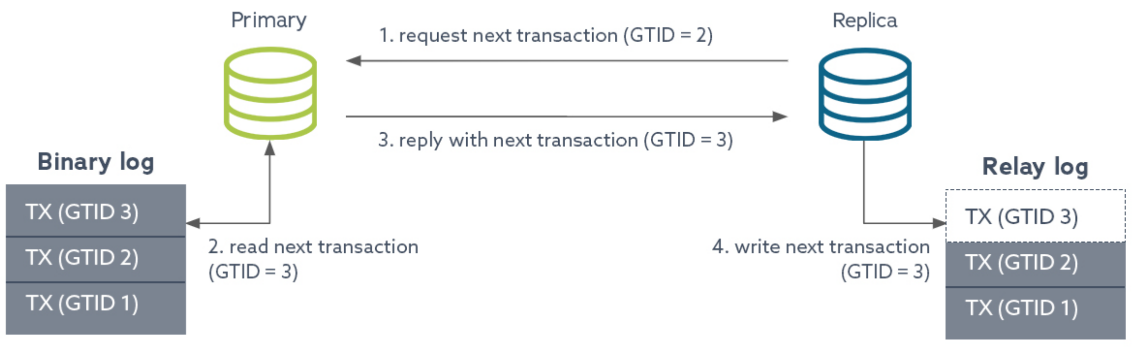


Asynchronous (primary/replica replication)
Primary
Replica
Replica
Replica
Semi-synchronous (primary/replica replication)
Primary
Replica
Replica
Replica
Synchronous (multi-primary clustering)
Primary
Primary
Primary

Diagram 1: Different types of replication

Primary/Replica Replication

The primary assigns transactions a global transaction ID (GTID) and writes them to its binary log. The replica requests the next transaction from the primary by sending the current GTID, writes it to the relay log, and executes it.



Primary
1. request next transaction (GTID = 2)
Replica
3. reply with next transaction (GTID = 3)
Binary log
TX (GTID 3)
TX (GTID 2)
TX (GTID 1)
2. read next transaction (GTID = 3)
Relay log
TX (GTID 3)
TX (GTID 2)
TX (GTID 1)
4. write next transaction (GTID = 3)

Diagram 2: The primary/replica replication process

Automatic failover

The database proxy, MariaDB MaxScale, will perform an automatic failover if the primary fails by promoting the most up-to-date replica (i.e., the one with the highest GTID) to primary and reconfiguring the remaining replica to replicate from it. In addition, if automatic rejoin is enabled, the failed primary will be reconfigured as a replica if it is recovered.

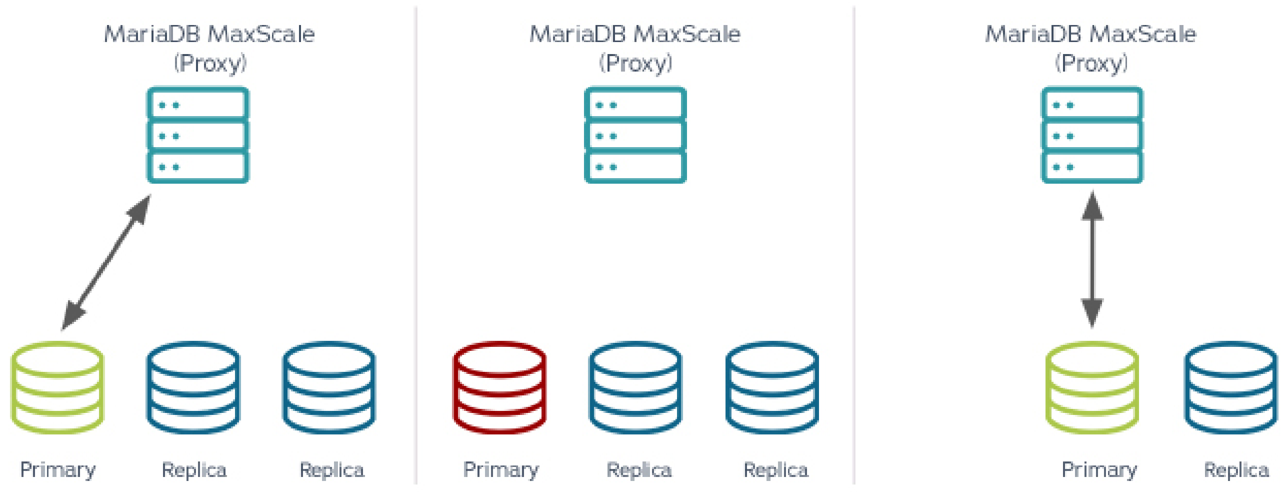


Diagram 3: Automatic failover with primary/replica replication

Asynchronous replication

With asynchronous replication, transactions are replicated after being committed. The primary does not wait for any of the replicas to acknowledge the transaction before committing it. It does not affect write performance. However, if the primary fails and automatic failover is enabled, there will be data loss if one or more transactions have not been replicated to a replica.

In the example below, the database proxy would promote Replica 1 to primary because it is the replica with the highest GTID. However, the most recent transaction (GTID = 3) had not been replicated before the primary failed. There would be data loss.

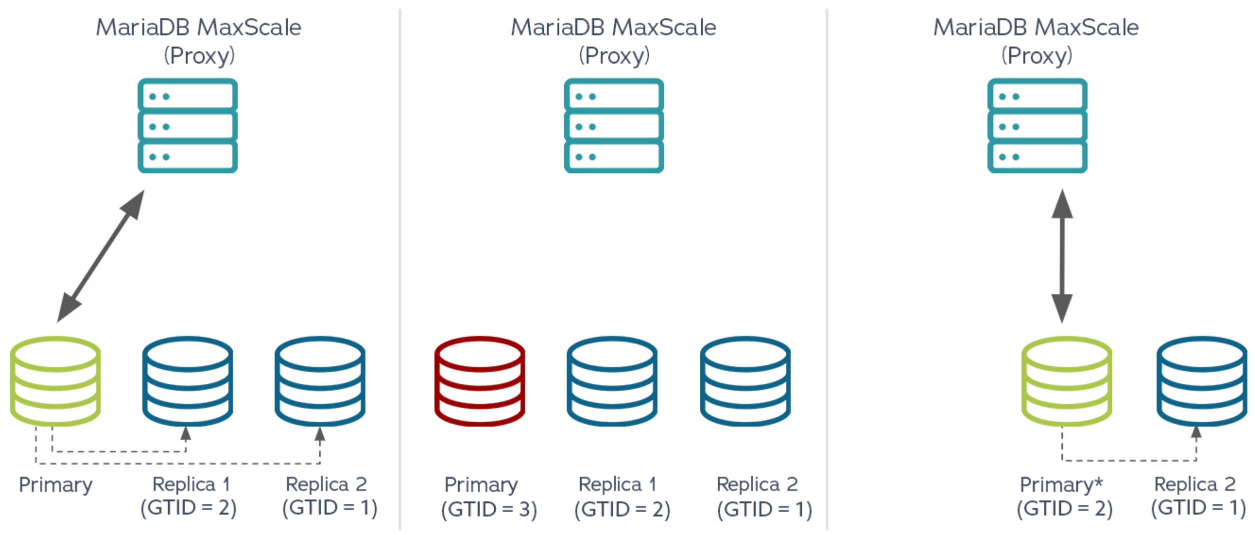


Diagram 4: The role of GTID in automatic failover with asynchronous replication

Asynchronous replication is recommended for read-intensive workloads or mixed/write-intensive workloads where the highest write performance is required.

Examples:

- **Read-intensive workloads**: product catalogs, reporting
- **Mixed workloads**: shopping carts, customer reviews
- **Write-intensive workloads**: clickstream data, sensor data

Semi-synchronous replication

With semi-synchronous replication, a transaction is not committed until it has been replicated to a replica. It affects write performance, but the effect is minimized by waiting for transactions to replicate to one replica rather than every replica. However, if the primary fails and automatic failover is enabled, there will be no data loss because every transaction has been replicated to a replica.

In the example below, the database proxy would promote Replica 2 to primary because it is the replica with the highest GTID. With semi-synchronous replication, there would be no data loss because at least one of the replicas will have every transaction written to its relay log.

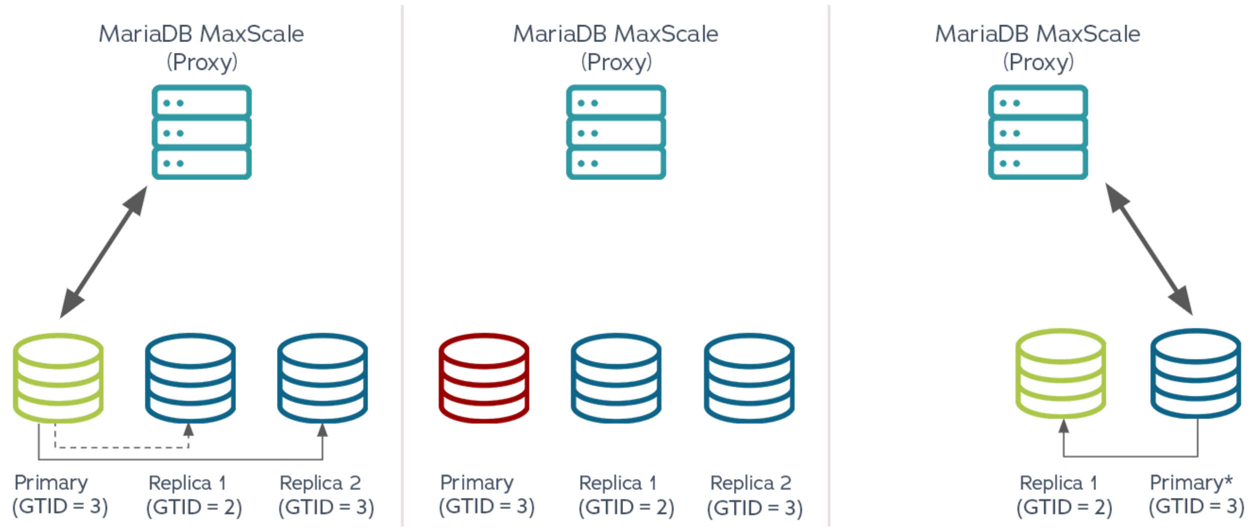


Diagram 5: The role of GTID in automatic failover with semi-synchronous replication

Note

The primary will wait for up to 10 seconds (default) for a transaction to be replicated to a replica before it reverts to asynchronous replication. If it does, and one of the replicas catches up, the primary will restore semi-synchronous replication. If all of the replicas are slow, the timeout can be reduced to maintain write performance (but with less durability), or increased to maintain durability (but with less write performance).

System variables

Variable	Values	Default
rpl_semi_sync_master_enabled	0 (OFF) | 1 (ON)	0
rpl_semi_sync_master_timeout	0 to n (ms, max: 18446744073709551615)	10000

Semi-synchronous replication is recommended for mixed/write-intensive workloads where high write performance and strong durability are required.
Examples:

- **Mixed workloads: inventory**

Multi-primary Clustering

MariaDB Enterprise supports multi-primary clustering via MariaDB Cluster (i.e., Galera Cluster). The originating node assigns a transaction a GTID, and during the commit phase, sends all of the rows modified by it (i.e., writes) to every node within the cluster, including itself. If the writes are accepted by every node within the cluster, the originating node applies the writes and commits the transaction. The other nodes will apply the writes and commit the transaction asynchronously.

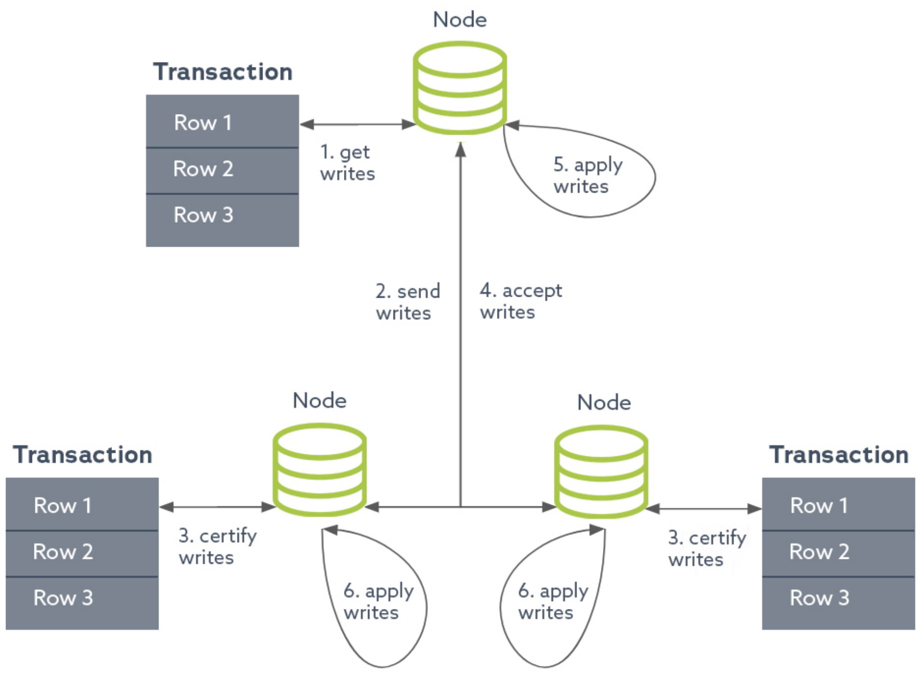


Diagram 6: The multi-primary clustering process (synchronous replication)

Automatic failover

If there is a node failure, the cluster will automatically remove it and the database proxy, MariaDB MaxScale, will stop routing queries to it. If the database proxy was routing reads and writes to the failed node, and because every node can accept reads and writes, the database proxy will select a different node and begin routing reads and writes to it.

Synchronous replication

With synchronous replication, a transaction is not committed until its changes (i.e., modified rows) have been replicated to every node within the cluster. The write performance is limited by the slowest node within the cluster. However, if the node a write was routed to fails, there will be no data loss because the changes for every transaction will have been replicated to every node within the cluster.

In the example below, the database proxy would be routing reads and writes to Node 2 because it has the lowest priority value of the remaining nodes. There would be no data loss because with synchronous replication, every node has the changes of every transaction.

Note

The database proxy can be configured so automatic failover is deterministic (e.g., based on priority value) by setting the use_priority parameter to "true" in the Galera Cluster monitor configuration and the priority parameter in the database server configurations.

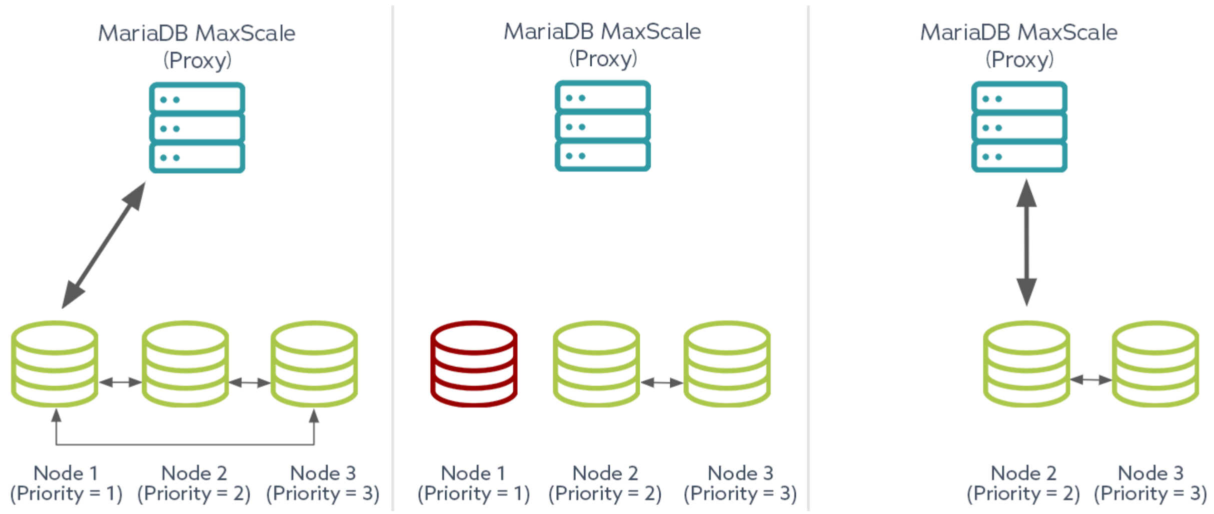


Diagram 7: Automatic failover with multi-primary clustering

Synchronous replication is recommended for mixed/write-intensive workloads where the strongest durability is required.

Examples:

- **Mixed workloads:** customer profiles
- **Write-intensive workloads:** payments

Transparent Recovery

The automatic failover process ensures the database is always available, but it is not transparent to applications because they have to create new connections and retry queries/transactions if the primary fails. However, the database proxy, MariaDB MaxScale, now includes advanced options to prevent applications from being interrupted by a failed database server with or without automatic failover.

Connection migration

When a database server fails or otherwise becomes unreachable/unavailable, client connections to it are closed by the database proxy, and applications must create new ones. However, the database proxy can now be configured to *migrate* connections to the primary promoted by automatic failover, so applications no longer have to create a new connection when a database server fails.

Session migration

The database proxy caches session commands, allowing it to migrate sessions by recreating them on a different database server. For example, if a session is created on a replica, and the replica fails, the database proxy will replay the session commands on a different replica so the application is not interrupted. When combined with connection migration, connections and sessions are automatically migrated when a database server fails – and it is transparent to applications.

Delayed retry

If an application sends a write query to the database after the primary has failed, and before automatic failover has completed, the database proxy will return an error. However, the database proxy can now be configured to wait and automatically retry the query. In effect, it waits for automatic failover to complete and then retries the query on behalf of the application, so it no longer has to retry queries after a database server has failed.

Note

The database proxy can be configured to route read queries to replicas when there is no primary, so if the primary has failed and automatic failover has not completed, read queries can still be executed.

Transaction replay

Further, if an automatic failover occurs after a transaction has started but before it has finished (i.e., an in-flight transaction), the database proxy can be configured to replay the transaction from the beginning on the new master. For example, if there were five inserts in a transaction and the primary failed after the first two, the database proxy would wait for the automatic failover process to complete and then replay the first two inserts to the new master, allowing the transaction to continue.

Parameters (MariaDB MaxScale)

Parameters	Description	Default
master_reconnection	True (enabled) | False (disabled)	False
master_failure_mode	fail_instantly (close the connection) fail_on_write (close the connection if a write query is received) error_on_write (return an error if a write query is received)	fail_instantly
delayed_retry	True (enabled | False (disabled)	False
delayed_retry_timeout	N (How long to wait before return an error)	10
transaction_replay	True (enabled) | False (disabled)	False

READ SCALABILITY

Primary/Replica Replication

If primary/replica replication is used for both high availability and read scalability, the database proxy, MariaDB MaxScale, can route writes to the primary and load balance reads across the replicas using read-write splitting.

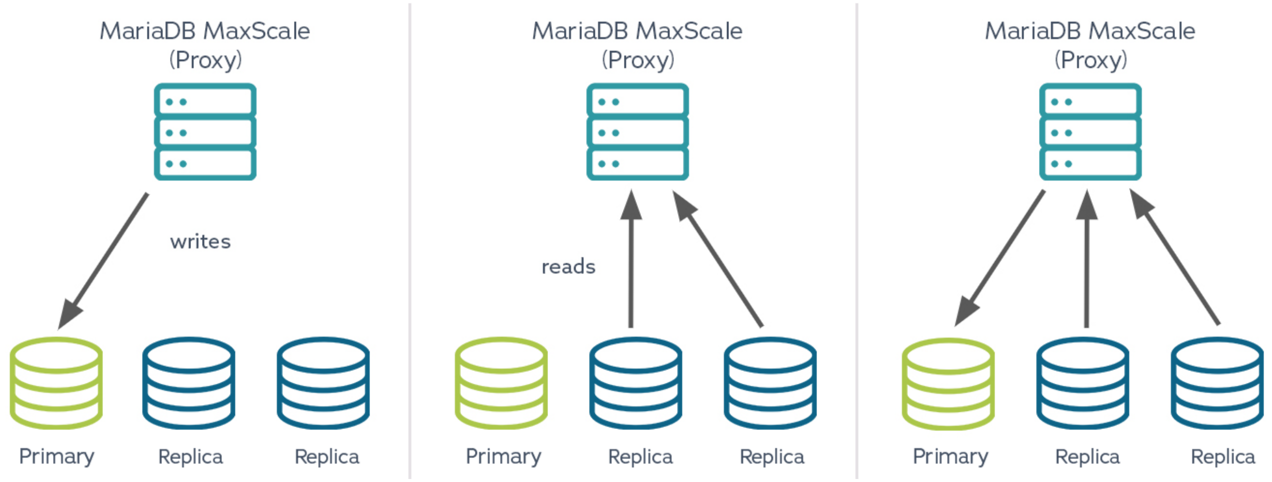


Diagram 8: Read-write splitting with primary/replica replication

However, consistency requirements should be considered. With primary/replica replication (asynchronous or semi-synchronous), querying replicas can return stale reads if there are transactions pending replication – and after transactions have been replicated and persisted to the relay log on one or more replicas, they still have to be executed.

If consistent reads are required, the consistent critical reads (CCR) filter in the database proxy should be enabled. If there is a write, the CCR filter will be triggered, causing the database proxy to route all subsequent reads to the primary for 60 seconds (default). If the replication lag is greater than 60 seconds (i.e., it's taking longer than 60 seconds to replicate writes to replicas), the time can be increased.

Tip

The CCR filter can be configured so it is triggered by specific writes rather than all writes.

Parameters

Variable	Description	Default
time	The length of time to route reads to the Primary (seconds)	60
count	The number of reads to route to the master	-
match	A regular expression to determine if a write should trigger routing	-
ignore	A regular expression to determine if a write should not trigger routing	-

Alternatively, causal reads can be enabled in the database proxy. When causal reads are enabled, the database proxy will modify the query, forcing the database to wait until it has caught up to the client before executing the query. It takes advantage of Global Transaction IDs (GTIDs). For example, if the GTID of the client's most recent write was 2000, the database would wait until its GTID reached or exceeded 2000 before executing the query.

Note
The context for causal reads is clients, not applications.

Parameters (MariaDB MaxScale)

Parameters	Description	Default
causal_reads	True (enabled) | False (disabled)	False
causal_reads_timeout	N (The number of seconds to wait before routing the master)	10

Clustering

If multi-primary clustering is used for both high availability and read scalability, the database proxy can assign the role of primary to a single node (and route writes to it) while assigning the role of replica to the remaining nodes (and load balancing reads across them). In multi-primary clusters, routing all writes to the same node prevents deadlocks and write conflicts.

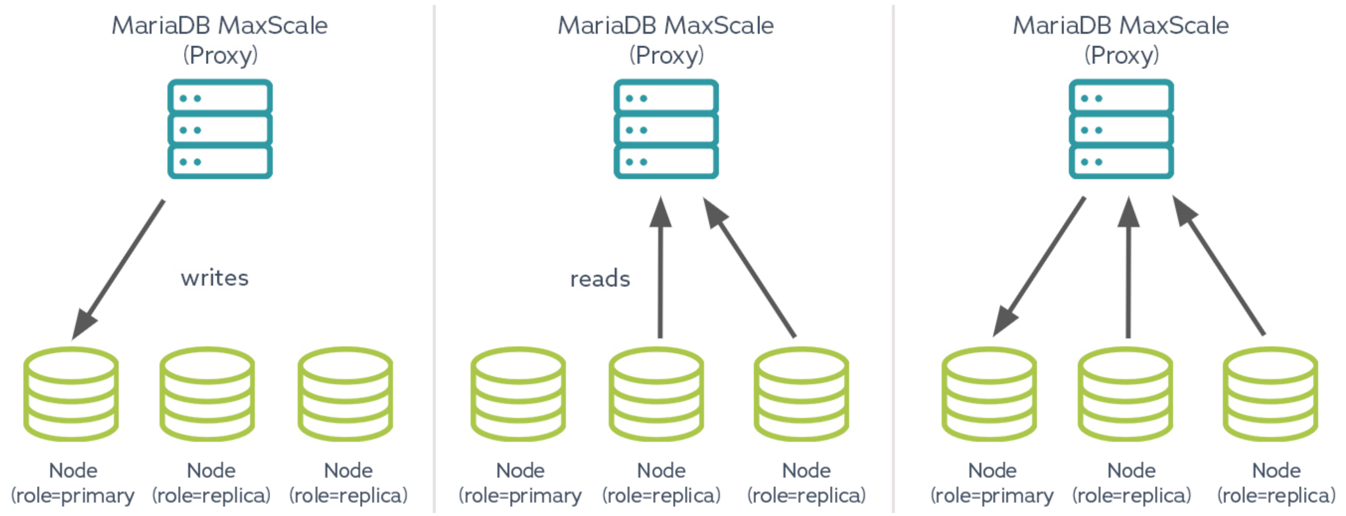


Diagram 9: Read-write splitting with multi-primary clustering

It is possible for nodes with the replica role to return stale reads because while write sets (i.e., transactions) are replicated synchronously, they are applied asynchronously. There is a small delay between receiving a write set and applying it.

However, stale reads can be prevented by setting the wsrep_sync_wait system variable to 1, forcing nodes to delay a read until all write sets have been applied. The impact on read latency is minimal, and ensures any data written to a node with the primary role can immediately be read from any node with the replica role.

Note
The wsrep_sync_wait system variable can be set to specify the types of queries to delay (e.g., READ) until all write sets have been applied.

System variables

Variable	Values	Default
wsrep_sync_wait	0 (DISABLED) 1 (READ) 2 (UPDATE and DELETE) 3 (READ, UPDATE and DELETE) 4 (INSERT and REPLACE) 5 (READ, INSERT and REPLACE) 6 (UPDATE, DELETE, INSERT and REPLACE) 7 (READ, UPDATE, DELETE, INSERT and REPLACE) 8 (SHOW), 9-15 (1-7 + SHOW)	0

ADVANCED TOPOLOGIES

Multiple Data Centers

Primary/Replica replication

In the example below, circular replication (e.g., bidirectional replication) can be used to synchronize data between an active data center (DC1) and a passive data center (DC2). The primary in DC1 is configured as a replica to the primary in DC2. The primary in DC2 is configured as a replica to the primary in DC1. If DC1 fails, applications can connect to the database proxy, MariaDB MaxScale, in DC2.

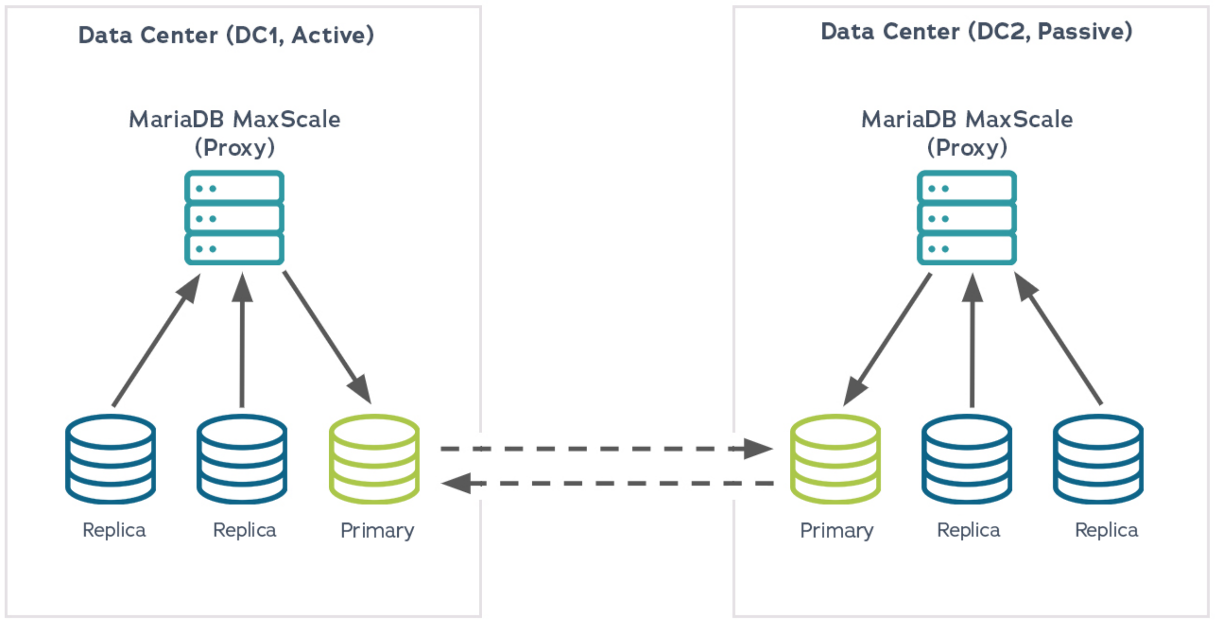


Diagram 10: Bidirectional, asynchronous replication between data centers

Clustering

In the example below, a three-node cluster is deployed across two data centers with two nodes in the active data center (DC1) and one node in the passive data center (DC2). The configuration for the database proxy in DC1, Proxy 1, assigns a priority value of 1 to Node 1, 2 to Node 2 and 3 to Node 3. It assigns the role of primary to Node 1 because Node 1 has the lowest priority value. Proxy 1 uses a basic router to route all reads and writes to any node assigned the primary role, Node 1 by default. If Node 1 fails, Proxy 1 will assign the role of primary to Node 2 – in the same data center, DC1.

If DC1 fails, applications can connect to the database proxy in DC2, Proxy 2. The configuration for Proxy 2 assigns a priority value of 1 to Node 3, 2 to Node 2 and 3 to Node 1. It assigns the role of primary to Node 3 because it has the lowest priority value. Proxy 2 uses a basic router to route all reads and writes to any node assigned the primary role, Node 3 by default.

Note

A cluster can be deployed across multiple data centers if a) there is enough network bandwidth between them to minimize latency and b) the write sets are small (i.e., transactions to not change a lot of rows).

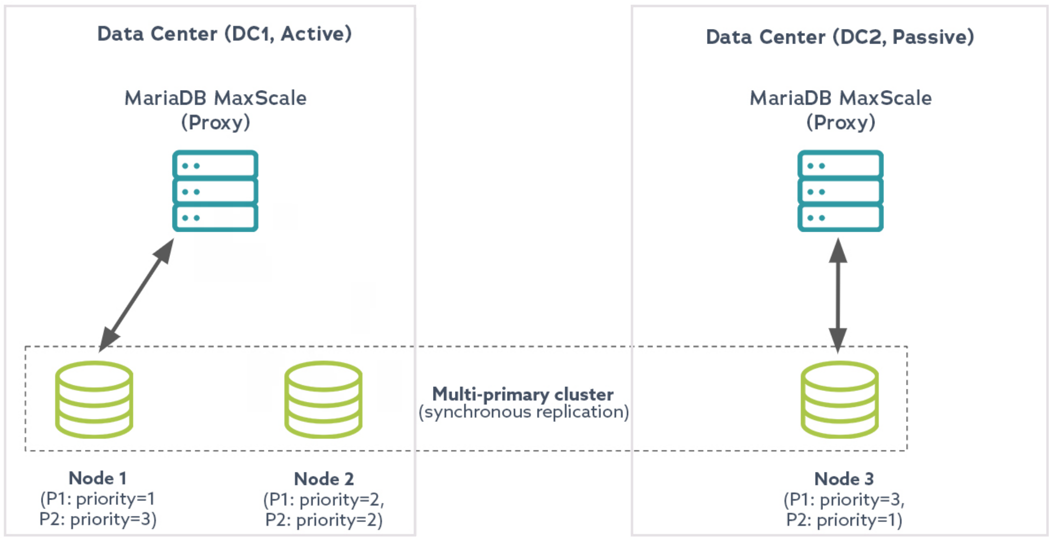

Data Center (DC1, Active)
MariaDB MaxScale (Proxy)
Data Center (DC2, Passive)
MariaDB MaxScale (Proxy)
Multi-primary cluster (synchronous replication)
Node 1 (P1: priority=1 P2: priority=3)
Node 2 (P1: priority=2, P2: priority=2)
Node 3 (P1: priority=3, P2: priority=1)

Diagram 11: Multi-primary clustering across multiple data centers

Read Scalability

Primary/Replica replication

In the example below, a second database proxy is configured and deployed as a binlog server to relay transactions from the primary to many replicas for read scaling. The binlog server reduces the replication overhead on the primary – instead of many replicas replicating from the primary, a single binlog server replicates from it.

The primary is configured for semi-synchronous replication, for high availability and durability, with Replica M1 and Replica M2, and for asynchronous replication, for read scalability, with the binlog server. The database proxy is configured with two routers, one for each cluster, with each router having a different port. The first will route all writes to the primary in Cluster 1. The second will route all reads to the replicas in Cluster 2 (Replica R2 to Replica R100).

Note

The application has to use different connections for port-based read-write splitting.

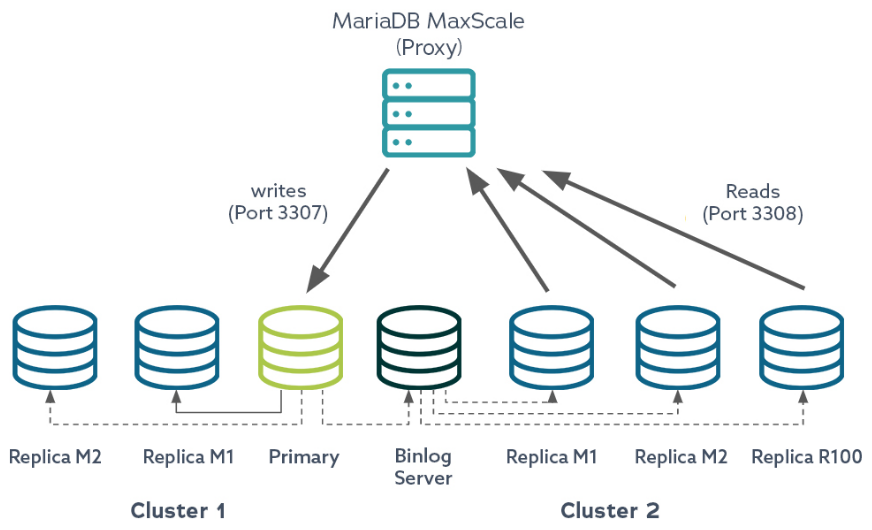


Diagram 12: Extreme read scaling with a binlog server

Dedicated Backup

Primary/Replica replication

In the example below, one of the replicas is dedicated to backups – the database proxy does not route reads to it. However, DBAs run MariaDB Backup on it to create backups. By dedicating one of the replicas to backups and backups only, the workload on the primary and remaining replicas will not be interrupted when a backup is created.

The primary is configured for semi-synchronous replication with Replica 2 and Replica 3 for high availability and durability, and asynchronous replication with Replica 1 for backups.

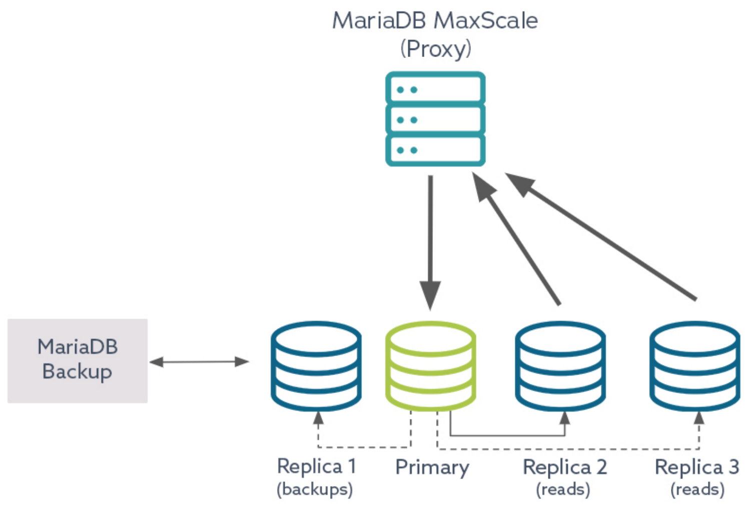


Diagram 13: Dedicate replica for backups

INTERNALS

Primary/Replica Replication

Components

Binary log (binlog)

The primary logs changes made by DML and DDL statements, and their execution time, as events in its binlog. The binlog is comprised of log files and an index file. While the binlog events are stored in a binary format, mysqlbinlog can display them as text.

Group commits

By default, the primary calls fsync() to flush binlog writes to disk during the commit phase of a transaction. However, when there are parallel transactions, it can use a group commit to flush the binlog writes of multiple transactions with a single fsync() call. To enable group commits, set the sync_binlog system variable to 1.

System variables

Variable	Values	Default
sync_binlog	0 (defer to OS) n (fsync every n transactions)	0

Format

The binlog supports three logging formats: statement-based, row-based and mixed (default). In the statementbased format, the statements are stored. In the row-based format, the rows changed by a statement are stored. In the mixed format, the statements are stored by default, but if a statement is not safe for replication (e.g., it is not deterministic), the rows changed by it are stored instead – making it safe to use non-deterministic functions with replication.

Tip

The format can be changed to row-based to improve replication performance if a lot of statements result in changes to a small number of rows and/or take a long time to execute.

System variables

Variable	Values	Default
binlog_format	STATEMENT | ROW | MIXED	MIXED

Encryption and compression

The binlog events can be encrypted to protect sensitive data and/or compressed via zlib to reduce disk and network IO. When binlog compression is enabled, individual binlog events are compressed before they are written to the binlog – and will remain compressed when replicated. The replica IO thread will decompress the binlog events before they are written to its relay log.

Note

If binlog compression is enabled, not all binlog events will be compressed. It depends on the length of the event (statement or row) and the minimum length configured for compression.

System variables

Variable	Values	Default
encrypt-binlog	0 (OFF) 1 (ON)	0 (OFF)
log_bin_compress	0 (OFF) 1 (ON)	0 (OFF)
log_bin_compress_min_len	10 - 1024	256

Global transaction IDs (GTIDs)

The primary groups, orders and replicates binlog events using GTIDs. GTIDs are comprised of three numbers separated by a dash: domain ID, a 32-bit unsigned integer; server ID, a 32-bit unsigned integer; and sequence, a 64-bit unsigned integer. The resulting identifier ensures transactions are unique across multiple database instances, enabling multi-source replication and circular replication (i.e., bi-directional primary/replica replication).

GTIDs enable replicas to continue reading binlog events when the primary changes. For example, if a replica is promoted to primary, the remaining replicas can be reconfigured to continue reading binlog events from it – and from where they left off, their current GTID.

In addition, GTIDs enable replicas to maintain a durable and consistent replication state. The mysql.gtid_replica_pos system table is where replicas store their current GTID. If this table is stored in a transactional storage engine (e.g., InnoDB), a single transaction will be used to update their current GTID and execute the binlog events associated with it.

Logical view of binlog

Commit ID	GTID	Server ID	Event type	Position	End position
100	0-1-200	1	Query	0	150
100	0-1-201	1	Query	151	500
100	0-1-202	1	Query	501	600
101	0-2-203	1	Query	601	800
101	0-2-203	1	Query	801	1000

Process

1. The replica IO thread requests binlog events, includes its current GTID
2. The primary returns binlog events for the next GTID(s)
3. The replica IO thread writes the binlog events to its relay log
4. The replica SQL thread reads the binlog events from its relay log
5. The replica SQL thread executes the binlog events and updates its current GTID

Multi-primary Clustering

Components

MariaDB Cluster

MariaDB Cluster, based on Galera Cluster, uses group communication, global transaction ordering, write sets and certification for synchronous replication.

Group communication

Clustering is based on group communication. It enables nodes to automatically join the cluster and for the cluster to automatically remove failed nodes. In the context of replication, group communication ensures total ordering of messages sent from multiple nodes.

Write sets

A write set contains all rows modified by a transaction (and their primary keys), and is created during the commit phase. It is replicated to every node, including the originating node, via group communication.

Global transaction ordering

When a write set is replicated, it is assigned a GTID, ensuring write sets (and thus transactions) are executed in the same order on every node. It is comprised of a UUID and a sequence number (64-bit signed integer) separated by a colon.

Certification

The write set will be certified on every node using its GTID and the primary keys of rows changed by the transaction. If the write set passes the certification test, it is applied and the transaction is committed. If it does not, the write set is discarded and the transaction is rolled back.

Process

1. Synchronous
   a. Originating node: create a write set
   b. Originating node: assign a global transaction ID to the write set and replicate it
   c. Originating node: apply the write set and commit the transaction
2. Asynchronous
   a. Other nodes: certify the write set
   b. Other nodes: apply the write set and commit the transaction

While write sets are replicated synchronously, they are certified and applied asynchronously. However, certification is deterministic – it succeeds on every node or it fails on every node. Thus, a transaction is committed on every node or it is rolled back on every node.

PERFORMANCE OPTIMIZATIONS

Replication

Parallel replication

The IO and SQL threads on replicas are responsible for replicating binlog events. The IO thread on replicas requests binlog events from the primary and writes them to the relay log. The SQL thread on replicas reads binlog events from the relay log and executes them, one at a time. However, when parallel replication is enabled, the replica will use a pool of worker threads to execute multiple binlog events at the same time.

By default, replicas execute binlog events in order. There are two modes: conservative (default) and optimistic. In the conservative mode, parallel replication is limited to a group commit. If multiple transactions have the same commit id, they were executed in parallel on the primary and will be executed in parallel on the replicas. However, the transactions will be committed in order. If two transactions do not have the same commit id, the second transaction will not be executed until the first transaction is in the commit phase – ensuring the transactions are committed in the same order the primary committed them.

In the optimistic mode, multiple transactions will be executed in parallel regardless of the commit id. However, exceptions include DDL statements, non-transactional DML statements and transactions where a row lock wait was executed on the master. If a conflict is detected between two transactions (e.g., two transactions try to update the same row), the first transaction will be committed and the second transaction will be rolled back and retried.

Note

The replica-parallel-threads system variable must be set to a value greater than 0 to enable parallel replication. In addition, the primary can be configured to wait for n microseconds or n transactions, before a group commit. If there are a lot of concurrent transactions on the primary, and the number of threads on replicas is high enough, increasing the wait can reduce binlog disk IO on the primary and enable replicas to commit transactions faster.

Tip

If there are few conflicts, the mode can be changed to optimistic for better performance.

System variables

Variable	Values	Default
replica-parallel-mode	optimistic | conservative | aggressive | minimal | none	conservative
replica-parallel-threads	0 - n (max: 16383)	0
binlog_commit_wait_count	0 - n (max: 18446744073709551615)	0
binlog_commit_wait_usec	0 - n (max: 18446744073709551615)	100000

Read throttling

The primary can throttle binlog replication by limiting replication bandwidth, reducing the load on the primary when multiple replicas are added or when multiple replicas try to replicate a lot of binlog events at the same time.

System variables

Variable	Values	Default
read_binlog_speed_limit	0 (unlimited) - n (kb, max: 18446744073709551615)	0

Clustering

Asynchronous InnoDB logging

InnoDB logs are flushed to disk when a transaction is committed (default). However, with clustering, transactions are made durable via synchronous replication. The originating node can fail before the InnoDB log has been flushed to disk and the transaction will still be committed on the other nodes. By writing and flushing InnoDB logs to disk asynchronously, write performance can be improved.

System variables

Variable	Values	Default
innodb_flush_log_at_trx_commit	0 (write and flush once a second) 1 (write and flush during commit) 2 (write during commit, flush once a second)	1

CONCLUSION

MariaDB Enterprise supports multiple high availability strategies to match the performance, durability and consistency guarantees of individual use cases – and includes the world's most advanced database proxy to simplify and improve high availability, further reducing both the business impact and the administrative overhead of infrastructure downtime, planned or unplanned.

Whether it is configured with asynchronous primary/replica replication for simplicity and performance, synchronous multi-primary clustering for availability and consistency, or something in between, MariaDB Enterprise has both the flexibility and the capability to meet complex, enterprise requirements on a case-by-case basis.

MariaDB combines engineering leadership and community innovation to create open source database solutions for modern applications – meeting today's needs and supporting tomorrow's possibilities without sacrificing SQL, performance, reliability or security.

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