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WHITE PAPER

Features, Pros, and Cons of MySQL Group Replication

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ABSTRACT

MySQL Group Replication is a MySQL plugin that provides high availability and a multi-master update-everywhere replication solution. It achieves this by database replication via a set of group communication primitives at its core. Those act as building blocks to create reliable, consistent, and dependable messaging between the servers in the group. This white paper outlines the main features of MySQL Group Replication as well as its advantages and limitations.

Learn about the technical details of the new and exciting MySQL Group Replication plugin and how it fits best into the overall picture of High Availability. We will also discuss the performance of MySQL Group Replication in comparison to Galera and other HA solutions. Additionally, you'll learn how the Group Replication plugin enables developers and DBAs to obtain elastic, highly available, and fault-tolerant replication topologies and how one can minimize the risks of losing data by having multiple copies of the same data. Discover the latest MySQL Group Replication enhancements and learn how you can leverage them.

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Introduction: What is MySQL Group Replication?

MySQL Group Replication is a multi-master, update-everywhere replication plugin for MySQL Server. It enables creating elastic, highly available, fault-tolerant replication topologies while providing a resilient, multi-master, update-everywhere replication solution with automatic distributed recovery, conflict detection, and group membership.

Main Features of MySQL Group Replication

Multi-master updates

- Provides multi-master, update-anywhere usage protocol with capabilities of any two servers to write to the same tuple

Automatic conflict detection and distributed server recovery

- Automatically detects and deals with conflicts as they arise
- A new server joining the group will automatically synchronize with the others. If a server is leaving the group, the others get notified automatically.

MySQL / InnoDB look and feel

- Provides the same look and feel as a regular MySQL plugin with monitor group replication statistics through Performance Schema tables that are easy to load and replicate
- Provides normal InnoDB usage with transparent optimizations for better support of Group Replication

Full GTID support

- Offers the ability for all group members to share the same UUID and group name in which users can specify the identifier for the transaction
- The support for global identifiers allows conflicts to be detected and replication from an outside server to a group to be synced.

Auto-increment handling

- Group is set not to have the same auto-increment value on all members and has a default offset provided by the server _ id with incremental value of 7. The increment size can be changed by the users to match their needs by using the following option:

  GROUP_REPLICATION_AUTO_INCREMENT_
  INCREMENR

Built-in communication engine

- Group Replication is based on Paxos algorithms that have built-in compression, multi-platform, dynamic membership, distributed agreement, quorum-based message passing, SSL, and IP whitelisting. It doesn't require network multicast or the third-party software support and can operate on cloud-based installations on which multicast is not allowed.

The Pros of MySQL Group Replication

- Provides a highly available replicated database
- Provides scalability in terms of data size, number of queries, and read/write load
- Provides transparency in access, scale, migration, and redesign online
- Highly consistent and concurrent
- Provides failover recovery
- Easy to set up
- Provides fault tolerance
- Enables update-everywhere setups
- Automates group reconfiguration (handling of crashes, failures, reconnects)
- Provides automatic distributed coordination (protects against split-brain and message loss)
- Less admin overhead

The Cons of MySQL Group Replication

- Replication event checksums are not supported.
- Transaction save points are not supported.
- By default, SERIALIZABLE isolation level is not supported in multi-primary deployments.
- Concurrent DDL vs DML/DDL operations on the same object, being executed on different servers in multi-primary deployments, are not supported.
- Gap Locks, so better to use READ-COMMITTED as tx_ isolation
- Table Locks and Named Locks are not supported.
- MGR only supports InnoDB tables, and each table must have a primary key for conflict detection of write sets.
- The global transaction identifier (GTID) feature must be enabled, and the binary log format must be set to ROW to select the master and write set.

- COMMIT may lead to a failure, which is similar to a snapshot failure scenario at the transaction isolation level.
- Currently, MGR supports a maximum of nine nodes.
- The foreign key is not supported and global constraint detection and partial rollback cannot be carried out.
- The binary log is not compatible with binlog event checksum.

Performance of MySQL Group Replication

Availability

Offers replication of data to several locations, therefore avoiding issues of single point of failure

Scalability

Able to serve more requests by sending read requests to replicas, therefore allowing the primary server to handle only write operations

Ability to overcome single server limit

MySQL Group Replication provides a solution when the data of big users reaches a point that it no longer fits in a single server. It overcomes single server limit by sharding data across multiple servers, through replication that takes care of data flow effective sharding operation.

Operation Mode

There are two operation modes:

Single-primary mode

In this mode, a single primary server is set to read-write mode while the other members in the group are automatically set to read-only mode. Only one server accepts updates at a time. In the event the primary server fails or is removed from the group, an election is performed and a new primary server is picked from the remaining servers in the group. The election process is performed by looking at the new view, ordering the server UUIDs in lexicographical order, and by picking the first one.

Multi-master mode

In multi-master mode, all servers are set to read-write mode when joining the group and all are set to accept updates. There is no need to engage in an election process when one of the servers is removed or fails since there is no server playing any specific role. The built-in group membership service is available for all servers at any given point of time, keeping the view of the group consistent. The multi-master mode has an automatic built-in mechanism that can detect an event such as a failure of one server member, or when one server member leaves unexpectedly and immediately notifies the rest. When a server joins, the group goes through a distributed recovery stage, during which the new server receives updates before handling requests.

MySQL Group Replication vs. Other Current HA Solutions: What's the Difference?

MySQL Group Replication:

- Offers synchronous replication - MySQL Group Replication provides virtually synchronous replication with built-in conflict, detection/handling, and consistency guarantees, all of which support multi-master, write-anywhere usage.
- Allows moving from a standalone instance of MySQL, which is a single point of failure, to a natively distributed, highly available MySQL service made up of N MySQL instances
- Integrates well with standard MySQL servers through a well-defined API and also with standard GTIDs, row-based replication, and performance schema tables
- Autonomic and operations-friendly in that it can heal itself with no admin overhead for handling server failovers
- Provides fault-tolerance by enabling multi-master, update anywhere, and a resilient distributed MySQL service
- Uses typical TCP connections between primary and secondary servers
- Based on Paxos implementation - MySQL Group Replication uses the Paxos protocol and displays high data consistency among the database.

MySQL Group Replication and Galera

The major differences between MySQL, Group Replication, and Galera:

- Group Replication is a MySQL plugin made by MySQL and is **packed and distributed with MySQL by default.**
- Group Replication is **available for and supported on all MySQL platforms.**
- **Group Communication** - MySQL (GR) uses a Group Communication, System-based, Paxos algorithm, enabling it to achieve optimal network performance while Galera uses a virtual synchrony QoS based on the Totem Single-Ring Ordering protocol, a proprietary group communication system layer for its communication.

- **InnoDB** - Group Replication uses High Priority Transactions in InnoDB that ensures conflicts are detected and properly handled while Galera needs to patch MySQL and add an extra layer to be able to kill a local transaction when there are certification conflicts.
- **Binary Log** - Group Replication uses binary log to enable it to perform synchronization for a node that has been out for a short period from the logs of the node that has been elected as donor. Galera doesn't use the binary log to perform incremental synchronization. Instead, it has an extra file called gchache where data is stored and only used for Incremental State transfer (IST).
- **GTID, Master-Master, Master-Slave** - In Group Replication, Galera nodes in the same group, even with the same UUID, have their own sequence number range (defined by group_replication_gtid_assignment_block_size). This is not the case with MySQL Group Replication. That is why, by default, your cluster runs in Single Primary Mode (controller by group_replication_single_primary_mode). For this case, the group itself automatically elects a leader and keeps managing this task when the group changes in case of failure of the leader.
- **Monitoring** - Group Replication uses Performance Schema to expose information, unlike Galera that uses only status variables.
- **Replication: Majority vs. All** - Galera delivers transactions synchronously to all nodes in the cluster. However, Group Replication requires just a majority of the nodes, confirming the transaction and transaction commit on the writer succeeds and returns to the client, even if a minority of nodes still have not received it.

Advantages of MySQL Group Replication Over Galera

- MySQL Group Replication delivers **more throughput of asynchronous replication** than Galera.
- MySQL Group Replication has **little overhead** when durability settings are introduced compared to Galera, on which the impact is much higher.
- MySQL Group Replication has a stable throughput with increased number of members **(up to nine servers)** compared to Galera, making scaling to large groups very effective.
- Group Replication delivers almost **2x the maximum throughput of Galera and around 3x when durability is used.**
- Group Replication has **lower latency** than Galera.
- Group Replication is **more stable** compared to Galera with only small dips during cleanup tasks.

Benefits of MySQL Group Replication to DBAs and Developers

How does using MySQL Group Replication help DBAs? It eliminates the need for DBAs to manually handle failures and primary failovers during a failure or scheduled maintenance on the primary server. It achieves this automatically with the built-in group membership management in MySQL Group Replication, so that those tasks are automatically managed. It provides data consistency guarantees, conflict detection and handling, node failure detection, and database failover-related operations in an automated process.

From the developer's perspective, implementing MySQL Group Replication using the single-primary mode is of great benefit in that it requires almost no change at the application level. This enables existing applications to be easily adopted when underlying infrastructure moves from a single server to a group of servers managed by MySQL Group Replication. This provides predictable behavior of InnoDB and Performance Schema, as well as other MySQL components.

Conclusion

MySQL Group Replication plugin can greatly reduce the complexity and challenges in creation of fault-tolerant systems. It helps reduce the need and dependence of replicated databases on maintenance and administration of several servers. It achieves this through the fusion of the database's logic and data replication by having several servers coordinated in a consistent and simple way. By providing distributed state machine replication with strong coordination between servers, MySQL Group Replication allows servers in the same group to automatically coordinate themselves.

For more information on MySQL Group Replication contact Datavail today. With a few clicks, Datavail provides you with the latest, and greatest technology for MySQL on the preferred hardware with optimal configuration. This will enable you to enjoy the elastic, highly available and fault-tolerant MySQL database services.

Datavail is a specialized IT services company focused on Data Management with solutions in BI/DW, analytics, database administration, custom application development, and enterprise applications. We provide both professional and managed services delivered via our global delivery model, focused on Microsoft, Oracle, and other leading technologies.

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Biography

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Charleste has more than 15 years of experience in the IT industry in a myriad of areas from software development to data analysis, architecture, and administration. She has worked supporting organizations from the very small to enterprise level in aerospace, agriculture, medicine, education, and other industries. She has developed solutions to unique problems for clients ranging from multi-level upgrades with minimal downtime, compliance conversions, documentation, monitoring, alerting, stabilization, trending, and forecasting problem areas, as well as tuning and performance monitoring.

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