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Advantages of Multi-Leader Replication over Single-Leader Replication in Multi-Data Center Deployment

DECEMBER 19, 2017SEPTEMBER 15, 2020 / EFFICIENTCODEBLOG

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When we have a database with replicas in several datacenters (either to tolerate failure of an entire datacenter, or to have datacenters closer to the users and thus reduce latency), with normal single-leader based replication setup, the leader has to be in one of the datacenters, and all writes must go through that datacenter.

In a multi-leader configuration, each datacenter can have a leader. Within each of the datacenters, regular leader-follower replication is used. Each datacenter's leader replicates it changes to the leaders in other datacenters.

Below are the advantages of having multi-leader configuration over single-leader replication setup in multi-datacenter operation:

- **Write Performance:**
  In a single-leader configuration, every write must go over the internet to the datacenter with the leader. This can add significant latency to writes and might contravene the purpose of having multiple datacenters in the first place.
  In a multi-leader configuration, every write can be processed in the nearest datacenter and is replicated asynchronously to the other datacenters. Thus, the inter-datacenter network delay is hidden from users, which means the perceived write performance may be better.
- **Tolerance of Datacenter Outages**:
  In a single-leader configuration, if the datacenter with the leader fails, the ***failover*** process promotes a follower from another datacenter to be the leader.
  In multi-leader configuration, each datacenter can still continue operating independently of the others, and replication of the failed datacenter catches up when it comes back online.
- **Tolerance of Network Problems:**
  Traffic to the datacenters goes over the internet which is very unrealiable. Single-leader configuration

is very sensitive to network problems because in single-leader configuration writes are made **synchronously**.
A multi-leader configuration with **asynchronous** replication can usually tolerate network problems better: a temporary network interruption does not prevent writes being processed.

It's also worth mentioning that **it rarely makes sense to use a multi-leader setup within single datacenter**, because the benefits rarely outweigh the added complexity.

Also, as multi-leader replication is a somewhat retrofitted feature in many databases, there are often subtle configuration pitfalls and surprising interactions with other database features. For example, auto-incrementing keys, triggers, and integrity constraints can be problematic. For this, enough caution should be taken while deciding whether to go with multi-leader replication setup or not as multi-leader replication is often considered dangerous territory that should be avoided if possible. Multi-leader replication also has a big downside: the same data can be concurrently modified in two different datacenters and resolving those write conflicts is often tricky.

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