Consistency, Fault Tolerance, and Availability

This page describes how ClustrixDB architecture was designed for Consistency, Fault Tolerance, and Availability.

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See also the System Administration Guide on Fault Tolerance and High Availability

Consistency

Many distributed databases have embraced *eventual* consistency over *strong* consistency to achieve scalability. However, eventual consistency comes with a cost of increased complexity for the application developer, who must develop for anomalies that may arise with inconsistent data.

ClustrixDB provides a consistency model that can scale using a combination of intelligent data distribution, multi-version concurrency control (MVCC), and Paxos. Our approach enables ClustrixDB to scale writes, scale reads in the presence of write workloads, and provide strong ACID semantics.

For an in-depth explanation of how ClustrixDB scales reads and writes, see Concurrency Control.

ClustrixDB takes the following approach to consistency:

- Synchronous replication within the cluster. All nodes participating in a write must provide an acknowledgment before a write is complete. Writes are performed in parallel.
- The Paxos protocol is used for distributed transaction resolution.
- ClustrixDB supports for Read Committed and Repeatable Read (Snapshot) isolation levels with limited support for Serializable.
- Multi-Version Concurrency Control (MVCC allows) for lockless reads and ensures that writes will not block reads.

Fault Tolerance

ClustrixDB provides fault tolerance by maintaining multiple copies of data across the cluster. By default, ClustrixDB can accommodate a single node failure and automatically recover with no loss of data. The degree of fault tolerance (nResiliency) is configurable and ClustrixDB can be set up to handle multiple node failures and zone failure.

For more information, including how to adjust fault tolerance in ClustrixDB, see Understanding Fault Tolerance, MAX_FAILURES, and Zones.

Availability

In order to understand ClustrixDB's availability modes and failure cases, it is necessary to understand our group membership protocol.

Group Membership and Quorum

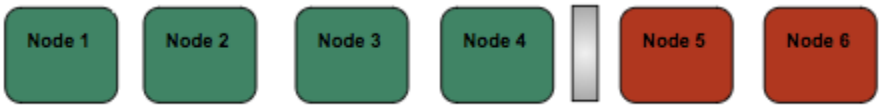
ClustrixDB uses a distributed group membership protocol. The protocol maintains two fundamental sets:

1. The static set of all nodes known to the cluster
2. The set of nodes that can currently communicate with each other.

The cluster cannot form unless more than half the nodes in the static membership are able to communicate with each other (a quorum).

For example, if a six-node cluster experiences a network partition resulting in two sets of three nodes, ClustrixDB will be unable to form a cluster.

However, if more than half the nodes are able to communicate, ClustrixDB will form a cluster.

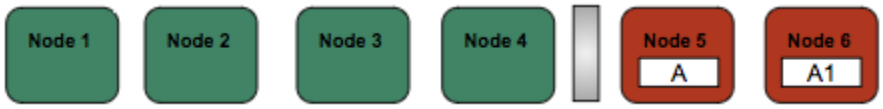


For performance reasons, MAX_FAILURES defaults to 1 to provide for the loss of one node or one zone.

Partial Availability

In the above example, ClustrixDB formed a cluster because a quorum of nodes remained. However, such a cluster could offer only partial availability because the cluster may not have access to the complete dataset.

In the following example, ClustrixDB was configured to maintain two replicas. However, both nodes holding replicas for A are unable to participate in the cluster (due to some failure). When a transaction attempts to access data on slice A, the database will generate an error that will surface to the application.



Availability Requirements

ClustrixDB can provide availability even in the face of failure. In order to provide full availability, ClustrixDB requires that:

- A majority of nodes are able to form a cluster (i.e. quorum requirement).
- The available nodes hold at least one replica for each set of data.