

# Understanding Fault Tolerance

ClustrixDB provides fault tolerance by maintaining multiple copies of data throughout the cluster. This enables a cluster to experience the loss of node(s) or zone(s), without data loss and allowing the cluster to automatically resume operations.

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## Built-in Fault Tolerance

By default, ClustrixDB is configured to accommodate a single node failure and automatically maintain 2 copies (replicas) of all data. As long as the cluster has sufficient replicas and a quorum of nodes is available, a cluster can lose a node without experiencing any data loss. Clusters with zones configured can lose a single zone.

The default settings for fault tolerance are generally acceptable for most clusters.

## Deploying Across Zones

ClustrixDB can be configured to be zone aware so that replicas (and acceptors) are placed across different zones (AWS Availability Zones within the same Region, different server racks, different network switches, different power sources). When zones are configured, a cluster can lose an entire zone and automatically recover without loss of data. See [Zones](#) for more information.

## Using Replication

Setting up disaster recovery site for your ClustrixDB cluster will allow you to recover from catastrophic failures. Setting up a secondary ClustrixDB cluster for DR will also allow for easier transition to new releases. For information regarding the various replication configurations supported by ClustrixDB, please see [Configuring Replication](#).

## MAX\_FAILURES

ClustrixDB can be configured to survive more than one node (or zone) failure by changing the value of MAX\_FAILURES, ensuring that all tables have additional replicas (and sufficient disk space), and that the cluster has a sufficient number of nodes (and zones). See [ALTER CLUSTER SET MAX\\_FAILURES](#) for more information.

Maintaining additional replicas has a performance overhead, so increasing MAX\_FAILURES increases latency for your cluster

## What Happens When a Node or Zone Fails?

When ClustrixDB experiences a node or zone failure:

- A node or zone fails a heartbeat check, meaning a node or zone can no longer communicate with other nodes of the cluster.
- A short group change occurs, after which the database becomes available (See [Group Changes](#) for more information).
- The timer associated with the global rebalancer\_reprotect\_queue\_interval\_s begins (default = 10 minutes).
- ClustrixDB establishes a queue of pending changes for the node's data and tracks all pending changes for that node or zone in that queue. This queue is necessary only if the failure is temporary.
- If the node returns within rebalancer\_reprotect\_queue\_interval\_s seconds, queued transactions are applied to the previously failed node(s) and processing resumes.
- If the node does not return within rebalancer\_reprotect\_queue\_interval\_s seconds, the queued transactions become unnecessary as the Rebalancer will begin copying data of the failed node(s) or zone from replica versions in the cluster. To monitor this reprotect process, see [Managing the Rebalancer](#).
- When the reprotect process completes, ClustrixDB will send a message indicating that full protection has been restored using [Database Alerts](#). An entry to that effect also appears in the query.log.
- The failed/unavailable node(s) may then be removed from the cluster. See [ALTER CLUSTER DROP](#).

## What Happens to Processes That Were Running?

Processes that were running when the heartbeat check failed will be impacted as shown:

Process	Result
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<p>Queries (DML and DDL)</p>	<p>If the global autoretry is true and a transaction is interrupted by a group change or encounters a retrieable error, the database will automatically retry some in-process transactions. Only transactions that were submitted with autocommit = 1, or the first statement of an explicit transaction are retried. Stored procedure and functions calls are never retried. If the retried statements are not executed successfully, the application will receive an error.</p> <p>ClustrixDB reads data exclusively from <a href="#">ranked replicas</a>. If the failed node(s) contained any ranked replicas for a slice, ClustrixDB assigns that role to another replica of that slice elsewhere.</p>
<p>Replication</p>	<p>Replication processes will automatically restart at the proper binlog location following the group change.</p>
<p>Other Connections</p>	<p>Connections to nodes that are still in <a href="#">quorum</a> will be reestablished and a new group will be formed with the available nodes.</p> <p>Connections to non-communicative nodes will be lost.</p>