# Database Replication Guide

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1.0 Database Replication in MarkLogic Server

This chapter describes Database Replication in MarkLogic Server in general terms, and includes the following sections:

- Terms Used in this Guide
- Understanding Database Replication
- Example Database Replication Configurations
- Database Replication for Disaster Recovery
- Rolling Back to the Non-Blocking Timestamp
- Updating Clusters Configured with Database Replication
- Comparison of Database Replication with Flexible Replication

Note: To enable Database Replication, a license key that includes Database Replication is required. For details on purchasing a Database Replication license, contact your MarkLogic sales representative.

1.1 Terms Used in this Guide

The following are the definitions for the Database Replication terms used in this guide:

- To Replicate is to create a copy of a document in another database and to keep that copy in sync (possibly with some time-lag/latency) with the original.
- A Local Cluster is the cluster of MarkLogic Server hosts at your current location.
- A Foreign Cluster is a remote cluster of MarkLogic Server hosts.
- A Master Database is the database being replicated. In any Database Replication scheme there is a Master database and at least one Replica database.
- A Master Forest is the forest being replicated. In any Database Replication scheme there is a Master forest and at least one Replica forest.
- A Master Cluster is shorthand for the cluster that hosts a Master Database.
- A Replica Database is the database that receives replicated data from the Master database.
- A Replica Forest is the forest that receives replicated data from the Master forest.
- A Replica Cluster is shorthand for the cluster that hosts a Replica Database.
- A Bootstrap Host is the MarkLogic Server host machine used by a foreign cluster to initiate communication with the local cluster.
- A Foreign Bind Port is the port used on each host to handle XDQP communication with foreign clusters.
• Asynchronous Replication refers to a configuration in which the Master does not wait for confirmation that the update has been received by the Replica before committing the transaction and proceeding with additional transactions. Database Replication is asynchronous.

• Transaction-aware refers to a configuration in which all updates that make up a transaction on the Master are applied as a single transaction on the Replica.

• Zero-day Replication refers to replicating the data from the Master database that existed before replication was configured.

1.2 Understanding Database Replication

Database Replication is the process of maintaining copies of forests on databases in multiple MarkLogic Server clusters. At a minimum, there will be a Master database and one Replica database. A Master database can replicate to multiple databases. A Replica database cannot serve as a Master database to another Replica.

Note: All hosts participating in Database Replication must:

• Run the same maintenance release of MarkLogic Server.
• Use the same operating system.

This section contains the following topics:

• Overview of Database Replication
• Bulk Replication
• Bootstrap Hosts
• Inter-cluster Communication
• Replication Lag
• Master and Replica Database Index Settings
1.2.1 Overview of Database Replication

Database replication operates at the forest level by copying journal frames from a forest in the Master database and replaying them on a corresponding forest in the foreign Replica database.

As shown in the illustration below, each host in the Master cluster connects to the remote hosts that are necessary to manage the corresponding Replica forests. Replica databases can be queried but cannot be updated by applications.
1.2.2 Bulk Replication

Any content existing in the Master databases before Database Replication is configured is bulk replicated into the Replica databases. Bulk replication is also used after the Master and foreign Replica have been detached for a sufficiently long period of time that journal replay is no longer possible. Once bulk replication has completed, journal replication will proceed.

The bulk replication process is as follows:

1. The indexing operation on the Master database maintains a catalog of the current state of each fragment. The Master sends this catalog to the Replica database.

2. The Replica compares the Master’s catalog to its own and updates its fragments using the following logic:
   - If the Replica has the fragment, it updates the nascent/deleted timestamps, if they are wrong.
   - If the Replica has a fragment the Master doesn't have, it marks that fragment as deleted (it likely existed on the Master at some point in the past, but has been merged out of existence).
   - If the Replica does not have a fragment, it adds it to a list of missing fragments to be returned by the Master.

3. The Master iterates over the list of missing fragments returned from the Replica and sends each of them, along with their nascent/deleted timestamps, to the Replica where they are inserted.

For more information on fragments, see the Fragments chapter in the Administrator’s Guide.
1.2.3 Bootstrap Hosts

Each cluster in a Database Replication scheme contains one or more bootstrap hosts that are used to establish an initial connection to foreign clusters it replicates to/from and to retrieve more complete configuration information once a connection has been established. When a host initially starts up and needs to communicate with a foreign cluster, it will bootstrap communications by establishing a connection to one or more of the bootstrap hosts on the foreign cluster. Once a connection to the foreign cluster is established, cluster configuration information is exchanged between all of the local hosts and foreign hosts.

For details on selecting the bootstrap hosts for your cluster, see “Identifying the Local Cluster to Foreign Clusters and Designating the Bootstrap Hosts” on page 30.
1.2.4 Inter-cluster Communication
Communication between clusters is done using the intra-cluster XDQP protocol on the foreign bind port. A host will only listen on the foreign bind port if it is a bootstrap host or if it hosts a forest that is involved in inter-cluster replication. By default, the foreign bind port is port 7998, but it can be configured for each host, as described in “Changing the Foreign Bind Port” on page 50. When secure XDQP is desired, a single certificate/private-key pair is shared by all hosts in the cluster when communicating with foreign hosts.

XDQP connections to foreign hosts are opened when needed and closed when no longer in use. While the connections are open, foreign heartbeat packets are sent once per second. The foreign heartbeat contains information used to determine when the foreign cluster's configuration has changed so updated information can be retrieved by the local bootstrap host from the foreign bootstrap host.

1.2.5 Replication Lag
Queries on a Replica database must run at a timestamp that lags the current cluster commit timestamp due to replication lag. Each forest in a Replica database maintains a special timestamp, called a Non-blocking Timestamp, that indicates the most current time at which it has complete state to answer a query. As the Replica forest receives journal frames from its Master, it acknowledges receipt of each frame and advances its nonblocking timestamp to ensure that queries on the local Replica run at an appropriate timestamp. Replication lag is the difference between the current time on the Master and the time at which the oldest unacknowledged journal frame was queued to be sent to the Replica.

You can set a lag limit in your configuration that specifies, if the Master does not receive an acknowledgement from the Replica within the time frame specified by the lag limit, transactions on the Master are stalled. The default lag limit is 15 seconds, and should work well for most installations. For the procedure to set the lag limit, see “Configuring Database Replication” on page 37.
1.2.6 Master and Replica Database Index Settings

Indexing information is not replicated by the Master database and is instead regenerated on the Replica system. If you want the option to switch over to the Replica database after a disaster, the index settings must be identical on the Master and Replica clusters.

If you need to update index settings after configuring Database Replication, update the settings on the Replica database before updating those on the Master database. This is because changes to the index settings on the Replica database only affect newly replicated documents and will not trigger reindexing on existing documents. Changes to the index settings on the Master database will trigger reindexing, after which the reindexed documents will be replicated to the Replica. When a Database Replication configuration is removed for the Replica database (such as after a disaster), the Replica database will reindex, if necessary.

The process of recreating index information on the Replica database requires information located in the schema database. You cannot replicate a Master database that acts as its own schema database. When replicating a Master schema database, create a second empty schema database for the Replica schema database on the Replica cluster. The diagram below shows the Schema2 database as the schema database from the Replica schema database.
1.3 Example Database Replication Configurations

This section describes some of the possible Database Replication configurations.

The most basic form of Database Replication consists of a two clusters, each containing a single database with a single forest, as shown below.

Master and Replica forests can be distributed differently across hosts in each cluster. For example, as shown below, all of the Master forests may reside on a single host and the Replica forests on two hosts.
A Master cluster can replicate forests to multiple Replica clusters. In the example shown below, the Master maintains a copy of each forest on two clusters:
In the example shown below, the Master maintains a single copy of Database 1 on Replica Cluster 1 and a single copy of Database 2 on Replica Cluster 2:

A cluster can contain both Master and Replica databases. On Cluster A in the example shown below, Database 1 is the Master database and Database 2 is the Replica database.
1.4 Database Replication for Disaster Recovery

The purpose of Database Replication is to make data continuously available to mission-critical applications with minimal impact to application performance. In a typical disaster recovery scheme, clusters are located in data centers at different geographical locations. In the event of a disaster in the location of the Master cluster, the data can be made available by the Replica cluster.

**Note:** In this section, the original Master and Replica databases are referred to as Database A and Database B, respectively.

There are two basic approaches to a disaster recovery operation, each of which involves redirecting the applications to Database B. Before executing your applications on Database B, the database must be rolled back, as described in “Rolling Back to the Non-Blocking Timestamp” on page 17.

- Simply disable Database Replication on Database B so that it is no longer a Replica and can accept updates.

- Reconfigure Database B as the Master database and replicate updates to a third foreign database (Database C).

![Diagram of Database A and Database B](image1.png)

![Diagram of Database A, Database B, and Database C](image2.png)
When Database A is returned to service, you can resynchronize it with Database B by either:

- Configuring Database A as a Replica of Database B. In this case, Database B will automatically bulk replicate to Database A.

- Running a backup operation on Database B and restoring Database A from the backup file, as described in "Backing Up and Restoring a Database" in the Administrator’s Guide.

Once the data has been restored on the Database A, you can redirect the applications from Database B back to Database A.
Database Replication can be used in combination with the local-disk failover feature described in the High Availability of Data Nodes With Failover and Configuring Local-Disk Failover for a Forest in the Scalability, Availability, and Failover Guide. For example, the Master and Replica clusters shown below are configured for both local-disk failover and Database Replication. Should, for example, the F1 forest in the Master cluster become unavailable, then the R1 forest resumes replication to the F1 forest in the Replica cluster.
1.5 Rolling Back to the Non-Blocking Timestamp

After you fail over your applications to a Replica database, each Replica forest will likely have committed its last transaction at different timestamps. If the Replica database has multiple forests and relationships exist between those forests, this inconsistency may cause problems. In order to return the database to a transactionally consistent state, all forests must be rolled back to the minimum non-blocking timestamp.

For example, the illustration below shows four forests and their committed transactions. Updates for each transaction are identified by the convention ‘T#-u#’ and commits are identified by a ‘C’. Each forest completed its last commit at a different point in time when the failure of the Master database occurred. In this example, Forest A has only committed transactions up to timestamp 3 while Forest B has committed transactions up to timestamp 6. This means that, in order to return the database to a transactionally consistent state, all forests must be rolled back to at least timestamp 3.

<table>
<thead>
<tr>
<th>Forest A</th>
<th>Forest B</th>
<th>Forest C</th>
<th>Forest D</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG-u2</td>
<td>TR-u3</td>
<td>TD-u3</td>
<td>TA-u1</td>
</tr>
<tr>
<td>TG-u3</td>
<td>T3-u4</td>
<td>TD-u4</td>
<td>TA-u2</td>
</tr>
<tr>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>TD-u5</td>
<td>TB-u1</td>
<td>TH-u1</td>
<td>A-u3</td>
</tr>
<tr>
<td>TD-u6</td>
<td>TB-u2</td>
<td>TH-u2</td>
<td>C</td>
</tr>
<tr>
<td>C</td>
<td>TH-u3</td>
<td>TB-u3</td>
<td>Ty-u6</td>
</tr>
<tr>
<td>TY-u1</td>
<td>TH-u4</td>
<td>TB-u4</td>
<td>TY-u7</td>
</tr>
<tr>
<td>TY-u2</td>
<td>TH-u5</td>
<td>C</td>
<td>TX-u1</td>
</tr>
<tr>
<td>TF-u1</td>
<td>C</td>
<td>TG-u1</td>
<td>TZ-u1</td>
</tr>
<tr>
<td>TF-u2</td>
<td>C</td>
<td>TG-u2</td>
<td>TZ-u2</td>
</tr>
</tbody>
</table>

Note: The procedure described in this section can also be applied to the Master database, should you want to roll it back to some point after the last merge timestamp. When the Master database is rolled back, the rollback will be replicated to the Replica databases.
For example, the database you want to restore has four forests, as shown below. You use the `xdmp:forest-status` function to locate the nonblocking-timestamp value for each forest and roll back all of your forests to the minimum nonblocking-timestamp value. In this example, the minimum nonblocking-timestamp is the timestamp of the last committed transaction in Forest A.

The following procedure describes how to restore to the minimum non-blocking timestamp using the XQuery API.

1. Use the `admin:database-get-merge-timestamp` function to get the current merge timestamp. Save this value so it can be reset after you have completed the rollback operation.

2. Use the `admin:database-set-merge-timestamp` function to set the merge timestamp to any time before the failure of the master database. This will preserve fragments in merge after this timestamp until you have rolled back your forest data.

3. Use the `xdmp:forest-rollback` function to roll back the forests to the minimum nonblocking-timestamp returned by the `xdmp:forest-status` function for each forest that is in the open or open replica state.
For example, you can use the following query to rollback your forest data for the Documents database:

```xquery
xquery version "1.0-ml";

let $db := xdmp:database("Documents")
let $timestamp := xdmp:database-nonblocking-timestamp($db)
let $rollback := xdmp:forest-rollback(
    xdmp:forest-open-replica(
        xdmp:database-forests($db)),
    $timestamp)

return
"Roll back done"
```

4. Use `admin:database-set-merge-timestamp` function to set the merge timestamp back to the value you saved in Step 1.

**1.6 Updating Clusters Configured with Database Replication**

The XDQP protocol version must be the same on all hosts in all of the clusters being replicated. If the XDQP protocol version is different, database replication will pause until the clusters are both upgraded to the same version. XDQP protocol versions generally change between major versions of MarkLogic, but they can sometimes change between maintenance releases.

If the Security database isn't replicated, then there shouldn't be anything special you need to do other than upgrade the two clusters.

If the security database is replicated, do the following:

1. Upgrade the Master cluster and run the upgrade scripts. This will update the Master's Security database to indicate that it is current. It will also do any necessary configuration upgrades.

2. Upgrade the Replica cluster.

3. The Replica's security database will receive the update from the Master's Security database, so the upgrade code won't trigger (i.e. it thinks the upgrade has already happened). You still need to upgrade the config files, so you must manually access the upgrade script and force it to run:

   ```
   http://security-host/security-upgrade-go.xqy?force=true
   ```
1.7 Comparison of Database Replication with Flexible Replication

MarkLogic Server provides two types of replication: Database Replication, as described in this guide, and Flexible Replication, as described in the *Flexible Replication Guide*. You should choose a replication type based on your application and high-availability requirements.

Depending on your requirements, one type of replication might have an advantage over the other.

The key differences between these two types of replication are:

- **Replicate all or part of the Master database** — Database Replication replicates the entire Master database to the Replica database. Flexible Replication replicates Content Processing Framework (CPF) domains and allows you to write XQuery filters that enable you to modify the replicated documents in some manner, determine whether to replicate a change, or select which parts of a document will be replicated. As a consequence, Flexible Replication enables you to replicate select content from the Master database.

- **Performance** — Flexible Replication uses CPF and generates information in the properties of each replicated document. Database Replication simply copies and replays journal frames. If you replicate a complete database, you can expect less overhead with Database replication than with Flexible Replication.

- **Transactional** — Database Replication replicates as soon as a document is inserted or updated and ensures that a single multi-document transaction in the Master database replicates as a single multi-document transaction to the Replica database. Flexible Replication replicates documents after each transaction without consideration of transactional grouping in the Master database. For example, if you have a transaction that commits 10 documents to the Master database and some sort of failure occurs, with Flexible Replication it is possible for the Replica to end up with 5 documents from that transaction on the Replica. With Database Replication, the Replica will either have no documents or all 10 of them.
2.0 Database Replication Quick Start

This chapter provides the quick-start procedures for creating a simple Database Replication configuration to replicate the Documents database from one MarkLogic Server host to another. The replicated MarkLogic Server hosts must be able to communicate with each other and they must not be on the same cluster.

Note: The purpose of this chapter is to walk you through a specific Database Replication configuration procedure. For more general details on how to configure Database Replication, see “Configuring Database Replication” on page 29.

Note: A cluster can consist of a single MarkLogic Server host.

This chapter includes the following sections:

- Identify the Local Cluster to Foreign Clusters
- Couple the Local Cluster with the Foreign Cluster
- Configure Database Replication
- Load Documents into the Master Database and Check Replication

All of the procedures described in this chapter are done using the Admin Interface described in the Administrative Interface chapter in the Administrator’s Guide.
2.1 Identify the Local Cluster to Foreign Clusters

Each cluster may be configured to have a descriptive name. It is a good practice to assign each cluster a name before coupling them with each other.

This section describes how to name the local cluster so it can be identified by foreign clusters. Repeat this procedure on a host for each cluster that is to participate in Database Replication.

1. On any host in the local cluster, select Local Cluster under Clusters at the bottom of the left-hand menu:

2. In the Edit Local Cluster Configuration page, enter the cluster name and select a host as the bootstrap host:
2.2 **Couple the Local Cluster with the Foreign Cluster**

Before you can configure Database Replication, each cluster in the replication scheme must be aware of the configuration of the other clusters. This can be accomplished by “coupling” the local cluster to the foreign cluster.

1. In the Local Cluster Configuration page, select the Couple tab.

2. In the Foreign Cluster portion of the Local Cluster Configuration page, enter the Host Name for the bootstrap host in the foreign cluster. Leave the default values for the other settings and click OK.
3. In the Specify SSL settings for XDQP communication & Timeouts page, leave all of the default settings and click OK.

4. In the Confirm to Couple Clusters page, click OK.
5. The Summary window appears and displays the summary for the Foreign Cluster configuration.

2.3 Configure Database Replication

The procedure described in this section configures Database Replication to replicate the Documents database on the Master to the Documents database on the Replica.

1. On the Master host, navigate to the Documents database in the left-hand menu and select Database Replication:

2. Select the Configure tab and select the foreign cluster from the pull-down menu. Click OK.
3. In the Configure Database Replication page, set Master for Local Database as.

4. Select the Documents database in the Foreign Database pull-down menu. Leave all other settings as default. Click OK.
5. A page appears to confirm the Database Replication configuration on the Master. Click OK.

6. The Confirm to Add Foreign Replica page appears. Click OK.

7. The Summary page appears with the Database Replication settings.
2.4 Load Documents into the Master Database and Check Replication

Once you have completed the Database Replication configuration procedures described in this chapter, documents loaded into the Documents database on the Master host will be replicated to the Documents database on the Replica host.

Methods for loading content into a database include:

- Using the XQuery load document functions, as described in Loading Content Using XQuery in the Loading Content Into MarkLogic Server Guide.
- Setting up a WebDAV server and client, such as Windows Explorer, to load your documents. See the section Simple Drag-and-Drop Conversion in the Content Processing Framework Guide guide for information on how to configure a WebDAV server to work with Windows Explorer.
- Creating an XCC application, as described in Using the Sample Applications in the XCC Developer’s Guide.

One way to confirm the content has been replicated to the Replica is to use the explore feature in Query Console to view the contents of the Replica database. For details on how to use Query Console to explore the contents of a database, see Exploring a Database in the Query Console User Guide.
3.0 Configuring Database Replication

This chapter describes how to configure your MarkLogic Server clusters for Database Replication. The topics in this chapter assume you are familiar with the replication principles described in “Understanding Database Replication” on page 5 and the basic configuration procedures described in the “Database Replication Quick Start” on page 21.

For details on using the REST API to script database replication, see Scripting Database Replication Configuration in the Scripting Administrative Tasks Guide.

This chapter includes the following sections:

• Database Replication Security
• Avoid Replicating the App-Services Database
• Identifying the Local Cluster to Foreign Clusters and Designating the Bootstrap Hosts
• Coupling the Local and Foreign Clusters
• Configuring Database Replication
• Connecting Master and Replica Forests with Different Names
• Deleting a Database Replication Configuration
• Decoupling the Local and Foreign Clusters
• Configuring App Servers on the Replica Cluster
• Changing the Foreign Bind Port
• TCP Tuning For High-Latency Environments

3.1 Database Replication Security

The admin role is required to configure and couple local and foreign clusters and to configure Database Replication.

When coupling clusters, you can configure SSL to encrypt the XDQP data passed between them. For details on configuring SSL, see “Coupling the Local and Foreign Clusters” on page 32. If SSL is enabled for XDQP, you must set the protocol to HTTPS in the procedures described in “Coupling the Local and Foreign Clusters” on page 32 and “Configuring Database Replication” on page 37.

3.2 Avoid Replicating the App-Services Database

The App-Services database is used to store information used in Query Console and for other internal applications. Therefore, it needs to be writable on all hosts, otherwise those applications might not work correctly. Therefore, MarkLogic recommends that you do not set up database replication on the App-Services database.
3.3 Identifying the Local Cluster to Foreign Clusters and Designating the Bootstrap Hosts

By default, the name of the cluster is that of the bootstrap host. You must edit the cluster name in the Local Cluster Configuration on the each local cluster to be coupled with foreign clusters.

1. On the local host, select Local Cluster under Clusters at the bottom of the left-hand menu:

2. Select the Configure tab to display the Edit Local Cluster Configuration page. Enter the cluster name:

3. As described in “Understanding Database Replication” on page 5, each cluster to participate in Database Replication must have one or more bootstrap hosts that stores the configuration information needed to establish an initial connection to foreign clusters. You must identify the bootstrap hosts in each cluster before attempting any of the configuration procedures described in this chapter.

A production Database Replication scheme will typically have more than one bootstrap host to ensure availability. When establishing an initial connection with a local cluster, a foreign cluster will connect to the first available bootstrap host.
In the Local Cluster Configuration page, select one or more hosts to serve as the bootstrap hosts for this cluster.

**Note:** It is best to choose the host that hosts your Security forest as your bootstrap host. If you have configured your Security forest for local disk failover, then also choose the host that hosts your Replica Security forest as a bootstrap host.

4. Click OK to save the Local Cluster Configuration.
3.4 **Coupling the Local and Foreign Clusters**

This section describes how to “couple” a foreign cluster configuration to the bootstrap host on your local cluster. If you have designated more than one bootstrap host on your local cluster, pick any one of them.

**Note:** The foreign cluster must be running the same version of MarkLogic as the local cluster.

**Note:** The procedure described in this section must be repeated for every Replica cluster.

1. On a bootstrap host on the Master cluster, select Local Cluster under Clusters at the bottom of the left-hand menu:

2. In the Local Cluster Configuration page, select the Couple tab.

3. In the Foreign Cluster portion of the Local Cluster Configuration page, enter the Host Name for any host in the foreign cluster to be coupled. You can also specify the Admin Port (if necessary) and the communication protocol to be used between the clusters (HTTP or HTTPS). When you have SSL enabled on the Admin App Server on the bootstrap host in the foreign cluster, set the protocol to https.
### Local Cluster

Local Cluster Configuration which will be transferred to Foreign Cluster.

<table>
<thead>
<tr>
<th>Cluster Name</th>
<th>Master</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hostname</td>
<td>Host ID</td>
</tr>
<tr>
<td>gordon-1.marklogic.com</td>
<td>11735669520674600252</td>
</tr>
</tbody>
</table>

### Foreign Cluster

Enter Host and Admin UI Port in Foreign Cluster.

<table>
<thead>
<tr>
<th>Host Name</th>
<th>Admin Port</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>gordon-2</td>
<td>8001</td>
<td>http</td>
</tr>
</tbody>
</table>

Required:
- Host in foreign cluster.
- Port of Admin UI on the foreign host.
- The host’s Admin UI has SSL enabled.
4. In the Foreign Cluster Configuration page, if you are using SSL for inter-cluster communication, configure the SSL security settings and timeout values.

<table>
<thead>
<tr>
<th>Foreign Cluster – Specified Host in Foreign Cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>foreign host name</td>
</tr>
<tr>
<td>foreign port</td>
</tr>
<tr>
<td>foreign protocol</td>
</tr>
</tbody>
</table>

- **xdcp ssl enabled**: Whether or not SSL is enabled for XDQP.
- **xdcp ssl allow ssllv3**: Whether or not SSLv3 is allowed for XDQP.
- **xdcp ssl allow tls**: Whether or not TLS is allowed for XDQP.

- **xdcp ssl ciphers**: A colon separated list of ciphers (e.g. ALL:LOW@STRENGTH)
- **xdcp timeout**: The XDQP protocol timeout, in seconds.
- **host timeout**: The host response timeout, in seconds.
5. In the Verify Add Foreign Cluster page confirm all of the settings are correct and click OK.

<table>
<thead>
<tr>
<th>Foreign Cluster Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>xdgq ssl enabled</td>
<td>Set to true to enable SSL to encrypt all XDQP traffic between the clusters.</td>
</tr>
<tr>
<td>xdgq ssl allow sslv3</td>
<td>Set to true to enable the Secure Sockets Layer (SSL) v3 protocol for inter-cluster XDQP communication.</td>
</tr>
<tr>
<td>xdgq ssl allow tls</td>
<td>Set to true to enable the Transport Layer Security (TLS) protocol for inter-cluster XDQP communication.</td>
</tr>
<tr>
<td>xdgq ssl ciphers</td>
<td>Enter one or more of the SSL ciphers defined in <a href="http://www.openssl.org/docs/apps/ciphers.html">http://www.openssl.org/docs/apps/ciphers.html</a> or leave as default. If MarkLogic Server is operating in FIPS mode, then the cipher must be a FIPS-approved cipher or SSL communication will fail.</td>
</tr>
<tr>
<td>xdgq timeout</td>
<td>Specify the time, in seconds, before the XDQP connection between the local cluster and the foreign cluster times out. Default is 10 seconds.</td>
</tr>
<tr>
<td>host timeout</td>
<td>Specify the time, in seconds, before a MarkLogic Server host on the local cluster communicating with a host on the foreign cluster times out. Default is 30 seconds.</td>
</tr>
</tbody>
</table>
6. The Summary window appears and displays the summary for the Foreign Cluster configuration. Bootstrapped indicates whether the foreign cluster configuration has been received by the local cluster. Last Bootstrap indicates the last time the foreign cluster configuration was received by the local cluster. Initially the status of Bootstrapped may appear as false and Last Bootstrap as never. Refresh your browser page to see the current status.

<table>
<thead>
<tr>
<th>Cluster ID</th>
<th>118692005207695882</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster Name</td>
<td>Replica-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XDQP Timeout</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Host Timeout</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XDQP SSL Certificate</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Foreign Cluster: Replica-1**  --  Foreign Cluster Configuration

---BEGIN CERTIFICATE-----
MIIClTCCAhCAAgEAMBQQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wRgYDVQQIEwNpZDJjZyBTQ00tMjAtMjAtMjAtMCowTQ0wMBQGA1wYIK<KEY>...

---END CERTIFICATE-----

| XDQP SSL Enabled | false |
| XDQP SSL Allow SSLv3 | true |
| XDQP SSL Allow TLS | true |
| XDQP SSL Ciphers | ALL|LOW@STRENGTH |

<table>
<thead>
<tr>
<th>Host</th>
<th>Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>gordon-1.marklogic.com</td>
<td>7998</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Local Database as</th>
<th>Database</th>
<th>Foreign Database</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master Documents</td>
<td>Documents</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Local Bootstrap Host</th>
<th>Bootstrapped</th>
<th>Last Bootstrap</th>
</tr>
</thead>
<tbody>
<tr>
<td>gordon-1.marklogic.com</td>
<td>true</td>
<td>2011-09-21T13:48:07.00</td>
</tr>
</tbody>
</table>

* If “Last Bootstrap” shows “never”, there is a cluster communication problem.

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Database Replication Guide—Page 36
3.5 Configuring Database Replication

This section describes how to configure Database Replication on the cluster that hosts the Master database. Before starting this procedure, you must have identified all of the foreign clusters you plan to replicate to by following the procedure described in “Identifying the Local Cluster to Foreign Clusters and Designating the Bootstrap Hosts” on page 30.

This section describes how to configure Database Replication from the Master cluster. You can also configure Database Replication on a Replica cluster. However, if you are replicating to multiple Replica clusters, it is more convenient to do all of the configuration from the Master cluster.

**Note:** When replicating a Master schema database, you must create a second empty schema database for the Replica schema database on the Replica cluster. For details see “Master and Replica Database Index Settings” on page 10.

**Warning** Any documents with URIs in a Replica forest that are not in its respective Master forest will be automatically cleared when Database Replication is configured.

Repeat the following procedure for each replicated database and for each Replica cluster.

1. On the bootstrap host in the Master cluster, navigate to the database to be replicated in the left-hand menu and select Database Replication:
2. Select the Configure tab and then the Replica cluster in the Foreign Cluster pull-down menu:

3. The Configure Database Replication page will change. For Local Database as, select Master. Select the database to be replicated to in the Foreign Database pull-down menu.
The other settings on the Configure Database Replication page are:

<table>
<thead>
<tr>
<th>Database Replication Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag Limit</td>
<td>The Replica cluster sends an acknowledgement to the Master cluster each time it receives a replicated journal frame. You can set a Lag Limit in your configuration that specifies that transactions on the Master will be stalled if the Master does not receive an acknowledgement from the Replica within the number of seconds specified by the Lag Limit. By default the Lag Limit is 15 seconds. For more information on Lag Limit, see “Replication Lag” on page 9.</td>
</tr>
<tr>
<td>Connect Forests by Name</td>
<td>If the forest names are the same on the Master and Replica clusters, set Connect Forests by Name to true. If new forests of the same name are later added to the Master and Replica databases, they will be automatically configured for Database Replication. If you set Connect Forests by Name to false, you must manually connect the Master forests on the local cluster to the Replica forests on the foreign cluster, as described in “Connecting Master and Replica Forests with Different Names” on page 42.</td>
</tr>
<tr>
<td>Foreign Admin UI Protocol</td>
<td>The communication protocol to be used to connect to the foreign Admin App Server. Select https if SSL is enabled on the Admin App Server on the bootstrap host in the foreign cluster. Otherwise, select http.</td>
</tr>
<tr>
<td>Foreign Admin UI Port</td>
<td>If the Admin App Server for the bootstrap host on the foreign cluster uses a port other than 8001, specify the port number.</td>
</tr>
<tr>
<td>Host in Foreign Cluster</td>
<td>The name of a host on the foreign cluster.</td>
</tr>
</tbody>
</table>
4. When you have finished, click OK. The final configuration page appears to confirm the Database Replication configuration. Click OK.

5. The Verify add of foreign Replica/Master page appears. Click OK.
6. The Summary page appears with the Database Replication settings.
3.6 Connecting Master and Replica Forests with Different Names

If you are replicating between databases that contain forests with different names, you can manually connect Master to Replica forests.

Note: The Replica databases must have at least as many forests as the Master database. Otherwise, not all of the data on the Master database will be replicated.

For example, if you have a database named Master on the Master cluster and a database named Replica on the Replica cluster and each database has unique forest names, use the following procedure.

1. On the bootstrap host in the Master cluster, navigate to the Master database in the left-hand menu and select Database Replication:

2. In the Configure Database Replication Step 1 page, select the Foreign Cluster that contains the Replica Database. Click OK.
3. In the Configure Database Replication Step 2 page, select Replica for the Foreign Database.
4. Select false for Connect Forests by Name and configure the other settings as described in “Configuring Database Replication” on page 37.

<table>
<thead>
<tr>
<th><strong>Configure Database Replication</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Local Database</strong></td>
</tr>
<tr>
<td><strong>Foreign Cluster</strong></td>
</tr>
<tr>
<td><strong>Local Database as</strong></td>
</tr>
<tr>
<td><strong>Foreign Database</strong></td>
</tr>
<tr>
<td><strong>Lag Limit (seconds)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Connect Forests by Name</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Foreign Admin Interface</strong></td>
</tr>
<tr>
<td><strong>Port</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Host in Foreign Cluster</strong></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
5. In the Connect Forests by Name table, use the pull-down menus to connect the Replica forests to the local Master forests. Click OK.
6. In the Confirm to Add Foreign Replica page, confirm the configuration and click OK.

![Confirm to Add Foreign Replica](image)

3.7 Deleting a Database Replication Configuration

You can delete a Database Replication configuration from a bootstrap host on either the Master or Replica cluster. The procedure described in this section describes how to delete a Database Replication configuration on the Master cluster.

1. On the bootstrap host in the Master cluster, navigate to the Master database in the left-hand menu and select Database Replication:
2. In the Foreign Replicas for Database section of the Summary page, click Delete.

![Foreign Replicas for Database Master](image)

3. In the Delete Database Replication page, select https as the UI Protocol if SSL is enabled on the Admin App Server on the bootstrap host in the Replica cluster. Click OK.

![Delete Database Replication](image)
4. In the Confirm to Delete Database Replication page, click OK.

3.8 Decoupling the Local and Foreign Clusters

This section describes how to decouple two clusters.

**Note:** Before decoupling clusters, you must remove any Database Replication configurations between the local cluster and the cluster to be decoupled.

For example, to decouple a cluster named Replica from the local cluster, do the following:

1. On the local host, select Clusters at the bottom of the left-hand menu:

2. Locate the foreign cluster to be decoupled and click Delete:
3. Click OK in the Decouple Clusters page:

![Decouple Clusters](image1)

4. Click OK in the Decouple Clusters- Validated page:

![Decouple Clusters - Validated](image2)

### 3.9 Configuring App Servers on the Replica Cluster

As described in [Reducing Blocking with Multi-Version Concurrency Control](Application Developer's Guide) in the *Application Developer's Guide*, setting multi version concurrency control to 'nonblocking' on an App Server minimizes transaction blocking, which is useful if the App Server makes use of a replica database that significantly lags its master database.

It is recommended that, at a minimum, you set multi version concurrency control to 'nonblocking' on the Admin App Server because the Security database is typically not frequently updated. The 'nonblocking' multi version concurrency control option minimizes transaction blocking at the cost of queries potentially seeing a less timely view of the database, so you should weigh these two factors when determining whether to set this options on other App Servers on your replica cluster.
3.10 Changing the Foreign Bind Port

As described in “Inter-cluster Communication” on page 9, communication between clusters is done using the intra-cluster XDQP protocol on the foreign bind port. By default, the foreign bind port is port 7998. This section describes how to change the foreign bind port.

**Note:** The procedure in this section must be repeated for each host in the cluster that is involved in inter-cluster replication.

1. Select a host in the local cluster under Hosts in the left-hand menu:

2. In the Host Configuration page, change the port number in the foreign bind port field:
3.11 TCP Tuning For High-Latency Environments

On Linux systems, if you have configured database replication where there is high-latency between the master and the replica environments (for example, if your master is in San Francisco and your replica is in Tokyo), you might need to tune the Linux TCP settings to increase throughput. The following are examples of the tuned Linux TCP setting (these settings are tuned with values greater than the typical defaults):

```
# sysctl -w net.core.rmem_max=8388608
net.core.rmem_max = 8388608
# sysctl -w net.core.wmem_max=8388608
net.core.wmem_max = 8388608
# sysctl -w net.ipv4.tcp_mem='8388608 8388608 8388608'
net.ipv4.tcp_mem = 8388608 8388608 8388608
# sysctl -w net.ipv4.tcp_rmem='4096 87380 8388608'
net.ipv4.tcp_rmem = 4096 87380 8388608
# sysctl -w net.ipv4.tcp_wmem='4096 87380 8388608'
net.ipv4.tcp_wmem = 4096 87380 8388608
# sysctl -w net.ipv4.route.flush=1
net.ipv4.route.flush = 1
```

To see your current TCP settings, run the following Unix command:

```
# sysctl -a | grep mem
```

The setting shown above will change the running system but will not survive a reboot. Once you have tuned your system to your satisfaction, you need to add these settings to your startup environment to persist them through system reboots.

For details on your TCP settings, see your operating system documentation. If you have questions about how these operating system parameters might behave with your MarkLogic environment, contact MarkLogic Technical Support.
4.0 Checking Database Replication Status

This chapter describes how to check replication status for a Master cluster. This chapter includes the following sections:

This chapter includes the following sections:

- Checking the State of the Replica Forests
- Checking the Journal Frames Received from the Master
- Checking the Update Lag on the Master

4.1 Checking the State of the Replica Forests

This section describes how to check the state of each Replica forest on the Replica cluster.

1. Access the Admin Interface on the bootstrap host in the Replica cluster. Navigate to the Replica database in the left-hand menu:

2. Select the Status tab:

3. The current state of each Replica forest appears near the top of the page.
The possible states related to Database Replication are listed in the table below.

<table>
<thead>
<tr>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Replica</td>
<td>The Replica forest is currently receiving replicated data in the form of journal frames from the Master forest. This is the normal state for Database Replication.</td>
</tr>
<tr>
<td>Syncing Replica</td>
<td>The Replica forest is “bulk synchronizing” with the Master forest. This occurs when a Master database containing documents is initially configured for Database Replication, after the Master and Replica have been detached for a sufficiently long period of time that journal replay is no longer possible, or following a local-disk failover. Once the Master and Replica databases are synchronized, the state is reset to Open Replica.</td>
</tr>
</tbody>
</table>

**Note:** While in this state, the status page will report that the database forests are in an error state. There is nothing wrong with the forests and they will appear as normal when the database returns to the Open Replica state.

### 4.2 Checking the Journal Frames Received from the Master

This section describes how to check the current journal frames received by each Replica forest from the Master.

1. On the bootstrap host in the Replica cluster, navigate to the Replica database in the left-hand menu and select Database Replication:
2. Select the Summary tab:

![Summary Tab Image]

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign Precise Time</td>
<td>The point in time the foreign Master forest asserted itself as a Master. If local-disk failover isn't configured on the Master, this is the time the forest was created, last cleared, last rolled back, and so on. If the foreign Master has local-disk failover configured, in addition to the previously mentioned events, this could be the time of the last failover.</td>
</tr>
<tr>
<td>Foreign FSN</td>
<td>The ID of the last journal frame received from the foreign Master. The ID is simply the current count of journal frames.</td>
</tr>
</tbody>
</table>
4.3 Checking the Update Lag on the Master

As described in “Replication Lag” on page 9, the Replica cluster sends an acknowledgement to the Master cluster when a replicated journal frame has been received and stored. The Lag Limit you set in your Master cluster configuration specifies that transactions on the Master will be stalled if the Master does not receive an acknowledgement from the Replica within the number of seconds specified by the Lag Limit. If the Pending-Lag value exceeds the Lag-Limit, new transactions that access the Master database are stalled.

If the XDQP timeout value set for the Replica cluster is exceeded, the Replica cluster is assumed to have failed. In this event, the Master cluster will detach from the Replica and transactions will continue normally on the Master. When the Replica cluster is available again, Database Replication will resume and the Replica database will resynchronize with the Master database.

You can check for lagging updates at the bottom of the database status page. For example, to check the Database Replication status of the Documents database do the following:

1. On the bootstrap host in the Master cluster, navigate to the Master database in the left-hand menu and select Database Replication:
2. Select the Summary tab:

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local-Forest-Name</td>
<td>The name of the Master forest.</td>
</tr>
<tr>
<td>Foreign-Forest-Name</td>
<td>The name of the Replica forest.</td>
</tr>
<tr>
<td>Foreign-Database-Name</td>
<td>The name of the Replica database.</td>
</tr>
<tr>
<td>Pending-Frames</td>
<td>The number of unreplicated journal frames.</td>
</tr>
<tr>
<td>Pending-Bytes</td>
<td>The number of unreplicated bytes.</td>
</tr>
<tr>
<td>Pending-Lag</td>
<td>The number of seconds since the last journal frame was replicated.</td>
</tr>
<tr>
<td>Lag-Limit</td>
<td>The current lag limit set for this database. For details on the lag limit, see “Replication Lag” on page 9.</td>
</tr>
</tbody>
</table>
5.0 Technical Support

MarkLogic provides technical support according to the terms detailed in your Software License Agreement or End User License Agreement.

We invite you to visit our support website at http://help.marklogic.com to access information on known and fixed issues, knowledge base articles, and more. For licensed customers with an active maintenance contract, see the Support Handbook for instructions on registering support contacts and on working with the MarkLogic Technical Support team.

Complete product documentation, the latest product release downloads, and other useful information is available for all developers at http://developer.marklogic.com. For general questions, join the general discussion mailing list, open to all MarkLogic developers.
6.0 Copyright

MarkLogic Server 8.0 and supporting products.
Last updated: May 28, 2015

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