Administration Guide Volume 1

SAP Replication Server® 15.7.1 SP200

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Contents

Conventions

These style and syntax conventions are used in SAP® documentation.

Style conventions

Key	Definition
`monospaced(fixed-width)`	• SQL and program code • Commands to be entered exactly as shown • File names • Directory names
`italic monospaced`	In SQL or program code snippets, placeholders for user-specified values (see example below).
italic	• File and variable names • Cross-references to other topics or documents • In text, placeholders for user-specified values (see example below) • Glossary terms in text
bold san serif	• Command, function, stored procedure, utility, class, and method names • Glossary entries (in the Glossary) • Menu option paths • In numbered task or procedure steps, user-interface (UI) elements that you click, such as buttons, check boxes, icons, and so on

If necessary, an explanation for a placeholder (system- or setup-specific values) follows in text. For example:

Run:

```
installation directory\start.bat
```

where *installation directory* is where the application is installed.

Syntax conventions

Key	Definition
{ }	Curly braces indicate that you must choose at least one of the enclosed options. Do not type the braces when you enter the command.
[ ]	Brackets mean that choosing one or more of the enclosed options is optional. Do not type the brackets when you enter the command.
( )	Parentheses are to be typed as part of the command.
|	The vertical bar means you can select only one of the options shown.
,	The comma means you can choose as many of the options shown as you like, separating your choices with commas that you type as part of the command.
...	An ellipsis (three dots) means you may repeat the last unit as many times as you need. Do not include ellipses in the command.

Case-sensitivity

- All command syntax and command examples are shown in lowercase. However, replication command names are not case-sensitive. For example, **RA_CONFIG**, **Ra_Config**, and **ra_config** are equivalent.
- Names of configuration parameters are case-sensitive. For example, **Scan_Sleep_Max** is not the same as **scan_sleep_max**, and the former would be interpreted as an invalid parameter name.
- Database object names are not case-sensitive in replication commands. However, to use a mixed-case object name in a replication command (to match a mixed-case object name in the primary database), delimit the object name with quote characters. For example: **pdb_get_tables** "*TableName*"
- Identifiers and character data may be case-sensitive, depending on the sort order that is in effect.
  - If you are using a case-sensitive sort order, such as “binary,” you must enter identifiers and character data with the correct combination of uppercase and lowercase letters.
  - If you are using a sort order that is not case-sensitive, such as “nocase,” you can enter identifiers and character data with any combination of uppercase or lowercase letters.

Terminology

SAP® Replication Server® works with various components to enable replication between supported database such as, SAP® Adaptive Server® Enterprise (SAP® ASE), SAP HANA® database, SAP® IQ, Oracle, IBM DB2 UDB, and Microsoft SQL Server. SAP Replication Server uses SAP ASE for its Replication Server System Database (RSSD) or it uses SAP® SQL Anywhere® for its embedded Replication Server System Database (ERSSD).

Replication Agent™ is a generic term used to describe the Replication Agents for SAP ASE, SAP HANA database, Oracle, IBM DB2 UDB, and Microsoft SQL Server. The specific names are:

- RepAgent – Replication Agent thread for SAP ASE
- Replication Agent for Oracle
- Replication Agent for Microsoft SQL Server
- Replication Agent for UDB – for IBM DB2 on Linux, Unix, and Windows
- Replication Agent for DB2 for z/OS

Introduction to SAP Replication Server

SAP® Replication Server® replicates data in a distributed database system. Learn the benefits and features of SAP Replication Server, methods and concepts for replicating data, as well as defining user roles in maintaining a replication system.

About Replication Server

Replication Server maintains replicated data in multiple databases while ensuring the integrity and consistency of the data. It provides clients using databases in the replication system with local data access, thereby reducing load on the network and centralized computer systems.

Replication Command Language
The Replication Command Language (RCL) enables you to customize replication functions and to monitor and maintain the replication system. For example, you can request subsets of data for replication at the table, data row, or column level. This feature further reduces overhead by allowing you to replicate only the data that is needed at the replicate site.

Heterogeneous Data Servers
Replication Server supports heterogeneous data servers. You can build a replication system from existing databases and applications without having to convert them. As your enterprise grows and changes, you can add data servers to your replication system to meet your needs.

Replication Model
Replication Server uses a basic publish-and-subscribe model for replicating data across networks. Users “publish” data that is available in a primary database, and other users “subscribe” to the data for delivery in a replicate database. Users can replicate both changes to the data (update/insert/delete operations) and stored procedures using this method.

Instructions to publish and subscribe to data are given at Replication Servers that control, or have a connection to, each database. The user creates a replication definition at a primary Replication Server, which controls the primary database containing the data to be published. The replication definition specifies information such as which columns are to be replicated, or in the case of a database replication definition, of the database objects to be replicated. The user creates a subscription at a replicate Replication Server, which controls the replicate database that will receive the information.

Replication Server Routes
Replication Servers communicate with each other through user-defined routes. Most commonly, a primary Replication Server sends data to a replicate Replication Server through one or more routes set up to transmit data from the primary database to the replicate database.

Users may also transmit stored procedures from the replicate to the primary to request updates of the primary data; in this case, data flows through one or more routes from the replicate Replication Server to the primary Replication Server.

Connections and routes define the structure of the replication system. They allow Replication Servers to send messages to each other and to send commands to databases. A connection transfers messages from a Replication Server to a database. A route transfers requests from a source Replication Server to a destination Replication Server.

Asynchronous Transaction Replication

Replication occurs asynchronously—that is, updates to data at the primary are transferred to replicate databases in transactions separate from the update itself.

While asynchronous replication provides important advantages, system designers should remain aware of the latency between initial and replicated updates.

Advantages of Replicating Local Data

Replicating tables on local data servers provides clients with local access to enterprise data, which results in improved performance and greater data availability.

Improved Performance

In a typical Replication Server system, data requests are completed on the local data server without accessing the WAN. Local clients gain improved performance because:

- Data transfer rates are faster on a LAN than they are on a WAN.
- Local access remains unaffected by network traffic over the WAN. Local clients that share local data server resources do not compete with the enterprise-wide user community for central resources.

Greater Data Availability

Because data is replicated at local and remote databases in a Replication Server system, clients can operate in a fault-tolerant environment so that:

- When a failure occurs at a remote database, clients can use local copies of replicated data.
- When a WAN failure occurs, clients can use local copies of replicated data.
- When the local data server fails, clients can use replicated data at another site.

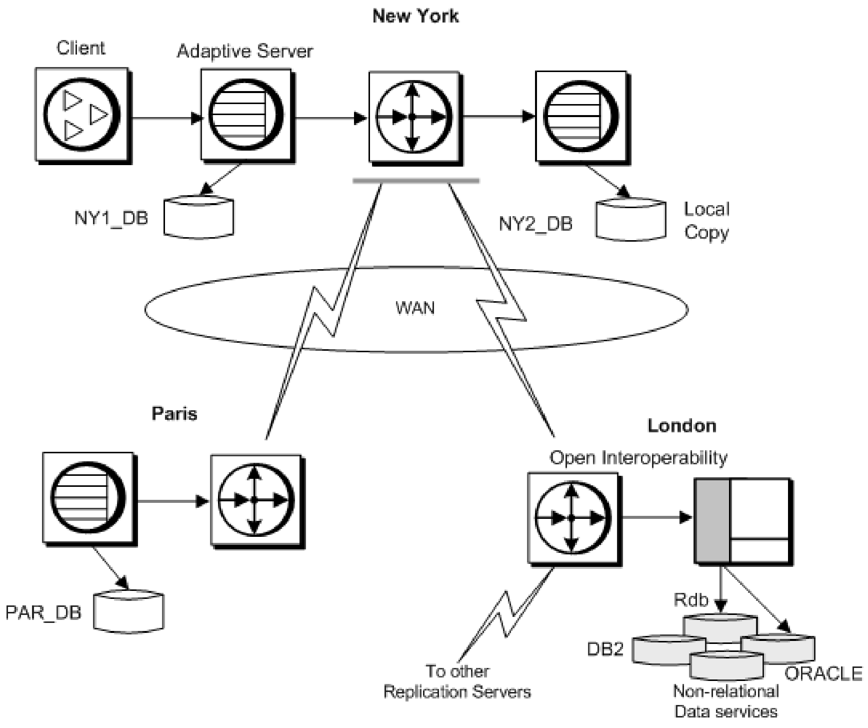
Network failure or database failure at other locations do not halt work at the local database. When WAN communications fail, Replication Server stores operations on replicated tables in *stable queues* (disk storage). The replicated tables at the unavailable databases are updated when communications resume. If a local data server fails, clients can continue working by temporarily accessing a replicate copy of the data.

Replication Server and Distributed Database Systems

Distributed database systems allow client applications to access data on multiple database servers throughout an enterprise—even geographically dispersed enterprises.

Replication Server ensures that data on replicate databases stays updated while off-loading processing responsibilities from the source database. As this figure illustrates, these enterprises may consist of many LANs and one or more WANs.

Figure 1: Replication System in a Distributed Environment



Replication Server minimizes performance and data-availability problems typically associated with remote access in distributed systems. Since Replication Server provides multiple copies of data, clients can rely on their own local data instead of remote, centralized databases. In addition, you can copy only the data you want to destination databases. Replication Server allows you to create a replication definition that identifies all or part of a table to replicate. You can then subscribe to only the rows you want. You can create a database replication definition that identifies the database objects—tables, functions, system procedures, transactions, and data definition language (DDL)—to replicate. You can also create a replication definition of a stored procedure—called a function replication definition

—to facilitate rapid replication of large amounts of data and to replicate updates from replicate databases back to the primary database. If your application requires it, you can consolidate or "roll up" replicated data from primary tables into a centralized database.

You can group replication definitions, both table replication definitions and functions replication definitions, in a publication and subscribe to them all at once. Publications allow you to organize subscriptions and then monitor them with a single command.

A Replication Agent—RepAgent for sites running Adaptive Server—transfers transaction information from a database to a Replication Server for distribution to replicate databases. SAP also offers Replication Agent for Microsoft SQL Server, DB2, and Oracle. RepAgent is an Adaptive Server thread; all other Replication Agents are separate processes.

Several models for replicating data in distributed systems exist in Replication Server. Consult the *Replication Server Design Guide* to help you determine which model best suits your application. The model that you choose determines how you set up your system.

Setting up a replication system based on your distribution model involves:

- Creating tables to store primary and replicate data
- Setting up routes and connections between Replication Servers and establishing permissions that control access to primary data
- Creating replication definitions that identify the data you want replicated
- Creating subscriptions from replicate databases to those replication definitions

See also

- *SAP Replication Server Technical Overview* on page 23
- *Manage a Replication System* on page 59

Replication Server Basic Primary Copy Model

The basic primary copy model is the simplest approach Replication Server uses to copy data to distribute updates from one source (primary) database to one or more destination (replicate) databases.

To ensure consistency, a source table is designated as the primary table. All other versions of the table are replicates. In this approach, replicate tables are read-only and used for operations that do not modify the data.

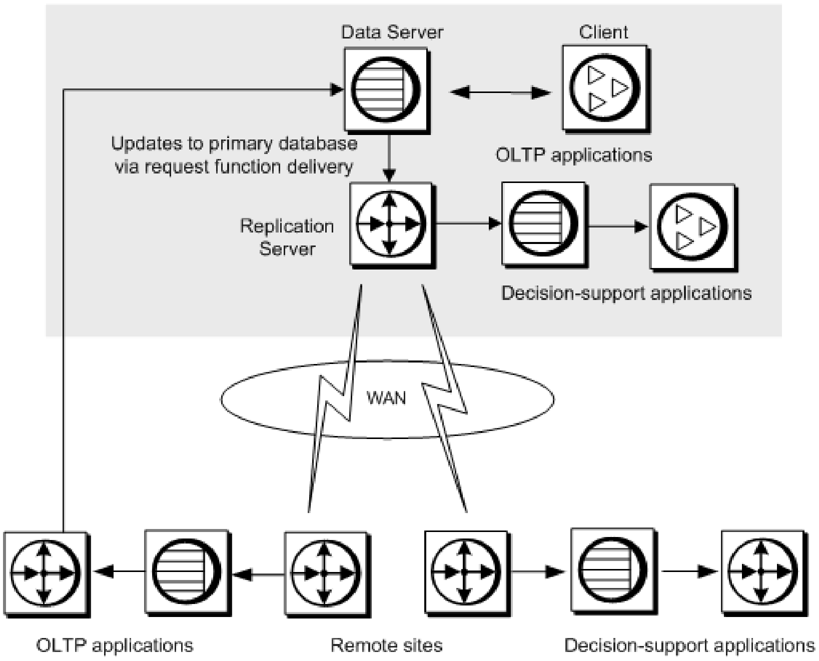
As updates occur at the primary table, Replication Server captures the updates and sends them to replicate data servers. In this model, clients at remote sites can also update primary data, either directly by accessing the primary database over the network or indirectly through replicated stored procedures.

If communication between the primary and destination databases fails, operations executed in the primary database are stored in Replication Server stable queues until they can be delivered to replicate sites. Likewise, operations executed remotely are held in stable queues until they can be delivered to the primary database.

This arrangement lets remote client applications take advantage of Replication Server fault tolerance while preserving the basic primary copy model.

This figure illustrates Replication Server configurations using the primary copy method of replicating data.

Figure 2: Replication Server Basic Primary Copy Model


Data Server
Client
Updates to primary database via request function delivery
OLTP applications
Replication Server
Decision-support applications
WAN
OLTP applications
Remote sites
Decision-support applications

See also

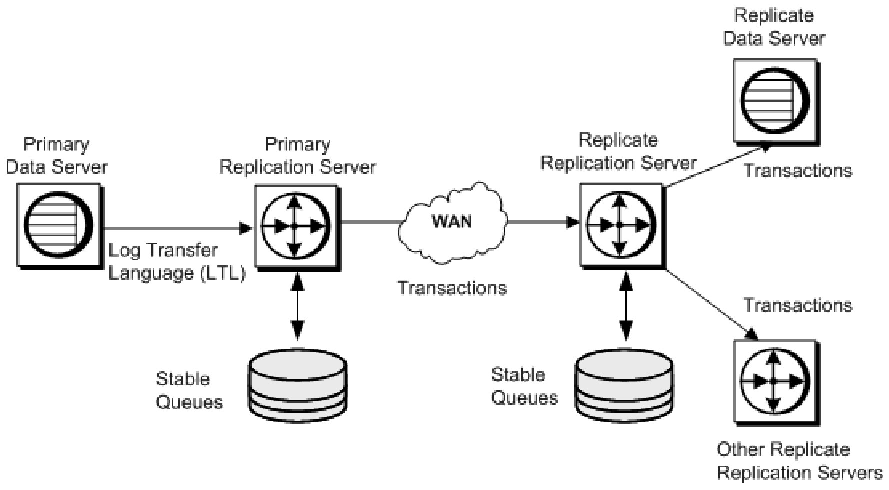
- *Specify Data for Replication* on page 30
- *Manage Replicated Functions* on page 355
- *Transaction Handling with Replication Server* on page 48

Replication System Processing

A typical replication system is based on the basic primary copy model, in which a primary Replication Server and a data server are separated across a WAN from replicate Replication Servers.

Note: This example does not cover the case where primary data is updated at the replicate database.

Figure 3: Replication System Overview


Replicate Data Server
Primary Data Server
Primary Replication Server
Replicate Replication Server
Transactions
WAN
Log Transfer Language (LTL)
Transactions
Transactions
Stable Queues
Stable Queues
Other Replicate Replication Servers

This Replication System Overview diagram illustrates how data is replicated from a primary database to replicate databases. The following actions take place:

1. RepAgent reads the primary database log and converts transactions for tables or stored procedures that are marked for replication into commands that are sent to Replication Server.The Replication Server stores the transactions in a stable queue using distributed concurrency control.
2. The primary Replication Server:
   a. Determines which Replication Servers manage replicate databases with subscriptions for the data

      The primary Replication Server may have a direct route to a subscribing Replication Server or an indirect route, with one or more intermediate Replication Servers in between.
   b. Forwards the transaction to the appropriate replicate Replication Server, where it is stored in a stable queue
   c. Applies the transaction to any local replicate database for which there is a subscription for the data
3. The replicate Replication Server performs one or both of the following actions:
   - Routes the transaction to another Replication Server
   - Applies the transaction to replicate databases that it manages

See also

- *Distributed Concurrency Control* on page 55

Set Up a Primary Copy Model System

You need to create and configure several replication system components to set up a replication system according to the basic primary copy model.

- Set up routes and connections between Replication Servers.
- Create the table in the primary and replicate databases. The table should have the same structure in each database.
- Create indexes and grant appropriate permissions on the tables.
- Allow replication on the tables using the **sp_setreptable** system procedure.
- Create a replication definition for the table at the primary site.
- At each site, create a subscription for the table replication definition at the primary site.

See also

- *Manage Routes* on page 141
- *Manage Database Connections* on page 165
- *Manage Replication Server Security* on page 207
- *Manage Replicated Tables* on page 279
- *Manage Subscriptions* on page 373

Other Distributed Data Models

Besides the basic primary copy model, Replication Server also lets you design your system based on other distributed data models.

Other distributed data models include:

- Distributed primary fragments
- Corporate rollup
- Redistributed corporate rollup

For complete information about these distributed data models, see *Replication Server Design Guide > Implementation Strategies*.

Warm standby applications represent another type of application model. See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications*.

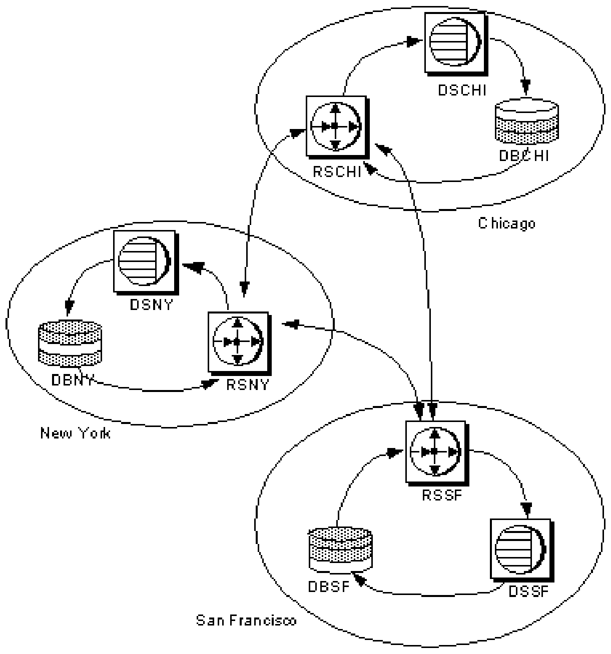
Distributed Primary Fragments

Applications that use the distributed primary fragments model include distributed tables that contain both primary and replicated data.

The Replication Server at each site distributes modifications made to local primary data to other sites and applies modifications received from other sites to the data that is replicated locally.

This figure shows the flow of data for distributed primary fragments.

Figure 4: Distributed Primary Fragments Model



The tasks needed to set up a distributed primary fragment system are similar to those for creating a basic primary copy system, with the following exceptions and additions:

- Your application should avoid or handle cases where multiple sites update the same data at the same time. SAP recommends that each fragment have a single “owner” site.
- Databases can be both primary and replicate. Make sure that tables with the same structure exist at both primary and replicate sites.
- Create routes from each primary site to all sites that subscribe to its data.
- Create a replication definition at any site where there is primary data, even if it is a “remote” site.
- Create subscriptions at each site for the replication definitions at the other sites. If *n* is the number of sites, create *n*-1 subscriptions for each replication definition.

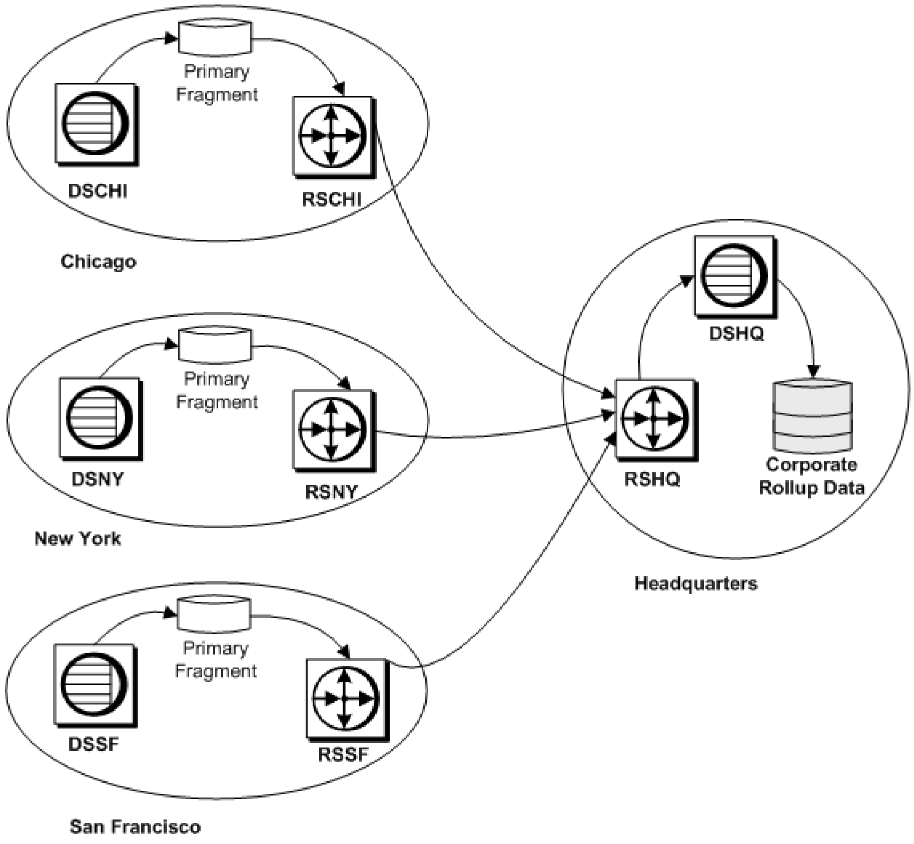
Corporate Rollup

The corporate rollup model has distributed primary fragments and a single, centralized consolidated replicate table.

The table at each primary site contains only the data that is primary at that site. No data is replicated to these sites. The corporate rollup table is a “roll-up” of the data at the primary sites.

This figure illustrates the flow of data for a corporate rollup application model:

Figure 5: Distributed Primary Fragments with Corporate Rollup



The corporate rollup model requires distinct replication definitions at each primary site. The site where the data is consolidated subscribes to the replication definition at each primary site.

Creating a Corporate Rollup Application

You can create a corporate rollup application from distributed primary fragments.

1. Activate a Replication Agent at each primary site. However, you do not need to activate a Replication Agent at the central site, since data is not replicated from that site.
2. Create tables in each primary database and in the database at the central site.
3. Allow for replication on tables at each remote database where primary data is stored.
4. Create replication definitions for tables at each remote site where primary data is stored.
5. At the headquarters site, where the data is to be consolidated, create subscriptions for the replication definitions at the remote sites.

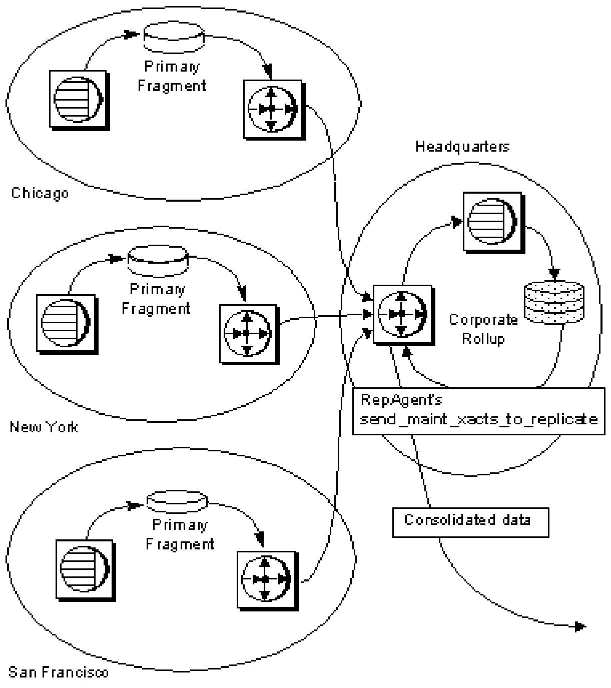
Redistributed Corporate Rollup

The redistributed corporate rollup model is similar to the corporate rollup model.

Primary fragments distributed at remote sites are rolled up into a consolidated table at a central site. At the site where the fragments are consolidated, however, a Replication Agent processes the consolidated table as if it were primary data. The data is then forwarded to Replication Server for distribution to subscribers.

This figure illustrates the flow of data in an application based on the redistributed corporate rollup model:

Figure 6: Distributed Fragments with Redistributed Corporate Rollup



The consolidated table is described with a replication definition. Other sites can then subscribe to this table. Do not allow applications to update the corporate rollup table directly. All updates should originate from the primary sites.

The tasks associated with creating a redistributed corporate rollup replication system are identical to the corporate rollup model, except that:

- A Replication Agent must be activated at the headquarters site for the consolidated database so that all updates are submitted to the Replication Server as if they were made by a client application.

  RepAgent must be configured with its **send_maint_xacts_to_replicate** option set to **true**. Otherwise, the Replication Agent filters will not redistribute replicated data as primary data.
- A Replication Agent is required for the headquarters Replication Server, since data will be redistributed from that site.
- At the headquarters site a replication definition must be created for each table. Other sites can create subscriptions to this replication definition, but the primary sites cannot subscribe to their own primary data.
- The headquarters Replication Server must have routes to the other sites that create subscriptions for the consolidated replicate table. If the primary sites create subscriptions, routes must be created to them from headquarters.
- Do not allow rollup sites to re-create subscriptions to their primary data. If they do, transactions could loop endlessly through the system.

See also

- *Manage a Replication System* on page 59

SAP Replication Server and Non-SAP ASE Data Servers

SAP Replication Server supports non-SAP ASE data servers through an open interface. You can use any data-storage system as a data server if it supports a set of required basic data operations and transaction-processing directives.

SAP provides:

- ExpressConnect for SAP HANA® database – to connect SAP Replication Server with SAP HANA® databases
- ExpressConnect for Oracle – to connect SAP Replication Server with Oracle data servers
- Enterprise Connect™ Data Access (ECDA) – to connect SAP Replication Server with other supported non-SAP ASE data servers

If a data server does not support SAP® Open Server™, and Open Client™ you can create an SAP Open Server gateway to allow SAP Replication Server to access the data server.

For detailed information about using SAP Replication Server with databases from different vendors, see the *Heterogeneous Replication Guide*.

Other open architecture components include:

- Replication Agents

  A Replication Agent detects modifications made to primary data and submits them to SAP Replication Server for distribution to other databases.

  The RepAgent thread in SAP ASE is the Replication Agent for SAP ASE databases.

  If you use non-SAP ASE data servers, you must provide a replication agent for them. Replication Agents for Microsoft SQL Server, IBM DB2 UDB, and Oracle databases are available from SAP. For details, see the *Design Guide* and documentation for Replication Agent.

- Error classes and error processing actions

  Error classes allow you to tailor your system to handle database errors for a type of data server. You can specify error actions in response to errors that a data server returns to SAP Replication Server. SAP Replication Server provides a default error class for SAP ASE. SAP Replication Server 15.2 and later provides default error classes for SAP HANA database, Oracle, Microsoft SQL Server, and IBM DB2 UDB databases. See *Handle Errors and Exceptions* in the *Administration Guide Volume 2*.
- Functions, function strings, and function-string classes

  SAP Replication Server uses function strings to format replicated operations correctly for a type of destination database. To aid replication system administrators, SAP Replication Server groups all the function strings for a particular type of database into a function-string class.

  SAP Replication Server provides default function-string classes for SAP ASE and provides connection profiles that install function-string classes for SAP HANA database, Oracle, Microsoft SQL Server, and IBM DB2 UDB databases. You can customize function strings to execute commands appropriate for your database and application. See *Customize Database Operations* in the *Administration Guide Volume 2* for details.

Warm Standby Applications

Use Warm standby applications to maintain a set of databases, one or more of which functions as standby copies of an active database.

As clients update the active database, Replication Server copies transactions to the standby databases, maintaining consistency between them. Should the active database fail for any reason, you can switch to a standby database, making it the active database, and resume operations with little interruption.

Replication Server provides two methods for setting up a warm standby application. In both methods, the active and standby databases must be Adaptive Server or Oracle databases. They can act as either a primary or replicate database with respect to other databases in the system.

- One method uses the multisite availability (MSA) feature to set up an active and one or more standby databases.
- The second method lets you set up an active and a single standby database, both of which must be managed by the same Replication Server. This warm standby application is considered a single logical unit in a Replication Server system.

  See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications* to set up warm standby applications for Adaptive Server databases.

  See *Replication Server Heterogeneous Replication Guide > Heterogeneous Warm Standby for Oracle* to set up warm standby applications for Oracle databases.

See also

- *Manage Replicated Objects Using Multisite Availability* on page 425

Mixed-Version Replication Systems

A replication system can include Replication Servers or Adaptive Servers of different versions. Each system presents different issues.

- If a replication system domain has Replication Server 15.5 and later, then the system version, and all site and route versions in the replication system domain, must be version 12.6 and later.

  You must upgrade Replication Server to version 12.6 or later, set site version to 12.6 or later, and upgrade routes to 12.6 or later, before you can upgrade to version 15.5 or later. See *Replication Server Configuration Guide > Upgrade or Downgrade Replication Server*.
- When all Replication Servers are at least version 12.6 and the system version is set to 12.6, each Replication Server uses features according to its *site version*. For example, Replication Servers running version 15.5 can use all 15.5 features among themselves, while Replication Servers running 15.0 can only use 15.0 features. Such a system is called a *mixed-version system*; each Replication Server can use all of its features.

Restrictions in Mixed-Version Systems

Interaction between Replication Servers of different versions is restricted to the capabilities of the oldest version.

Information associated with new features may not be available to Replication Servers of earlier versions. See the documentation for each feature introduced in a new version, such as function-string inheritance or multiple replication definitions, for additional information about usage restrictions in mixed-version environments.

Refer to the installation and configuration guides and the release bulletin for your platform for more information about mixed-version systems and about setting the site version and system version.

Mixed Versions of SAP ASE

You can use SAP Replication Server version 15.0 or later with different versions of SAP ASE.

Although you can use data sources and destinations other than SAP ASE, SAP Replication Server requires SAP ASE for warm standby databases and either SAP ASE or SAP® SQL Anywhere® for Replication Server System Databases (RSSD).

Note: SAP does not support replication of SAP ASE system databases, such as `tempdb`, `model`, `sybsystemprocs`, `sybsecurity`, and `sybsystemdb`. The replication of the SAP ASE system database master is supported only if the SAP ASE supports master database replication.

Some capabilities of SAP Replication Server version 15.0.1 require you to use an SAP ASE version 15.0.1 or later.

Some capabilities of SAP Replication Server version 15.2 require you to use an SAP ASE version 15.0.3 or later. For example, the SQL statement replication feature in SAP Replication Server version 15.2 requires SAP ASE version 15.0.3 or later.

See the installation and configuration guides and the release bulletin for your platform for more information about using SAP ASE with SAP Replication Server.

Replication System Security

Replication Server provides careful management of the login names, passwords, and permissions that are essential for system security. In addition, Replication Server supports third-party security mechanisms that safeguard data transmission across the network.

See also

- *Manage Replication Server Security* on page 207

Replication Server Security Features

Replication Server enforces security using several features.

Replication Server enforces security using login names, encryption, and permissions.

- Replication Server login names

  Each Replication Server has its own set of login names, which are distinct from data server login names. This distinction gives the replication system administrator control over replicated data and other aspects of the replication system.
- Data server login names

  Data server login names are used with client applications to connect to data servers. Clients are generally given permission to update primary data. On replicate tables, however, clients are generally granted permission to select or view data, but are prohibited from making changes to data. These permissions are controlled in the data server, according to the application.
- Data server maintenance user login names

  Replication Server uses a special data server *maintenance user* login name for each local data server database that contains replicate tables. This allows Replication Server to maintain and update the replicate tables in the database.
- Password encryption

  You can encrypt passwords in sensitive areas of the replication system.
- Permission system

  Replication Server permissions are assigned to and cancelled from Replication Server login names using the **grant** and **revoke** commands.

See also

- *Replication Server Roles and Responsibilities* on page 19

Network-based Security Features

Replication Server supports third-party, network-based security mechanisms.

Third-party network-based security mechanisms can:

- Establish unified logins to servers on the network.

  The security mechanism authenticates users at login. Each authenticated user is given a security credential that can be presented to remote servers as needed. As a result, users can seamlessly access different servers using a single login.
- Ensure secure data transmission across the network

  A choice of different data protection services can:
  - Encrypt and decrypt data transmissions
  - Verify that a transmission has not been tampered with
  - Verify the origin of each transmission
  - Verify that a transmission has not been captured and re-sent
  - Verify that transmissions are received in the order sent

See also

- *Manage Network-based Security* on page 237

Replication Server Roles and Responsibilities

Administering the replication system is primarily the role of the replication system administrator. The database administrator plays a subsidiary role by supporting some Replication Server administration tasks. At some sites, role distinctions may not be clear-cut and some responsibilities can overlap.

Replication System Administrator

The replication system administrator installs, configures, and administers the replication system.

On a WAN, this role may be performed by different people at different locations. If this is the case, various tasks for administering Replication Server may require coordination between replication system administrators.

The replication system administrator has **sa** user permissions, which provide that person with the ability to execute nearly all commands in the replication system. In managing the system, the replication system administrator may need to coordinate with database administrators for both local and remote databases.

Database Administrator

The database administrator has two responsibilities.

The database administrator is responsible for:

- Administering local data servers, including login names and permissions.
- Managing data in a distributed database system. Various tasks may require coordination between database administrators for different databases.

Replication Server Tasks and Responsibilities

Use the Replication Server Tasks and Responsibilities table to assign tasks and roles to maintain the replication system.

Table 1. Replication Server Tasks and Responsibilities

Task	References	Roles
Installing Replication Server and initial configuration.	Installation and configuration guides	replication system administrator (RSA), database administrator (DBA)
Starting up and shutting down Replication Server.	*Manage a Replication System* on page 59	RSA
Quiescing Replication Server.	*Manage a Replication System* on page 59	RSA, DBA
Adding login names, database users, and administering appropriate permissions.	*Manage Replication Server Security* on page 207	RSA, DBA
Monitoring Replication Server.	*Manage a Replication System* on page 59	RSA
Configuring Replication Server.	*Manage a Replication System* on page 59	RSA

Task	References	Roles
Adding replicated tables and stored procedures or changing table schemas. • Creating and modifying replicated tables and stored procedures. • Creating and modifying table and function replication definitions. • Creating and materializing subscriptions at replicate sites.	• *Manage Replicated Tables* on page 279 • *Manage Replicated Functions* on page 355 • *Manage Subscriptions* on page 373	RSA, DBA
Defining data server function-string classes and function strings.	*Replication Server Administration Guide Volume 2 > Customize Database Operations*	RSA, DBA
Maintaining routes. • Creating and modifying routes.	*Manage Routes* on page 141	RSA
Maintaining and monitoring database connections. • Suspending and resuming connections.	*Manage Database Connections* on page 165	RSA
Creating a warm standby application.	*Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications*	RSA, DBA
Localizing Replication Server.	*Replication Server Design Guide*	RSA
Adding a primary or replicate database connection.	*Manage Database Connections* on page 165	RSA, DBA
Adding or removing a Replication Server.	*Manage a Replication System* on page 59	RSA
Processing rejected transactions.	*Replication Server Administration Guide Volume 2 > Handle Errors and Exceptions*.	RSA, DBA

Task	References	Roles
Administering local data server. • Suspending or resuming data server.	Adaptive Server or local server documentation.	DBA
Managing the RSSD.	*Manage a Replication System* on page 59	RSA, DBA
Managing Embedded Replication Server System Database (ERSSD).	*Manage a Replication System* on page 59	RSA, DBA
Creating, deleting, and modifying databases for replication.	Adaptive Server or local server documentation.	DBA
Setting up database user login names and passwords.	Adaptive Server or local server documentation.	DBA
Performing regular backups.	*Replication Server Administration Guide Volume 2 > Verify and Monitor Replication Server*.	DBA
Applying database recovery procedures.	*Replication Server Administration Guide Volume 2 > Replication System Recovery*	RSA, DBA
Reconciling database inconsistencies.	*Manage Subscriptions* on page 373	RSA, DBA
Auditing user actions performed on Replication Server.	*Command Auditing* on page 275	RSA

SAP Replication Server Technical Overview

Acquire a technical overview of SAP Replication Server and the replication system.

Learn about:

- Components of a distributed database system based on SAP Replication Server
- Movement of transactions from a primary database to a replicate database.
- Aspects of SAP Replication Server that play a role in receiving and distributing data at primary and replicate sites.
- Diagnosing and troubleshooting replication system problems.

Replication System Components

A replication environment consists of components and resources that must be present or assembled before you can run Replication Server.

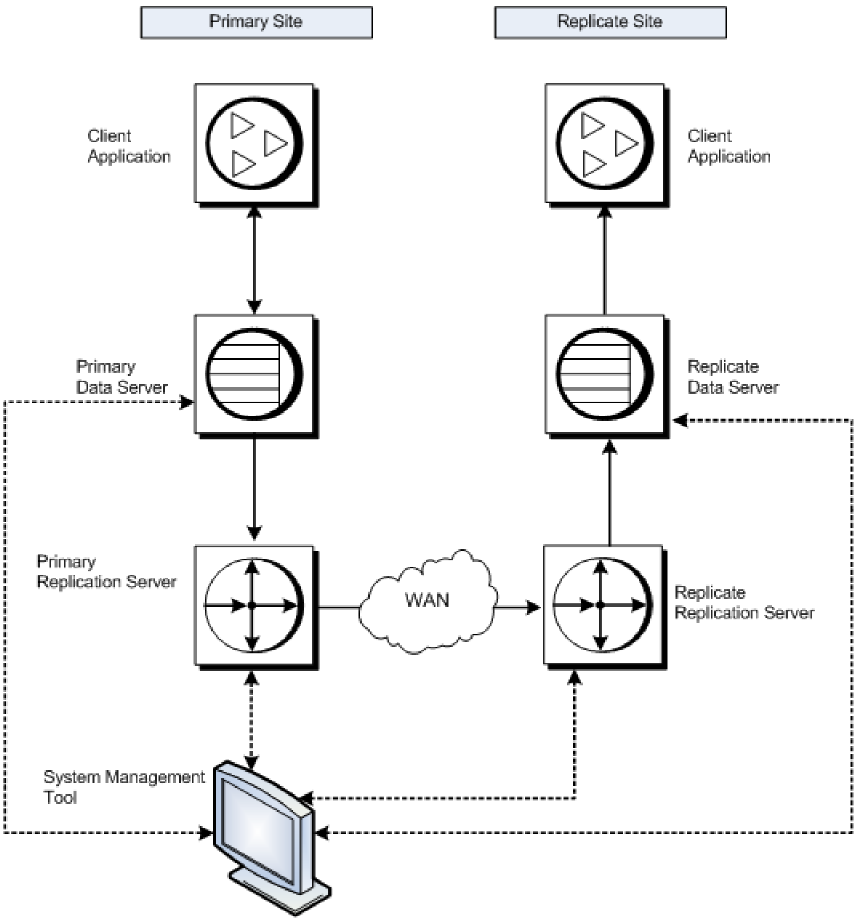
Components in a Replication Server environment can include:

- SAP Replication Server
- Data servers such as SAP ASE
- SAP Replication Server System Database (RSSD)
- Replication Agent, ExpressConnect for SAP HANA® database, ExpressConnect for Oracle, and ECDA
- Client applications
- System management tools such as SAP® Control Center

Each component uses the Open Client/Server™ Interface to communicate with other components.

This SAP Replication Server Domain diagram illustrates a simple configuration for a WAN-based distributed database system based on SAP Replication Server.

Figure 7: SAP Replication Server Domain



Replication Server

The Replication Server at each primary or replicate site coordinates data replication activities for local data servers and exchanges data with Replication Servers at other sites.

Replication Server provides guaranteed delivery of transactions to each replicate site by:

- Receiving transactions from primary databases through a Replication Agent and distributing them to replicate database sites that have subscriptions for the data
- Receiving transactions from other Replication Servers and applying them to local replicate databases or forwarding them to other replication servers that have subscriptions for the data
- Receiving requests for data updates from a replicate database and applies them to a primary database

The information needed to accomplish these tasks is stored in Replication Server system tables that are stored in the Replication Server System Database.

See *Replication Server Administration Guide Volume 2 > Performance Tuning > Replication Server Internal Processing* for more information about the internal elements of the Replication Server.

See also

- *Replication Server System Database (RSSD)* on page 26

ID Server

The ID Server is a Replication Server that registers all Replication Servers and databases in the replication system.

In addition to the usual Replication Server tasks, the Replication Server acting as the ID Server assigns a unique ID number to every Replication Server and database in the replication system. The ID Server also maintains version information for the replication system. Otherwise, the ID Server is like any other Replication Server.

To allow a new Replication Server, or the Replication Server that manages the new database, to log in and retrieve an ID number, the ID Server must be running each time a:

- Replication Server is installed
- Route is created
- Database connection is created or dropped

Because of these requirements, the ID Server is the first Replication Server that you install and start when you install a replication system. If you have only one Replication Server, or if you are installing Replication Server for the first time, then that Replication Server is also the ID Server. If you are adding a Replication Server to an existing replication system, you must know the name of the Replication Server in the system that is the ID Server.

The ID Server must have a login name for Replication Servers to use when they connect to the ID Server. The login name is recorded in the configuration files of all Replication Servers in the replication system by the **rs_init** configuration program when you are setting up and managing the replication system.

Warning! The ID Server is critical to your replication environment, and is difficult to move once it has been installed. Once you have selected a name for the ID Server, you cannot change to a different Replication Server. SAP does not support any procedures that change the name of the ID Server in the configuration files.

See also

- *Manage a Replication System* on page 59

Replication System Domain

Replication system domain refers to all replication system components that use the same ID Server.

Some organizations have multiple independent replication systems. Since the ID Server determines member Replication Servers and databases in a replication system, one replication system in an organization with multiple replication systems is also called an ID Server domain.

No special steps are required to set up multiple ID Server domains. Every Replication Server or database belongs to one replication system and has a unique ID number in that ID Server domain.

You can set up multiple replication system domains, with the following restrictions:

- Replication Servers in different domains cannot exchange data. Each domain must be treated as a separate replication system with no cross-communication between them. You cannot create a route between Replication Servers in different domains.
- A database can be managed by only one Replication Server in one domain. Any given database is in one, and only one, ID Server's domain. This means that you cannot create multiple connections to the same database from different domains.

See also

- *Add a Replication System Domain* on page 66

Replication Server System Database (RSSD)

The Replication Server System Database (RSSD) is a database that contains the Replication Server system tables.

Each Replication Server requires an RSSD or an Embedded Replication Server System Database (ERSSD) to hold the system tables for one Replication Server. The RSSD is managed by the Adaptive Server. The ERSSD is managed by SQL Anywhere®.

System Tables

Replication Server system tables hold information that Replication Server requires to send and receive replicated data.

System tables hold information such a:

- Descriptions of replicated data and related information
- Descriptions of replication objects, such as replication definitions and subscriptions
- Security records for Replication Server users
- Routing information for other Replication Server sites
- Access methods for the local databases
- Other administrative information

The Replication Server system tables are loaded into the RSSD during Replication Server installation.

See *Replication Server Reference Manual > Replication Server System Tables* for a comprehensive list of system tables.

System table contents are modified during Replication Server activities such as the execution of RCL commands. Only the replication system administrator, or members of the **rs_systabgroup** group, can alter the system tables.

To query the system tables and find status information:

- Use Replication Server system information or system administration commands. See *Replication Server Reference Manual > Introduction to the Replication Command Language > System Information Commands* and *Replication Server Reference Manual > Introduction to the Replication Command Language > System Administration Commands*.
- Use Adaptive Server stored procedures to display information about the replication system. See *Replication Server Reference Manual > Adaptive Server Commands and System Procedures*.

Warning! RSSD tables are for internal use by Replication Server only. You should never modify RSSD tables directly unless directed by SAP Technical Support.

RSSD and Replication Agent Specifications

A Replication Agent is needed for the RSSD if the Replication Server is the source for any route.

If Replication Server is the source for any route, Replication Server distributes some of the information in its RSSD to other Replication Servers.

The RSSD is dedicated to the Replication Server that it supports; do not use it to store user data. However, a single data server may contain the RSSD and user databases. The database device space for the RSSD must be at least 20MB (10MB for data and 10MB for the log). It is best to put the database and the database log on separate devices.

See also

- *Manage Routes* on page 141

Adaptive Server or Other Data Server

Adaptive Server or other data servers in a replication system, manage databases containing either primary or replicate data.

Client applications use Adaptive Server to store and retrieve data and to process transactions and queries.

Each Replication Server requires an Adaptive Server database for its Replication Server System Database (RSSD) or an SQL Anywhere database for its Embedded Replication Server System Database (ERSSD), which contains the Replication Server system tables.

Replication Server also supports non-ASE data servers through an open interface. You can use any system for storing data if it supports a set of required basic data operations and transaction processing directives. For data servers that contain primary databases, you must use a compatible Replication Agent program.

Actively supported data servers are data servers for which SAP provides all the required software, documentation, and support for the data servers to serve as both a primary or a replicate data server.

See the *Replication Agent Release Bulletin* for the list of actively supported non-ASE data servers and see the *Replication Server Heterogeneous Replication Guide* for details on heterogeneous data server support.

Replication Agent

A Replication Agent notifies Replication Server of actions in a primary database that must be copied to other databases.

The Replication Agent reads the database transaction log and transfers log records for replicated tables and stored procedures to the Replication Server managing the database, which distributes the modifications to databases that subscribe to the data.

A Replication Agent is needed for every database that contains primary data and for every database where stored procedures that need to be replicated are executed. A database that contains replicated data and no stored procedures marked for replication does not require a Replication Agent.

Replication Agents communicate with Replication Server by executing commands in Log Transfer Language (LTL).

See *Replication Server Design Guide > Introduction to Replication Agents* for more information about LTL commands.

Which Replication Agent for Your System?

The Replication Agent you use depends on the data servers in the replication system.

Supported Replication Agents are:

- RepAgent – for Adaptive Server data servers. RepAgent, a thread in Adaptive Server, is the Replication Agent described in the *Replication Server Administration Guide*.
- Replication Agents available for non-ASE data servers:
  - IBM DB2
  - IBM DB2 UDB
  - Microsoft SQL Server

- Oracle

ExpressConnect for HANA DB

ExpressConnect for HANA DB provides direct communication between Replication Server and a replicate HANA database.

ExpressConnect for HANA DB, which is available with Replication Server 15.7.1 SP100 and later, eliminates the need for installing and setting up a separate gateway server, thereby improving performance and reducing the complexities of managing a replication system.

See the *Replication Server Heterogeneous Replication Guide* and the Replication Server Options documentation.

ExpressConnect for Oracle

ExpressConnect for Oracle provides direct communication between Replication Server and a replicate Oracle data server.

ExpressConnect for Oracle which is available with Replication Server Options 15.5 and later, eliminates the need for installing and setting up a separate gateway server, thereby improving performance and reducing the complexities of managing a replication system.

See the *Replication Server Heterogeneous Replication Guide* and the Replication Server Options documentation.

Enterprise Connect Data Access

Enterprise Connect™ Data Access (ECDA) is an integrated set of software applications and connectivity tools that allows you to access data within a heterogeneous database environment.

ECDA gives you the ability to access a variety of LAN-based, non-SAP data sources, as well as mainframe data sources. It consists of components that provide transparent data access within an enterprise. You require a specific ECDA component for each actively supported non-SAP ASE database that does not already provide an SAP Open Server interface. This is required for replication to the non-SAP ASE database.

See the *Heterogeneous Replication Guide* and the Replication Server Options documentation.

Client Applications

A client application is a program that accesses a data server.

When the data server is Adaptive Server, applications can be programs created with Open Client Client-Library or DB-Library™, Embedded SQL™, or any other front-end development tool that is compatible with the Open Client/Server Interfaces™ (C/SI) such as SAP® PowerBuilder®. Open Client/Server includes routines and protocols for client/server communications.

In a simple replication system, clients update primary databases and Replication Server updates replicate databases. By replicating stored procedures, clients can update primary data from any replicate database.

System Management Tools

You can use system management tools such as SAP Control Center, to manage your replicaton system.

SAP Control Center for Replication

SAP® Control Center for Replication is a Web-based solution that monitors the status and availability of servers in a replication environment.

SAP Control Center for Replication allows you to monitor and manage large, complex, and geographically dispersed replication environments. It lets you search, sort, and filter servers and component objects to support a larger environment than what the current Replication Manager and Replication Monitoring Services can handle.

SAP Control Center for Replication provides status information at a glance, using server monitors and a heat chart for displaying the availability or status of a specific server. The server monitors display high-level information, such as server version and platform. The server monitors also display critical performance counters to aid you in troubleshooting replication performance.

To help you control the flow of data and configure replication parameters to improve server performance, SAP Control Center for Replication provides a quick administration tool that you can easily access through every replication monitor.

In addition to the monitors, SAP Control Center for Replication provides a topology view that graphically displays the servers, the connections between servers, data flow in the environment, and a replication path's sources and targets. Graphs and charts are also available for monitoring performance counters.

See *SAP Control Center > SAP Control Center for Replication*.

Specify Data for Replication

Replication Server lets you define the data and stored procedures that you want to replicate at remote databases, as well as letting you specify the destination databases themselves.

Replication Server uses the relational database model to represent data in tables that have a fixed number of columns and a varying number of rows. Each table you want to replicate must have one or more columns that can be used as a primary key to uniquely identify each row.

As part of design and planning, you designate source and destination databases for your replication system and create the routes that replicated data follows from one Replication Server to another.

In general, a source database contains primary data and may be called the primary database, while a destination database contains replicate data and may be called the replicate database. Depending on your implementation, the same database may contain both primary and replicate data. Transactions or stored procedure executions are replicated from primary to replicate databases. Stored procedure executions may also be replicated from replicate to primary databases.

See also

- *Replication Server Basic Primary Copy Model* on page 8

Replication Definitions and Subscriptions for Tables

You create one or more replication definitions to describe each primary (source) table.

A replication definition lists a table's columns and datatypes, the columns that make up the primary key, the columns that can be used in subscribing to the primary data, and specifies the location of the primary version of the table.

A replication definition may include additional settings to let you customize how you will use it. For example, you can create a replication definition just for replicating into a standby database in a warm standby application.

You then create subscriptions for transactions on the data defined in the replication definition. A subscription instructs Replication Server to copy transactions for all rows or for qualifying rows only. Copies of a table can be limited to only the rows or columns needed.

Typically, creating a subscription causes Replication Server to copy the initial requested data from the primary database to the replicate database. This process is called subscription materialization. Once the subscription is created and materialized, Replication Server begins distributing database operations for the primary data as they occur.

See also

- *Manage Replicated Tables* on page 279
- *Manage Subscriptions* on page 373

Replication Definitions for Database Objects

You can use multisite availability (MSA) to create a single database replication definition to describe the data to be sent to the replicate database.

The database replication definition describes the database objects that are to be replicated. You can choose to replicate, or not replicate, individual tables, transactions, functions, system stored procedures, and DDL.

You then create a single database subscription at each subscribing database for the data described in the database replication definition. Database subscriptions cannot limit the data copied.

MSA provides a simple replication methodology that requires only one replication definition for the primary database and only one subscription for each subscribing database. If you want to transform the data or if a table needs to have a different **replicate minimal columns** or dynamic SQL setting than the target connection, you must add table and function replication definitions.

See also

- *Manage Replicated Objects Using Multisite Availability* on page 425

Replication Definitions for Stored Procedures

A replication definition of a stored procedure is called a function replication definition.

For certain operations, replication of stored procedures may offer significant performance improvements over table replication. In addition, you can replicate stored procedures to update data from a replicate database to a primary database.

See also

- *Deferred Name Resolution* on page 107
- *Manage Replicated Functions* on page 355
- *Manage Subscriptions* on page 373

Benefits of Replicated Functions over Normal Replication

Learn the benefits of replicated functions.

Adaptive Server logs a record for each row modified by a Transact-SQL® command. When a single Transact-SQL command modifies multiple rows, Replication Server treats each log record received from the Replication Agent as a separate command in the transaction. For example, to replicate the results of a single **update** command that modifies 1000 rows in the primary database, Replication Server may execute 1000 **update** commands in each replicate database.

Commands that modify many rows can affect performance of replicate Adaptive Servers and the replication system. The volume of rows delivered through the replication system may use all available space in stable queues.

If an application updates multiple rows in a primary table, you can use replicated stored procedures to maintain data in destination databases. Because commands in stored procedures can modify multiple rows, using stored procedures allows you to update rows in replicate databases without passing images of the rows through the replication system. Only a single record reflecting stored-procedure execution and its parameters replicates through the system.

You can use SQL statement replication to improve the performance for a single Transact-SQL command which modifies multiple rows. See *Replication Server Administration Guide Volume 2 > Performance Tuning > SQL Statement Replication*.

In Replication Server, you can enable support for the Adaptive Server deferred name resolution feature.

See also
- *Manage Replicated Functions* on page 355
- *Manage Subscriptions* on page 373
- *Deferred Name Resolution* on page 107

Use Replicated Functions

A function replication definition describes a replicated stored procedure.

A function replication definition includes:

- The parameters and datatypes
- The location of the primary data that the stored procedure may modify
- Parameters that can be used in subscribing to stored-procedure executions
- The name of the stored procedure to execute at the destination database

There are two types of replicated function delivery:

- Applied – executed at primary databases first and affect primary data. Replication Servers propagate the stored procedure and its parameters, applying data changes asynchronously at replicate sites that have subscriptions for an applied function replication definition. The maintenance user executes the applied function at the replicate sites.
- Request – executed at primary databases first and affect primary data. Replication Servers propagate the stored procedure and its parameters, applying data changes asynchronously at replicate sites that have subscriptions for a request function replication definition. The same user who executes the stored procedure at the primary databases executes the request function at the replicate sites.

  Typically, the request function delivery is used to modify the remote data asynchronously at databases on other sites. The changes are replicated back to the originating site via either normal data replication or applied function delivery.

See also
- *Manage Replicated Functions* on page 355
- *Manage Subscriptions* on page 373

Publications

A publication lets you collect replication definitions for related tables and stored procedures and then subscribe to them as a group.

You create publications at the primary Replication Server and subscribe to them at the destination Replication Server.

When you use publications, you create and manage these objects:

Article – identifies a replication definition, primary database, and publication. It may also limit the number of rows or parameters sent to the replicate database.

Publication – a collection of articles from a primary database.

Publication subscription – a subscription to a publication. When you create a publication subscription, Replication Server creates a subscription for each article in the publication.

Publications allow you to group replication definitions and subscriptions in a manner that makes sense for your system. It also allows you to create and check the status of only one subscription for a set of tables and procedures.

Overview of Replicating Tables

Learn the tasks you must perform at the data servers and Replication Servers in a replication system to replicate transaction data from a primary (source) to a replicate (destination) table.

1. At the replicate data server: Create a copy of a table into which data will be replicated from the primary table. The copy may contain all or a subset of the columns from the primary table.
2. At the primary Replication Server: Create a replication definition to identify the table data you want to replicate. You can create one or more replication definitions per table that can be replicated into different replicate databases. You can also create replication definitions for stored procedures.

   After you have created a replication definition, transactions are available for replication to qualifying destination Replication Servers that subscribe to the replication definition.

   You can create a set of articles that reference replication definitions and group them in a publication. If you want to limit the transactions sent to the replicate database to those that affect certain rows, use a **where** clause in the article.
3. At the primary data server: Use the **sp_setreptable** system procedure to mark a table as replicated if Adaptive Sever is the primary data server. If you use a different data source with a Replication Agent, refer to your Replication Agent documentation for information about marking primary objects for replication.

   When you mark a table as replicated in the primary data server, the Replication Agent for the primary database can forward the table's transactions to the primary Replication Server.

   If you want to replicate `text`, `unitext`, or `image` columns, you may also need to use the **sp_setrepcol** system procedure.
4. At replicate Replication Servers: Create a subscription for replication definitions that were created in primary Replication Servers. A subscription allows the replicate table to receive the initial data from the primary table through a process known as *materialization*, and to begin receiving subsequent replicated data updates.

   You can create multiple subscriptions for each replication definition, but a replicate table can subscribe to only one replication definition. You can set up a subscription to receive all transactions for a replicate table, or use a **where** clause to receive just the transactions that affect certain rows.

   Create publication subscriptions for publications created at the primary Replication Server. When you do so, Replication Server creates an article subscription for each article in the publication.

Creating subscriptions completes the process of replicating data.

See also

- *Mark Tables for Replication* on page 307
- *Manage Replicated Functions* on page 355
- *Manage Subscriptions* on page 373
- *Replicating Tables in the Example Replication System* on page 406

Commands for Managing Replicated Data

Replication Server also provides table replication definition, function replication definition, publication, subscription, and publication subscription RCL commands to manage replicate data.

See also

- *Commands for Managing Table Replication Definitions* on page 285
- *Commands for Managing Function Replication Definitions* on page 358
- *Commands for Creating and Managing Publications* on page 342
- *Subscription Commands* on page 393
- *Commands for Creating and Managing Publication Subscriptions* on page 417

Establish Replication Server Connections

Replication Server uses the Open Client/Server Interfaces to communicate between client applications and servers.

Server programs, including Replication Servers, Adaptive Servers, and gateway software for other data servers, are registered in a directory service—either an `interfaces` file, Kerberos, or a Lightweight Directory Access Protocol (LDAP) server—so that client applications and other server programs can locate them.

Note: If you are using network-based security, use the directory services of your network security mechanism to register Replication Servers, Adaptive Servers, and gateway software. Refer to the documentation that comes with your network-based security mechanism for details.

Interfaces File

The interfaces file contains network definitions for servers in the replication system, including SAP Replication Servers and data servers.

Generally, one interfaces file at each site contains entries for all local and remote SAP Replication Servers and data servers. The entry for each server includes its unique name and the network information that other servers and client programs need to connect with it. The interfaces file at a site requires entries for these components:

- ID Server (if SAP Replication Server is not also the ID Server)
- SAP Replication Server
- RSSD SAP ASE or ERSSD SAP SQL Anywhere for this SAP Replication Server
- ERSSD SAP Replication Agent if a route is to be created from the current site
- Data servers with databases managed by this SAP Replication Server
- Backup Server to back up SAP ASE databases, including RSSDs
- SAP Replication Servers at other sites that manage databases containing primary data that is replicated to this site
- SAP Replication Servers at other sites with subscriptions for primary data maintained at this site
- Other SAP Replication Servers to which this SAP Replication Server has a route with no intermediate SAP Replication Servers

You can use the default interfaces file or you can specify an alternative interfaces file at the command line when you start SAP Replication Server. The interfaces file is usually located in the SAP Sybase release directory. Use a text editor to modify the interfaces file. See the installation and configuration guides for your platform for more information.

Kerberos

Kerberos is a network authentication protocol that uses secret-key cryptography so that a client can prove its identity to a server in a network-based security mechanism.

Kerberos assumes the key distribution center (KDC) is running and configured for your realm, and the client libraries are installed under or on each client host in your realm.

Refer to the documentation and online help pages that are provided with Kerberos software for the configuration information.

Replication Server Principal Names

Replication Server accepts Kerberos Open Client ™ connections that have a user-defined Replication Server principal name.

Replication Server authenticates the principal name with the Kerberos key distribution center (KDC). By default, the principal name is the name of the Replication Server. If you have multiple instances of Replication Server running, specify different principal names for each Replication Server.

To specify a different principal name:

- While starting Replication Server, set **-k rs_principal_name** option in the **repserver** executable program, or,
- Before starting the Replication Server, set the SYBASE_RS_PRINCIPAL environment variable in the **isql** command line tool.

Use **admin show_principal_name** command to view the Replication Server principal name.

If you modify the principal name of any Replication Server, execute **sysadmin principal_users[,reload]** to reload the principal name of all Replication Servers stored in the `rs_principal_users.cfg` configuration file.

See **admin show_principal_name** and **sysadmin principal_users[,reload]** in the *Replication Server Reference Manual* .

See also

- *Adaptive Server-to-Adaptive Server Replication with Kerberos Scenario* on page 242

Specifying the Replication Server Principal Name

To specify the Replication Server principal name, use either the SYBASE_RS_PRINCIPAL environment variable or the **-k rs_principal_name** option.

Prerequisites

To use Kerberos authentication with the principal names, configure these network-based security configuration files:

- `libtcl.cfg` on 32-bit machines
- `libtcl64.cfg` on 64-bit machines
- `objectid.dat`
- `interfaces` file

Task

1. Set the SYBASE_RS_PRINCIPAL variable before starting Replication Server:

   ```
   setenv SYBASE_RS_PRINCIPAL <principal_name>
   ```

   By default, the principal name is the name of the Replication Server. If you have multiple instances of Replication Server running, specify different principal names for each Replication Server. Replication Server uses the value of this variable to authenticate itself to Kerberos.
2. Set the **-k rs_principal_name**, before you start Replication Server using the **repserver** executable program:

   ```
   -k rs_principal_name
   ```

   When you start Replication Server with the Kerberos security mechanism enabled, Replication Server first uses the principal name specified with the **–k rs_principal_name** option for Kerberos authentication. If the **–k rs_principal_name** option is not specified, Replication Server looks for the principal name set in the SYBASE_RS_PRINCIPAL environment variable. If neither is specified, Replication Server uses the server name for authentication.

In this example, the Replication Server name is "secure_rs" and the realm name is "MYREALM.COM". The Replication Server name is specified on the command line with *-s* parameter to the *dataserver*.

The current realm is specified in the `libtcl.cfg` configuration file on a 32-bit machine or `libtcl64.cfg` configuration file on a 64-bit machine by a **secbase** attribute value:

```
[SECURITY]
csfkrb5=libsybskrb.so
secbase=@MYREAL.COM libgss=/krb5/lib/libgss.so
```

To override the default Replication Server principal name:

- Option 1 – set the `–k rs_principal_name` option in the **repserver** program.

  For example:

  ```
  {repserver | repsrvr} [-C config_file] [-i id_server]
  [-S secure_rs] [-I interfaces_file]
  [-E errorlog_file] [-M] [-v] [-K keytab_file] [-k rsprincipal]
  [-upgr] [-A erssd_release_dir] [-purgeq]
  [-nodb {all|dbid_1[,dbid_2[,dbid_3[,…]]]]}
  [-e]
  ```

  where:

  - -s secure_rs@MYREALM.COM – is the default Replication Server principal name.
  - -k rsprincipal@MYREALM.COM – is the Replication Server principal name.

  See *Replication Server Reference Manual> Executable Programs> repserver*.
- Option 2 – set SYBASE_RS_PRINCIPAL before starting Replication Server:

  ```
  setenv SYBASE_RS_PRINCIPAL rsprincipal@MYREALM.COM
  ```

  The Replication Server principal name that gets authenticated with Kerberos is "rsprincipal@MYREALM.COM", the value of SYBASE_RS_PRINCIPAL environment variable.
- Option 3 – if neither **-k rs_principal_name** nor SYBASE_RS_PRINCIPAL variable is set, Replication Server uses the `interfaces` file.

  The Replication Server principal name that is authenticated with Kerberos is "secure_rs@MYREALM.COM".

See also

- *Configure libtcl.cfg* on page 239
- *Configure objectid.dat* on page 240
- *Configure the interfaces File* on page 241
- *Set Environment Variables (Kerberos)* on page 241

Considerations

Considerations for using the Kerberos principal name to access Replication Server.

- When you set the **use_security_services** parameter on and the **unified login** parameter to *required*, use these commands to access the Replication Server:
  - `isql -Vsecurity_option -Sserver_princ`
  - `isql -Vsecurity_option -Sserver_princ -Uxx`

  In this case, you can access the Replication Server only with the credential of a principal user.
- When you set the **use_security_services** parameter on and the **unified login** parameter to *not_required*, use these commands to access the Replication Server:
  - `isql -Uxx -Pxx -Sserver_name`
  - `isql -Vsecurity_option -Sserver_princ`
  - `isql -Vsecurity_option -Sserver_princ -Uxx`

  In this case, you can access the Replication Server with the credential of a principal user or a password.

See also

- *isql Command Line Options for Security* on page 266

LDAP Server

An LDAP server provides global directory services for sharing component information such as server names and connection properties.

LDAP directory services allow components to look up directory information in a network-based system. Any type of LDAP service or gateway is an LDAP server. An LDAP driver calls LDAP client libraries to establish connections to an LDAP server. The LDAP driver and client libraries define the communication protocol and content of messages exchanged between clients and servers. LDAP runs directly over the Transmission Control Protocol (TCP).

When the LDAP driver connects to the LDAP server, the server establishes the connection based on one of two authentication models:

- Anonymous access – which does not require any authentication information, and is used typically for read-only privileges, or
- User name and password access – which is same as the user name and password used to access Replication Server.

Note: You can use an LDAP administrator account with a search filter for server lookup or authenticate a Replication Server user with an LDAP server.

Server Lookup

Replication Server uses the access information as an extension to the LDAP URL for server lookup.

Access information is taken from the `libtcl.cfg` file:

- UNIX – `$SYBASE/$SYBASE_OCS/config/libtcl.cfg`
- Windows – `%SYBASE%\%SYBASE_OCS%\ini\libtcl.cfg`

Replication Server uses LDAP for authenticating server names and connection properties. You can use LDAP services in place of an Replication Server interface file. The `libtcl.cfg` configuration file is used to search the server directory information. For example, Replication Server and Adaptive Server information.

You must edit the ldap32 entry under the DIRECTORY section in `libtcl.cfg` to include `libsybdldap.so` and `libsybdldap64.so`. Otherwise, Replication Server cannot connect to LDAP on 64-bit platforms. For example:

```
[DIRECTORY]
ldap32=libsybdldap.so ldap://sylvester:3389
/dc=Sybase,dc=com??one??bindname=cn=Manager,dc=Sybase,
dc=com??secret
ldap64=libsybdldap64.so ldap://sylvester:3389
/dc=Sybase,dc=com??one??bindname=cn=Manager,dc=Sybase,
dc=com??secret
```

To start the LDAP session with the **dscp** utility, enter:

```
open ldap32
```

Replication Server uses Open Client/Server libraries to connect to LDAP servers and Open Client/Server configurations and procedures to set up and maintain LDAP services. See the *Replication Server Configuration Guide* for your platform for directions on how to set up an LDAP directory. For detailed information about Open Client/Server LDAP support, see the *Open Client Client-Library/C Reference Manual*.

LDAP User Authentication

Replication Server uses OpenLDAP client APIs to communicate with the LDAP server for user authentication.

The OpenLDAP API, which is precompiled with OpenSSL, is dynamically loaded from a shared library, `libsybaseldap*`, found in the `$SYBASE/$OCS/lib3p` or `$SYBASE/$OCS/lib3p64` directory.

The LDAP user authentication uses an LDAP URL to search the user information. The LDAP URL is defined in the **sysadmin ldap** command.

An example of LDAP URL:

```
ldap://john.doe.com:8888/dc=doe,dc=com??SUB?(cn=*)
```

See **sysadmin ldap** in the *Replication Server Reference Manual*.

Replication Server and LDAP User Account Management

An LDAP administrator creates and maintains user accounts in the LDAP server.

A database administrator creates and maintains Replication Server users. Alternatively, the database administrator can choose administration options that provide flexibility with user accounts when integrating Replication Server with the LDAP user authentication. For example, the database administrator administers the Replication Server roles, default database, language, and other login-specific attributes using administration commands and procedures.

Configure LDAP user authentication by setting the **user_authentication_source** parameter and the LDAP URL.

Table 2. Updates to rs_users if LDAP Authentication Is Enabled

Existing User in rs_users?	User Authenticated by LDAP?	Update to rs_users
No	Yes	Login fails. No change to `rs_users`.
No	No	Login fails. No change to `rs_users`.
Yes	Yes	Login successful. Update `rs_users` with the authenticated password.
Yes	No	• **If user exists in LDAP –** login fails. No change to `rs_users`. • **If user does not exist in LDAP –** login either fails or falls back to `rs_users` for decision with no changes.

LDAP User Authentication Configuration

The LDAP user authentication allows you to use LDAP enterprise-wide passwords instead of Replication Server passwords.

Replication Server uses the OpenLDAP API for the LDAP user authentication and this API supports LDAPv3.

When connecting to an LDAP server as a client, Replication Server supports any LDAP server, which conforms with a standard LDAP protocol, including Microsoft Windows Active Directory and OpenLDAP directory servers.

The primary data structure used with the LDAP protocol is the LDAP URL, which specifies a set of objects or values on an LDAP server. Replication Server uses LDAP URLs to specify an LDAP server, and search criteria to authenticate user login requests.

The LDAP URL uses this syntax:

```
ldapurl:=ldap://host:port/node?attribute?[base | one | sub]?filter
```

where:

- **host –** is the host name of the LDAP server.
- **port –** is the port number of the LDAP server.
- **node –** specifies the node in the object hierarchy at which to start the search.
- **attributes –** is a list of attributes to return in the result set. Each LDAP server may support a different list of attributes.
- **base | one | sub –** qualifies the search criteria.
  - **base –** specifies a search criteria for the base node.
  - **one –** specifies a search criteria for the base node and a sublevel under the base node.
  - **sub –** specifies a search of the base node and all node sublevels.
- **filter –** specifies the attribute or attributes to be authenticated. The filter can be simple, for example, "`uid=*`" or compound, for example, "`&(uid=*)(ou=group)`".

  The wildcard replacement fails if the first attribute in a wildcard search filter is not mapped to the login name attribute.

  For example, if the search filter is "`&(uid=*)(ou=group)`" and the login name is "mylogin", during authentication, Replication Server uses "mylogin" to generate an output filter "`&(uid=mylogin)(ou=group)`". If the search filter is specified as "`&(ou=*)(uid=*)`", the login name is "ou=mylogin", which is incorrect. The wildcard replacement for the user authentication fails.

An example of the LDAP URL:

```
ldap://john.doe.com:8888/dc=doe,dc=com??SUB?(cn=*)
```

Upgrading Replication Server to Use LDAP User Authentication

Use **sysadmin ldap** and **configure replication server** to configure the LDAP user authentication.

Prerequisites

- Install, configure, and start the LDAP server using the vendor-supplied documentation.
- Add an **sa** user in the LDAP server.

Task

1. In upgraded Replication Server installations, configure LDAP user authentication.

a) Test the LDAP server connection:

```
sysadmin ldap check_url, 'ldapurl' [,'dn', 'pwd']
```

b) Specify the LDAP server URL and values for an administrative access account:

```
sysadmin ldap
set_primary_url, 'ldapurl'
set_access_acct, 'dn', 'password'
```

where:

- **ldapurl –** is the primary LDAP server URL.
- **dn –** is the distinguished name (DN) of the administrative LDAP account. Each user entry in an LDAP server has a unique identifier called the distinguished name.
- **password –** is the password of an LDAP user.

c) Configure the **user_authentication_source** to LDAP only:

```
configure replication server
set user_authentication_source to 'ldap'
```

2. Add users for the replication system in the LDAP directory server using the vendor-supplied documentation.
3. Add the same set of users that you have added in step 2 using the **create user** command in Replication Server.

Note: If the LDAP user authentication is enabled, you cannot use the password specified with the **create user, set password** command. The password is synchronized from the LDAP server when the user is authenticated.

See *sysadmin ldap* and *configure replication server* in the *Replication Server Reference Manual*.

Migrating Existing SAP Replication Server to LDAP User Authentication

Migrate the existing SAP Replication Server to LDAP authentication using **sysadmin ldap** and **configure replication server** commands.

Prerequisites

Install, configure, and start the LDAP server using the vendor-supplied documentation.

Task

1. Test the LDAP server connection:

```
sysadmin ldap check_url, 'ldapurl'
```

2. Specify the LDAP server URL and values for an administrative access account:

```
sysadmin ldap
set_primary_url, 'ldapurl'
set_access_acct, 'dn', 'password'
```

where:

- **ldapurl –** is the primary LDAP server URL.
- **dn –** is the distinguished name (DN) of the administrative LDAP account.

3. Configure the **user_authentication_source** to both SAP Replication Server and LDAP server:

   ```
   configure replication server
   set user_authentication_source to 'any'
   ```

4. Add all existing SAP Replication Server users in the LDAP directory server.

   You can add users simply by resetting the password for users in the LDAP server.

5. Set the **user_authentication_source** to LDAP only after adding all users to the LDAP server:

   ```
   configure replication server
   set user_authentication_source to 'ldap'
   ```

   Note: If the LDAP user authentication is enabled, you cannot use the password specified with the **create user, set password** command. The password is synchronized from the LDAP server when the user is authenticated.

   See *sysadmin ldap* and *configure replication server* in the *Reference Manual*.

Configuring Primary LDAP Server to Use SSL/TLS

Configure the primary LDAP server URL to use Secure Sockets Layer (SSL) or Transport Layer Security (TLS) for user authentication.

Replication Server supports two ways to secure the connection:

- Use SSL with an `ldaps://` URL.
- Use TLS with an `ldap://` URL and **sysadmin ldap, starttls_on_primary, starttls_on_secondary|starttls_on_secondary, 'true'** command.

1. Configure the Replication Server to use LDAP only for user authentication:

   ```
   configure replication server set user_authentication_source to
   'ldap'
   go
   ```

2. Add a user to Replication Server and set the primary LDAP server URL with the certificate authorities (CA) root file path:

   ```
   sysadmin ldap, set_primary_url,
   'ldap://andre:888/dc=sybase,dc=com??sub?cn=*'
   go
   ```

   ```
   sysadmin ldap, set_access_acct, 'cn=Manager', 'secret'
   go
   ```

   ```
   sysadmin ldap, set_cacert_file,
   'user/SYBASE/config/trusted.txt'
   go
   ```

3. Enable TLS on the primary LDAP server and log in to Replication Server with a new user name and password:

```
sysadmin ldap, starttls_on_primary, 'true'
go
```

```
isql -SmyRs -UnewUserName -PnewUserPwd
```

4. Configure the primary LDAP server to use the SSL port.

   Before using this command, set the **starttls_on_primary** parameter to false.

   ```
   sysadmin ldap, starttls_on_primary, 'false'
   go
   ```

   ```
   sysadmin ldap, set_primary_url,
   'ldaps://andre:8889/dc=sybase,dc=com??sub?cn=*'
   go
   ```

5. Log in to Replication Server using the new user name and password:

   ```
   isql -SmyRS -UnewUserName -PnewUserPwd2
   ```

Disabling LDAP User Authentication

Disable the LDAP user authentication in an existing SAP replication system.

1. Configure the **user_authentication_source** to both SAP Replication Server and the LDAP server:

   ```
   configure replication server
   set user_authentication_source to 'any'
   ```

   You must ensure that all passwords in `rs_users` are valid before you disable the LDAP user authentication. You can simply reset the password in SAP Replication Server using the **reset password** command.

2. After completing the password validation for each user, configure the **user_authentication_source** to SAP Replication Server:

   ```
   configure replication server
   set user_authentication_source to 'rs'
   ```

See also

- *Resetting a Lost or Forgotten sa User Password* on page 226

Make Replication Server Connections

To connect data servers and Replication Servers at the sites on a LAN or WAN, the replication system administrator at each site defines connections and routes.

Organizing connections and routes is fundamental in planning replication. The connections and routes you establish determine the number of Replication Server components you need. In addition, how you map replication between source and destination databases can impact system performance and data availability.

To specify where data is copied requires that you create the following paths or message streams between Replication Servers and between Replication Servers and databases in the system:

- A connection from a Replication Server to a database

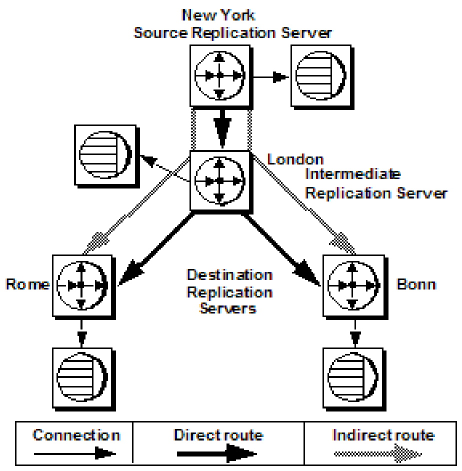
  Replication Servers distribute transactions received from primary databases through connections to the replicate databases they manage. A Replication Server may have connections to several databases, but each database can have only one connection from a Replication Server.

  Warm standby applications also use a logical connection, which represents both a database and its standby database.
- A route from a Replication Server to another Replication Server

  From each source Replication Server that manages databases containing primary data, you must specify a route to each destination Replication Server that subscribes to the data.

  You can specify a direct route from a source Replication Server to a destination Replication Server, or an indirect route, with intermediate Replication Servers between the source and destination Replication Servers.

Figure 8: Routes and Connections



This figure depicts an enterprise with several locations in Europe. A New York Replication Server routes all information for Europe through the London Replication Server. This arrangement reduces the number of direct connections the New York Replication Server makes and reduces WAN traffic. Data is sent once from New York to London, rather than from New York to each European location. The London Replication Server distributes the replicated data to the other European locations.

See the *Replication Server Design Guide* for details and rules on designing routes and connections for a replication system.

See *Replication Server Administration Guide Volume 2 > Managd Warm Standby Applications* for more information about logical connections.

See also

- *Manage Routes* on page 141
- *Manage Database Connections* on page 165

Specify Database Operations

Replication Server distributes database operations from a primary database to destination Replication Servers as functions that consist of a name and a set of data parameters.

The destination Replication Server then uses function strings to map functions to the commands recognized by the destination data server. These commands represent transaction-control directives (**begin transaction** or **commit transaction**) or data-manipulation instructions (**insert**, **update**, or **delete**). The function string serves as a template or meta-command that transforms a function to a data-server-specific command. The use of function strings makes it possible for a primary site to replicate data to multiple heterogeneous data servers. Function strings are categorized into function-string classes according to data server type.

For example, a primary Replication Server transmits the **rs_insert** function to a destination Replication Server, which uses the appropriate function string to translate the function into the insert command specific for the data server in use at that site, whether the database is Adaptive Server, DB2, or another database.

There are two types of functions:

- System functions – represent data-server operations with function strings supplied by Replication Server or available when you install a new database to the replication system.
- User-defined functions – allow you to customize Replication Server applications to distribute stored procedures.

See *Replication Server Administration Guide Volume 2 > Customize Database Operations* for details.

Function Strings

Function strings for functions can be automatically generated for function-string classes that come with Replication Server.

Function strings must be customized for any function-string class that the user creates that does not inherit its functions strings from one of the provided classes. To customize a function string, you modify an existing function string with data-server-specific commands or by invoking a remote procedure call (RPC). A customized function string can also contain function string variables that represent the values of columns, procedure parameters, system-defined information, and user-defined variables. Replication Server replaces the variables with actual values before sending function strings to the data server.

See *Replication Server Administration Guide Volume 2 > Customize Database Operations* for details.

Function-string Classes

A function-string class comprises all of the function strings used with a type of database.

SAP Replication Server provides function-string classes for SAP ASE and with version 15.2, SAP Replication Server provides function-string classes for non-SAP ASE data servers: SAP® IQ, SAP HANA, IBM DB2 UDB, Microsoft SQL Server, and Oracle. Although function strings may contain data-server-specific instructions, they can often be used with several databases maintained by the same data server type. You can create classes with all new function strings or create a derived class that inherits function strings from an existing parent class.

Transaction Handling with Replication Server

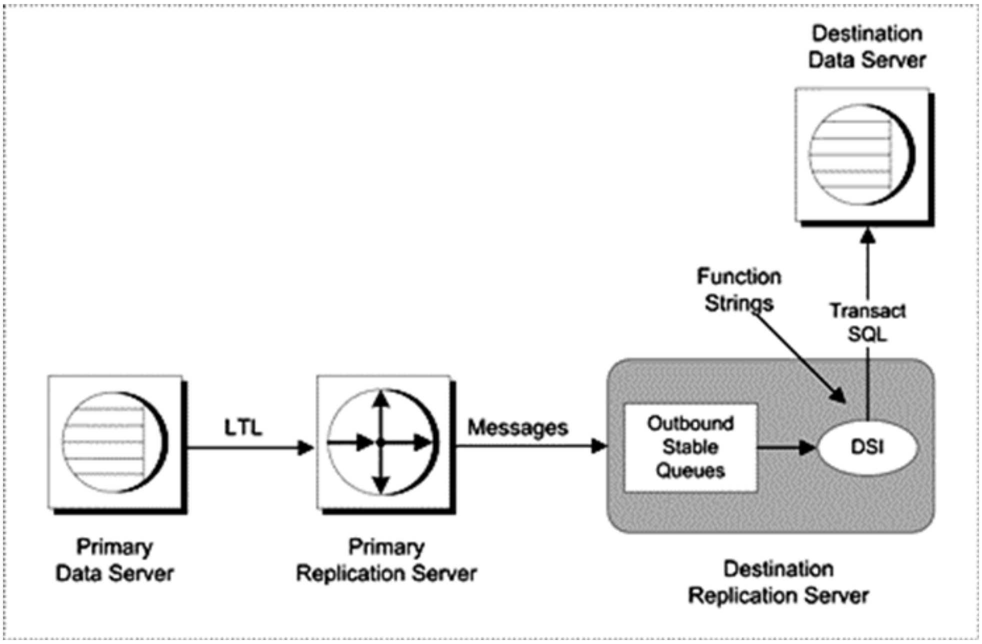
Replication Server depends on data servers to provide the transaction-processing services needed to protect stored data.

To ensure the integrity of distributed data, data servers must comply with the following transaction-processing conventions:

- A transaction is one unit of work. Either all operations in the transaction are performed or none are performed.
- Transaction results are permanent. A transaction cannot be arbitrarily undone after it is committed.

Replication Server copies committed transactions from primary sites to replicate sites, and distributes transactions in the order they are committed so that copied data passes through the same states as the primary data.

This figure illustrates the Replication Server method for translating transactions.



Once the primary Replication Server sends transactions to subscribing sites, destination Replication Servers store the transactions in the outbound Data Server Interface (DSI) stable queue.

Stable Queues

When you install Replication Server, you set up a disk partition that Replication Server uses to establish stable queues. During replication operations, Replication Server temporarily stores updates in these queues.

There are three types of stable queues, each of which stores a different type of data:

- Inbound queue – holds messages only from a Replication Agent. If the database you add contains primary data, or if request stored procedures are to be executed in the database for asynchronous delivery, Replication Server creates an inbound queue and prepares to accept messages from a Replication Agent for the database.
- Outbound queue – holds messages for a replicate database or a replicate Replication Server. There is one outbound queue for each of these destinations:
  - For each replicate database managed by a Replication Server, there is a Data Server Interface (DSI) outbound queue.
  - For every Replication Server to which a Replication Server has a route, there is a Replication Server Interface (RSI) outbound queue.
- Subscription materialization queue – holds messages related to newly created or dropped subscriptions. This queue stores a valid transactional “snapshot” from the primary

database during subscription materialization or from a replicate database during dematerialization.

You can add more partitions later if your replication system requires more space for stable queues.You can also create partitions that automatically grow or shrink according to usage.

See the *Replication Server Troubleshooting Guide* for information on how to examine queue contents for troubleshooting purposes.

See also

- *Partitions for Stable Queues* on page 52
- *Automatically Resizable Partitions* on page 53

Queue Management

Replication Server uses the Stable Queue Manager (SQM) thread to manage each stable queue.

Threads are subprocesses that manage specific tasks, such as receiving messages. Some queues also have an additional Stable Queue Transaction (SQT) thread. See *Replication Server Administration Guide Volume 2 > Performance Tuning > Replication Server Internal Processing > Processes in the Primary Replication Server* for details on the SQM and SQT threads.

When transactions are ready to leave the stable queue, one of these threads submits the transactions in the queue:

- Data Server Interface (DSI) thread – manages the connection with the data server.
- Replication Server Interface (RSI) thread – manages the connection with the replicate Replication Server.

The enhanced queue **dump** commands give you flexibility in identifying the stable queues, controlling the stable queue contents to dump, and supporting additional output file options. In addition, Replication Server introduces commands that allow you to delete and restore specific transactions from the SQM.

Commands to Manage Stable Queues

Replication Server provides RCL commands to manage stable queues.

- **sysadmin dump_queue**
- **sysadmin sqt_dump_queue**
- **resume connection**
- **sysadmin log_first_tran**
- **sysadmin sqm_zap_tran**
- **sysadmin sqm_unzap_tran**
- **sysadmin dump_tran**

See the *Replication Server Reference Manual* for detailed information about these commands.

DSI Thread

The DSI thread translates the transaction modifications into RPCs or the language as specified by the function strings in the function-string class assigned to the destination database.

SAP Replication Server starts DSI threads to submit transactions to a replicate database to which it has a connection.

The DSI thread performs the following tasks:

- Collects small transactions into groups by commit order.
- Maps functions to function strings according to the function-string class assigned to the database connection.
- Executes the transactions in the replicate database.
- Takes action on any errors returned by the data server; depending on the assigned error actions, also records any failed transactions in the exceptions log.

To improve performance in sending transactions from an SAP Replication Server to a replicate database, you can configure a database connection so that transactions are applied using multiple DSI threads. See *Administration Guide Volume 2 > Performance Tuning > Use Parallel DSI threads* for a description of this feature.

SAP Replication Server includes support for bulk copy-in to improve performance when replicating large batches of **insert** statements on the same table in SAP ASE 12.0 and later. SAP Replication Server implements bulk copy-in using the Open Client SAP Open Server Bulk-Library. See *Administration Guide Volume 2 > Performance Tuning > DSI Bulk Copy-in*.

The DSI thread may apply a mixture of transactions from all data sources supported by the SAP Replication Server. The transactions are processed in the single outbound stable queue for the destination data server.

RSI Thread

RSI threads send messages from one Replication Server to another. There is one RSI thread for each destination Replication Server.

The primary Replication Server processes transactions, causing those destined for other Replication Servers to be written to RSI outbound queues. An RSI thread logs in to each destination Replication Server and transfers messages from the stable queue to the destination Replication Server.

When a direct route is created from one Replication Server to another, an RSI thread in the source Replication Server logs in to the destination Replication Server. When an indirect route is created, Replication Server does not create a new stable queue and RSI thread. Messages for indirect routes are handled by the RSI thread for the direct route.

See also

- *Establish Replication Server Connections* on page 35

Partitions for Stable Queues

Replication Server stores messages destined for data servers or other sites on partitions.

Replication Server allocates space in a stable device by partition and further divides the partitions into segments and blocks. Each stable queue holds messages to be delivered to another Replication Server or to a database.

The **rs_init** program assigns the initial partition to the Replication Server. Refer to the Replication Server installation and configuration guides for more information about working with partitions in **rs_init**.

The minimum initial partition is 20MB. You may need additional partitions, depending on the number of databases the Replication Server manages and the number of remote sites to which the Replication Server distributes messages. Larger partitions may also be necessary when subscriptions are initiated or when there are long-running transactions.

A Replication Server can have any number of partitions of varying sizes. The sum of the partition sizes is the Replication Server capacity for queued transactions.

Use the **create partition** command to assign additional partitions or **alter partition** to expand partitions. See the *Replication Server Reference Manual* for syntax, parameter descriptions, examples and usage information.

You can also create automatically resizable partitions that grow or shrink according to usage.

When choosing a partition for Replication Server, consider these guidelines:

- For the best performance, install Replication Server partitions on fast file systems or operating system raw devices.

  Restriction: You cannot use raw devices on Windows or for automatically resizable partitions.
- Do not mount the partition for use by the operating system.
- Do not use the partition for any other purpose, such as storing file systems, maintaining swap space, or locating Adaptive Server devices.
- Allocate the entire partition to Replication Server. If you allocate just a portion of a partition for Replication Server, you cannot use the remainder for any other purpose.
- Do not allow any users read/write permissions on the partition unless the user is going to start Replication Server.
- Since the **sqm_async_seg_delete** parameter that you can set with **configure replication server** is on by default, Replication Server may require a larger partition when you upgrade to version 15.7 or later. See:
  - *Replication Server Configuration Guide > Preparation for Installing and Configuring Replication Server > Plan the Replication System > Initial Disk Partition for Each Replication Server*.

- **sqm_async_seg_delete** and **alter partition** in *Replication Server Reference Manual > Replication Server Commands*.

You can choose how Replication Server allocates queue segments to partitions or you can use the default mechanism. The default mechanism assigns queue segments to the next partition in an ordered list. Use the **alter connection** or **alter route** command to choose a different allocation mechanism. See *Replication Server Administration Guide Volume 2 > Performance Tuning > Allocate Queue Segments* for more information.

See also

- *Automatically Resizable Partitions* on page 53

Use Disk Files for Stable Queues

To use a disk file for a partition, create the file before you execute the **create partition** command.

You can create an empty file and set its permissions so that Replication Server can read and write to the file. Replication Server extends the file to the size you specify.

Partitions can be either raw disk partitions, which is preferable, or operating system files. Where a choice is available, raw disk partitions provide the best recoverability, since disk writes to raw disk partitions are not buffered by the operating system.

Automatically Resizable Partitions

Use Replication Server partitions that automatically grow or shrink according to usage.

An automatically resizable partition consists of separate partition files. With an automatically resizable partition, you need not manually increase the partition size or create a new partition when consumption from storing stable queue messages increases, and you need not manually reduce the partition size to conserve disk space if consumption decreases.

Instead, Replication Server responds immediately and automatically grows by creating a new partition file when consumption reaches 80% of the total capacity of the partition. You can set the individual partition file size according to your requirements, and you can set a limit to the total size of the partition according to the available disk space. Replication Server does not create a new partition file, even if consumption for the entire partition reaches 80% capacity, if Replication Server calculates that a new file exceeds the limit for the total size of the partition.

In addition, Replication Server automatically conserves disk space if consumption of the partition drops, by removing the last partition file that was added in a automatically resizable partition, if the file becomes empty. To improve response time and replication performance in case there are rapid fluctuations in disk consumption, Replication Server delays the shrinking of the partition until the total partition usage without the last partition file is lower than 50%.

Use **create auto partition path** to:

- Create a logical partition path for the partition files that Replication Server automatically creates.
- Associate the logical partition path to a physical location with sufficient disk space for the partition files.
- Set the size of the partition files that Replication Server automatically creates.
- Set the maximum total size for all the partition files in the partition.

```
create auto partition path logical_name
on 'physical_path'
with auto expand size = size
max size = max_size
```

For example, to create the `auto_uxp` logical partition path on the UNIX device named `/usr/user1`, with an initial partition file size of 100MB, and automatically add a new 100MB partition file to `auto_uxp` every time the partition file reaches 80% usage, and limit the total size for all the partition files that Replication Server can create automatically to102,400MB, enter:

```
create auto partition path  auto_uxp on '/usr/user1'
with auto expand size=100 max size=102400
```

You can create multiple automatically resizable partitions but each partition must have a unique physical path or logical name, and sufficient disk space.

Replication Server names the partition files that it automatically creates according to the `"`*`logical_name`*`"_"`*`partition_number`*`"` format, where *partition_number* is a ten-digit number that Replication Server generates automatically and increases sequentially from 0000000001 to 2147483647 with each file that Replication Server adds. Replication Server can automatically grow or shrink partitions only with partition files named using this format. All other partitions must be manually managed by Replication Server administrators.

Warning! Do not manually delete files in the partition physical location with names that follow the *`logical name_partition number`* format as the partition files may contain data, unless the partition file has not been used by Replication Server. You can use **admin disk_space** to check if Replication Server is using the partition file. Consult the system administrator or technical support.

To manage automatically resizable partitions, use:

- **alter auto partition path** – to change the sizeof one partition file and the maximum size of a automatically resizable partition
- **drop auto partition path** – to remove an automatically resizable partition from Replication Server
- **admin auto_part_path** – to display information on automatically resizable partitions
- **admin disk_space** – to check if a device is an automatically resizable partition
- **rs_helppartition** – stored procedure to display information on all automatically resizable and manually managed partitions

See the *Replication Server Reference Manual* for descriptions and examples of all the commands and the stored procedure.

There are several restrictions and guidelines to consider when you create and manage automatically resizable partitions

- You must have write permission to the physical path before you can create a automatically resizable partition.
- You cannot create a automatically resizable partition on a raw device.
- You cannot use the **disk_affinity** parameter to select a automatically resizable partitions for partition affinity. See *Select Disk Partitions for Stable Queues* in the *Replication Server Administration Guide Volume 2*.
- You can use **drop auto partition path** to remove only automatically resizable partitions. You cannot use **drop auto partition path** to remove partitions created with other commands.
- You can use **drop partition** to manually remove an automatically resizable partition if there is an urgent need to release disk space. Otherwise, use **drop auto partition path** to manage the removal of automatically resizable partitions to ensure that disk space is released properly.
- Replication Server does not immediately remove an automatically resizable partition if you execute **drop auto partition path**. Instead, once this command marks the affected logical partition path as "drop-pending", Replication Server does not create any new automatically resizable partition file on the path. Replication Server only removes the automatically resizable partition after the partition files on the path have been dropped by Replication Server.
- Installation of Replication Server creates an initial partition. The initial partition and any partitions you subsequently create manually constitute the minimal partition size that Replication Server retains even after you remove all automatically resizable partitions. You can remove some of the partitions in the minimal partition size but you must ensure that Replication Server retains some partitions of a sufficient size for replication to continue.

Distributed Concurrency Control

Data servers that store primary data provide most of the concurrency control needed for the distributed database system. If a transaction fails to update a primary version of a table, the primary Replication Server does not distribute the update to other sites.

When a transaction succeeds in updating primary data, the Replication Server distributes the changes. Unless a failure occurs, the update succeeds at all sites with subscriptions to the data.

Transactions that Modify Data in Multiple Databases

A transaction that modifies primary data in more than one data server may require additional concurrency control.

According to the transaction processing requirements, either all of the operations in the transaction must be performed, or none of them. If a transaction fails on one data server, it must be rolled back on all other data servers updated in the transaction.

If a multi-database transaction is replicated, updates to each database flow to replicate databases as independent transactions because there is one Replication Agent per database.

Failed Replicate Table Updates

A modification to primary data may fail to update a copy of the data at a subscribing site.

The primary version is the "official" copy and updates that succeed there are expected to succeed at subscribing sites with copies. If the updates do not succeed, one of the following reasons may explain why:

- Replicate and primary versions are out of sync following a system recovery and a loss has been detected.

  See *Replication Server Administration Guide Volume 2 > Replication System Recovery* for more information.
- The data server storing the copy of the table has constraints that are not enforced by the data server storing the primary version.
- The data server storing the copy of the table rejects the transaction due to a system failure, such as lack of space in the database or a full transaction log.

When a transaction fails, Replication Server records the transaction in an exceptions log for handling that is appropriate to the application. Replication Server offers error handling flexibility through its error action feature. This feature allows responses to data server errors based on your own defined configuration settings. For example, you can specify that transactions be retried at the site where they failed.

A client at each site must resolve transactions in the exceptions log, because the appropriate resolution is application-dependent. In some cases, you can automate the resolution by encapsulating the logic for handling rejected transactions in an intelligent application program.

Transaction Processing by the Replication Agent

The Replication Agent scans the database transaction log and sends transaction information to Replication Server for distribution to subscribing databases. Learn the transaction processing by Adaptive Server RepAgent thread.

Note: Replication Agents for other databases may work differently. See the Replication Server Options documentation for the Replication Agent and database you are working with.

Coordinate Adaptive Server Log Truncation

As long as there is space in the Adaptive Server database transaction log, Adaptive Server continues to process transactions. To prevent the log from filling up, it must be emptied ("truncated") periodically.

You can use the Adaptive Server **dump transaction** command or set the Adaptive Server **trunc log on chkpt** option to "on" so that the log truncates automatically.

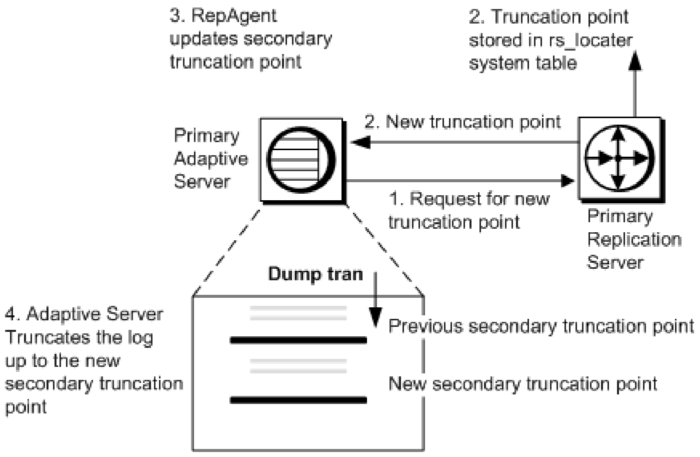
Each primary database maintains primary and *secondary truncation points* in its database log. The primary truncation point marks the last log record Adaptive Server has finished processing. The secondary truncation point normally marks the log record that contains the **begin transaction** command for the oldest open transaction not yet fully applied by Replication Server. Replication Server stores a copy of the latest secondary truncation point in the `rs_locater` table of the RSSD.

RepAgent requests a new secondary truncation point when it has scanned a predetermined number (batch) of records or has reached the end of the log and there is no new activity. Replication Server acknowledges receipt of a batch of transaction records by giving RepAgent the information that allows it to move the secondary transaction point.

Adaptive Server makes sure that only transactions already processed and passed to the Replication Server are deleted by never truncating the log past the secondary truncation point.

RepAgent updates the secondary truncation point as shown in the "Adaptive Server Log Truncation" figure.

Figure 9: Adaptive Server Log Truncation


3. RepAgent updates secondary truncation point
2. Truncation point stored in rs_locater system table
Primary Adaptive Server
2. New truncation point
1. Request for new truncation point
Primary Replication Server
Dump tran
4. Adaptive Server Truncates the log up to the new secondary truncation point
Previous secondary truncation point
New secondary truncation point

1. RepAgent requests a new secondary truncation point from the primary Replication Server.
2. The primary Replication Server returns the latest secondary truncation point to the RepAgent and also writes it into the `rs_locater` system table.

3. RepAgent updates the secondary truncation point in the transaction log.
4. At the next checkpoint or **dump transaction** command, the log is truncated up to the new secondary truncation point.

Schema information describes the structure of the database. Each time you change the schema of a database object—such as dropping a table, creating a clustered index, or renaming a column—Adaptive Server records current schema information for that object. Thus, when RepAgent scans the transaction log, it can always retrieve the correct schema for a table or procedure—even if the original database object has been changed or no longer exists. You do not need to drain the transaction log before executing schema changes at the primary site.

Manage a Replication System

You can start and shut down Replication Server, and monitor, maintain, and configure the replication system.

Set Up a Replication System

Learn the basic steps in setting up a replication system. This process requires planning and careful attention to the replication needs of your organization.

If you are new to SAP Replication Server, see first the *Design Guide* for information that can help you plan your replication system.

You can perform some of these steps in **rs_init**, SAP Replication Server configuration utility, which allows you to configure SAP Replication Servers and add databases to your system. You can use SAP Control Center for Replication to monitor the status and availability of servers in a replication environment and configure replication parameters to improve server performance. See *SAP Control Center > SAP Control Center for Replication*.

Before you set up replication system, install your SAP software according to the installation guide for your platform.

After you install SAP Replication Server, use the **rs_init** utility program to start and configure the replication system and to add databases.

See **rs_init** in the *Configuration Guide*.

Create Connections and Routes

To replicate data from one database into another, you must first establish the routes and connections that allow Replication Server to move the data from its source to its destination.

- Create connections

  When you use **rs_init** to add a database to your replication system, the program creates the connection for you. You never have to create a connection using the command line option **create connection** unless you are replicating data to or from a database that is not an Adaptive Server database.

  See **rs_init** in the *Replication Server Configuration Guide*.
- Create routes

  Use the **create route** command at the source Replication Server.

See also

- *Manage Database Connections* on page 165
- *Manage Routes* on page 141

Set Permissions and Security

Set up login names, passwords, and permissions to establish Replication Server security for the replication system.

Replication Server login names and specific permissions are required for:

- Users who are setting up replicated data or monitoring and managing the Replication Server.
- Components of the replication system, such as the data server and the Replication Server. You can create system users in **rs_init** or at the command line.

  See the installation and configuration guides for your platform for information about **rs_init**.

If network-based security is enabled at your site, you can set up secure pathways and choose message protection options for Replication Server to Replication Server communications.

See also

- *Manage Replication Server User Security* on page 219
- *Manage Replication Server System Security* on page 207
- *Manage Network-based Security* on page 237

Verify the Replication System

You must verify that the entire replication system is working before you create replication definitions or subscriptions or perform system diagnostics.

See *Replication Server Administration Guide Volume 2 > Verify and Monitor Replication Server > Verifying a Replication System* .

Create Replication Definitions

To set up a table for replication, mark it as replicated in Adaptive Server and define a replication definition for it in Replication Server. The replication definition describes the table and contains information about the columns to be replicated.

- If you plan to replicate stored procedures, create the stored procedure in both the primary and replicate database.
- If you are replicating the procedure from the primary to replicate database, mark the stored procedure for replication in the primary database.
- If you are replicating the procedure from the replicate to the primary database, mark the stored procedure for replication in the replicate database.

Create a function replication definition for the stored procedure at the primary Replication Server, even if you are replicating the stored procedure from a replicate database to the primary database.

See also
- *Manage Replicated Tables* on page 279
- *Manage Replicated Functions* on page 355

Create Subscriptions

If you create a replication definition for a table at Replication Server, you must create a subscription for that table replication definition at the replicate database. A subscription instructs Replication Server to copy data from primary tables to specified replicate databases.

Similarly, if you create a function replication definition for a stored procedure, you must create a subscription for that function replication definition at the replicate database. However, you do not need to create subscriptions for table or function replication definitions that update primary databases.

See also
- *Manage Subscriptions* on page 373

Perform Replication Server Tasks

Use **rs_init**, SAP Control Center, or **isql** with RCL commands to interact with Replication Server.

rs_init allows you to set up a new Replication Server and add new databases to the system.

The SAP Control Center provides a graphical user interface for managing and monitoring the servers and their components in the replication environment.

You execute RCL commands by connecting to Replication Server using a client application. You can use the **isql** or a custom application program that you create with Open Client Client-Library.

RCL commands are similar to Transact-SQL commands. See *Replication Server Commands* in the *Replication Server Reference Manual* for the complete syntax for all RCL commands.

Since many of the commands are used on an as-needed basis, **isql** is a convenient way to execute them.

Use rs_init

Use **rs_init** to configure a new Replication Server and to add Adaptive Server databases to your replication system.

If you have an existing Replication Server, you can use **rs_init** to upgrade to a new version or downgrade to a previous version. **rs_init** is installed with the SAP software. You can use it interactively or with a resource file.

See the *Replication Server Configuration Guide* for your platform for instructions to use **rs_init**.

Manage Replication Server with SAP Control Center

SAP Control Center is a Replication Server system management tool.

SAP Control Center provides a graphical user interface that allows you to monitor the components of the replication system and perform some Replication Server tasks.

With SAP Control Center, you can:

- View a graphical representation of the topology of the replication system, which allows you to group objects and view status information. SAP Control Center also provides menus for performing tasks and monitoring objects.
- Display multiple Replication Server connections and selectively view the contents of queues.

See *SAP Control Center for Replication*.

Use isql

You can use isql to interact with Replication Server.

You can use the **isql** utility to execute:

- ERSSD (Embedded Replication Server System Database) commands, using the primary user name and password from the Replication Server configuration file.
- RCL commands interactively
- Scripts stored in text files

For simple operations, using **isql** interactively may be easiest.

For more complex operations, SAP recommends using **isql** to execute scripts, so you can keep a record of the RCL commands you have executed to set up a Replication Server. You can edit scripts and resubmit them whenever necessary. Scripts are also useful when you are verifying a new system or investigating the cause of a failure.

You can use **isql** to log in to Replication Server or Adaptive Server. You can use **isql** with both the interactive and script methods to interact with Replication Server. For information about using **isql** with Adaptive Server, refer to the Adaptive Server utility programs manual for your operating system.

Using isql Interactively

You can use **isql** interactively for simple operations.

1. If necessary, start the Replication Server.
2. Log in to the Replication Server using the following command:

   ```
   isql -Uuser_name -Ppassword -Sserver_name
   ```

   Specify the name of the Replication Server using the **-S** flag.

If your login is accepted, **isql** displays a prompt:

```
1>
```

3. Enter the RCL command you want to execute.

   When you press the Return key at the end of a line, **isql** increases the line number. Some commands require more than one line.
4. To execute the command, enter "go" (on a line by itself, with no blanks) and press Return.

   To cancel the command, enter "reset" and press Return. The prompt's line number is reset to 1.

   Some RCL commands display immediate results. Others execute asynchronously, that is, they return a system prompt without necessarily having completed the desired action and report only syntax errors.
5. To exit **isql**, enter "quit" at the beginning of a line.

Note: You can check the status of asynchronous commands by executing RCL commands that display status or by querying the RSSD system tables at the affected sites. See *Replication Server Reference Manual > Replication Server System Tables* for more information on system tables and the stored procedures you can use to query them.

See also

- *Starting Replication Server* on page 64

Using isql to Execute Scripts

You can create scripts of RCL commands and execute the scripts using **isql**, which is useful when you need to execute the same set of commands in Replication Servers at multiple sites.

1. Start Replication Server if it is not running.
2. Create a text file for your script, and enter into it the RCL commands you want to execute. As with the interactive method, separate each command with a **go** command on a line by itself.
3. Execute the script using this **isql** syntax:

   ```
   isql -Uuser_name -Ppassword -Sserver_name
               -iscript_name
   ```

   isql displays the results from the commands in the script on your screen as the standard output. Optionally, you can redirect the output to a file:

   ```
   isql -Uuser_name -Ppassword -Sserver_name
               -iscript_name > output_file
   ```

See also

- *Starting Replication Server* on page 64

Starting Replication Server

Start Replication Server and replication system components in sequence.

Normally, you need to restart Replication Server only if you are reconfiguring system files or if your system experienced a failure that brought down Replication Server. Initially, the installation process starts the replication system for you.

1. Start the data server containing the databases that Replication Server manages.
2. If Replication Server uses Adaptive Server Enterprise for the RSSD, start the RSSD. For more details, see the *Replication Server Installation Guide* for your platform.
3. Start Replication Server by running the **repserver** on UNIX systems or **repsrvr.exe** on Windows systems, or by executing the Replication Server run file.
4. Start RepAgent for the data server and for the RSSD if RepAgent has not been configured to start automatically at server startup.
5. To ensure that Replication Server started with no errors:
   a) Check the `repserver.log` file for error messages (indicated with the letter "E" on the left), as described in *Replication Server Administration Guide Volume 2 > Handle Errors and Exceptions > Error log files > Replication Server Error Log*.
   b) Use **isql** to log in to each Replication Server, or use a script that logs in to each server. See *Replication Server Administration Guide Volume 2 > Verify and Monitor Replication Server > Monitoring Replication Server > Verify Server Status*.

See also

- *Replication Server Executable Program* on page 64

Replication Server Executable Program

Use **repserver** or **repsrvr.exe** at the operating system prompt to run the Replication Server program.

For example, to run **repserver**, log in to the operating system as the "sybase" user, and execute **repserver** using the following syntax:

```
repserver [-C config_file] [-i id_server] [-S rs_name]
    [-I interfaces_file] [-E errorlog_file] [-M] [-v]
    [-K keytab_file]
```

See *Replication Server Reference Manual > Executable Programs* for complete information about each of the parameters of the **repserver** command.

The **rs_init** program creates the run file "RUN_*name*," where *name* is the name of the Replication Server. The run file specifies the **repserver** command with parameters set for the installed Replication Server. Normally, you start Replication Server by executing the run file.

The Replication Server executable program is located in the `bin` subdirectory, and the Replication Server `run` file is in the `install` subdirectory of the SAP Sybase release directory. Refer to the Replication Server installation and configuration guides for your platform for more information.

Replication Server Configuration File

Replication Server finds the startup information it needs in the Replication Server configuration file.

The file is created by the **rs_init** program, but it can be edited with a text editor. If it contains encrypted passwords, however, you must modify them using **rs_init**. See the Replication Server installation and configuration guides for your platform. The default name for the Replication Server configuration file is the Replication Server name with "`.cfg`" appended.

Stopping a Replication Server Using isql

Stop a Replication Server using the **isql** utility.

When you shut down a Replication Server, it refuses additional connections, terminates threads, and exits.

1. Use **isql** to log in to the Replication Server as the System Administrator:

   ```
   isql -Usa -Psa_password -Sservername
   ```
2. Enter:

   ```
   shutdown
   go
   ```

Add a Replication Server

To add a Replication Server to a replication system, use the **rs_init** program, as described in the installation and configuration guides for your platform.

Always conduct a careful review and analysis of how the additional Replication Server will fit into your system. Determine the other processes that are required for the server and designate required names and accounts for these processes.

The first Replication Server you install must be the ID Server. It must be running when you install new Replication Servers or add databases to the replication system.

You can use SAP Control Center to add Replication Server to a replication system when you are creating a replication environment.

When you install each Replication Server, **rs_init** performs the following tasks:

- Creates a configuration file for the Replication Server
- Creates an executable run file to start the Replication Server
- Sets RepAgent parameters at Adaptive Server

- Creates and initializes the RSSD or the ERSSD.
- Starts the Replication Server and RepAgent for the RSSD, as necessary

After you have executed **rs_init** for each Replication Server you are adding:

1. Determine the routing for the Replication Server, and modify the routes in the existing system to accommodate the new Replication Server.
2. If you want to add a new database, prepare that database for replication.
3. Grant users the appropriate permissions for Replication Server commands.
4. If applicable, add replication definitions, subscriptions, function-string classes, and error classes for the Replication Server.

See *Customize Database Operations* and *Errors and Exceptions Handling* in the *Replication Server Administration Guide Volume 2*.

See also

- *Manage Routes* on page 141
- *Manage Database Connections* on page 165
- *Manage Replication Server Security* on page 207
- *Manage Replicated Tables* on page 279
- *Manage Subscriptions* on page 373

Add a Replication System Domain

A replication system domain includes all replication system components that use the same ID Server.

Most replication systems should be set up as a single domain with a single ID Server. However, you may require replicates of two separate data environments in the following situations if:

- Your enterprise requires data management by separate groups, sites, or independent organizations.
- You need to eliminate an ID Server as a single point of failure, thereby creating a fault-tolerant system.

  An ID Server failure in a domain results in system degradation. New Replication Servers and databases cannot be added to a domain as long as the ID Server is shut down.

If you do use multiple replication system domains, be sure to have completely independent data environments. For example, assume you have one data environment tracking personnel, and another tracking inventory. As long as there is no data sharing or relationship between these two groups, you can create two separate domains, one for each data environment.

Guidelines for Adding Replication System Domains

You must observe certain guidelines before you create multiple ID Servers for multiple replication system domains.

- Make sure all Replication Server and data server names are globally unique across domains.

  By using unique names, you simplify your administration and prevent confusion, especially in the interfaces files, which contain network access information for servers.
- You need to assign the ID number each time a Replication Server or database is added to the replication system.
- Maintain unique names and distinct ID numbers to accommodate the future possibility of data transfer between domains (that is, merging of domains).
  - Provide a different range of database and Replication Server ID numbers for each domain.
  - Make sure the ID numbers of any additional domains are large enough so that they do not overlap with the ranges of the first domain.
- Make sure that replication definition names are globally unique within and between ID Server domains.

Examples of Assigning ID Numbers

You can only use the ID numbers within specified ranges for each ID Server in your replication environment.

The ID number is increased each time a Replication Server or database is added to the replication system. By default, your first ID number for a data server is 101. For a Replication Server it is 16,777,317. The last possible ID number for a data server is 16,777,316. For a Replication Server it is 33,554,431.

If you are creating two domains, you could assign ID numbers according to the table.

Table 3. Suggested ID Numbers for Multiple ID Servers

Component	First ID number	Last ID number
1st domain data server	101	99,999
2nd domain data server	100,000	16,777,316
1st domain Replication Server	16,777,317	17,777,316
2nd domain Replication Server	17,777,317	33,554,431

When you are installing an ID Server using the **rs_init** program, you can specify the Starting Replication Server ID and the Starting Database ID.

Note: Make sure your ranges do not overlap from one domain to another. Make your ranges large enough so that ID numbers can never increase to the next range. For example, a range of 99,999 accommodates nearly all possible cases.

Set Replication Server Configuration Parameters

You can configure Replication Server or specific objects within the replication system by using one of several methods that update configuration parameters in the `rs_config` system table in the RSSD or the ERSSD.

You can also check configuration status information in this table.

Note: Replication Server startup information is stored in a configuration file created by **rs_init**. The default name for the Replication Server configuration file is the Replication Server name with "`.cfg`" appended. See *Replication Server Reference Manual > Executable Programs* for more information about the configuration parameters stored in this file.

Replication Server Configuration Parameters

Replication Server reads configuration parameters from the `rs_config` system table in the RSSD or ERSSD.

All configuration parameters have default values, which are inserted in the table when you use the **rs_init** utility to create the RSSD or ERSSD. The default values are sufficient for most replication systems. Normally, you change default values only for unusual environments or special situations. For example, you may need to adjust parameters for performance tuning if your system has a large number of replication definitions or subscriptions. You can change default values using **configure replication server**.

Basic parameters governing the names and version numbers of the Replication Server and its components can also be set with **rs_init**.

rs_init also sets the password encryption configuration parameter.

Many configuration parameters also have values for specific objects. You set these values after installation when your system requires the fine-tuning that these parameters allow. For example, default route parameters affect all routes that originate at the current Replication Server. If necessary, you change the default settings for these parameters with **configure replication server**. You also can set parameter values for individual routes by using the **alter route** command.

Setting some configuration parameters requires a technical understanding of the replication system.

It is important to back up the RSSD periodically, and whenever you do anything to change its state. ERSSD is already configured for daily automated backup.

See *Replication Server Administration Guide Volume 2 > Performance Tuning*. See *Replication Server Administration Guide Volume 2 > Performance Tuning > Configuration Parameters that Affect Performance*.

See also

- *SAP Replication Server Technical Overview* on page 23
- *Manage the RSSD* on page 72
- *Manage the Embedded Replication Server System Database* on page 74

Basic Configuration Parameters

Basic parameters govern the names and version numbers of the Replication Server and its components.

Warning! Do not change the values for the basic configuration parameters. The values are set when you run **rs_init** and should only be modified by the **rs_init** program when you upgrade or downgrade Replication Server.

Table 4. Basic Configuration Parameters

Configuration Parameter	Description
current_rssd_version	The Replication Server version supported by this RSSD. The Replication Server checks this value at startup.
id_server	The name of the ID Server for this Replication Server.
minimum_rssd_version	The minimum version of the Replication Server that can use this RSSD. When the **current_rssd_version** is greater than the version of the Replication Server, this value is checked when the Replication Server is started.
oserver	The name of the current Replication Server.
prev_min_rssd_version	Following an **rs_init** installation upgrade, this value contains the previous value of **minimum_rssd_version**.
prev_rssd_version	Following an **rs_init** installation upgrade, this value contains the previous value of **current_rssd_version**.
rssd_error_class	Error class for the RSSD. Default: **rs_sqlserver_error_class**
send_enc_pw	Ensures that Replication Server makes client connections to the RSSD with an encrypted password. Values are “on” and “off” (the default).

See also

- *Send Encrypted Passwords for Replication Server Client Connections* on page 216

Different Types of Configuration Parameters

There are different types of configuration parameters in the `rs_config` system table that affect the Replication Server and different database objects.

The method for changing a parameter also varies according to the object that the parameter affects. The different types of configuration parameters are:

- Local Replication Server – parameters whose effects are restricted to the current Replication Server. These include the basic configuration parameters and the parameters listed in *Replication Server Administration Guide Volume 2 > Performance Tuning > Configuration Parameters that Affect Performance* > Replication Server Parameters that Affect Performance.
- Route – parameters that affect routes from the current Replication Server to other Replication Servers.
- Database connection – parameters that affect database connections originating with the Replication Server. See *Replication Server Administration Guide Volume 2 > Performance Tuning > Use Parallel DSI Threads > Parallel DSI parameters*.
- Logical database connection – Replication Server parameters that apply to logical database connections for warm standby applications. See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications > Alter Warm Standby Database Connections > Alter Logical connections > Change Parameters Affecting Logical Connections* f or information about setting default and per-target values for logical connection parameters.
- Network-based security services – parameters that affect network security.
- Performance – parameters that affect the performance of a Replication Server. See *Replication Server Administration Guide Volume 2 > Performance Tuning > Configuration Parameters that Affect Performance* and *Replication Server Administration Guide Volume 2 > Performance Tuning > Use Parallel DSI Threads > Parallel DSI parameters*.

See also

- *Change SAP Replication Server Parameters* on page 70
- *Change Routes* on page 153
- *Set and Change Parameters Affecting Physical Connections* on page 174
- *Manage Network-based Security* on page 237
- *Basic Configuration Parameters* on page 69

Change SAP Replication Server Parameters

You can modify configuration parameters that affect the current SAP Replication Server by using **configure replication server** at the SAP Replication Server.

To change default configuration parameter values using **configure replication server**, log in to SAP Replication Server and execute **configure replication server** at the **isql** prompt.

Use this syntax where *config_param* is a character string that corresponds to the configuration parameter name and *value* is a character string representing the setting you want for the parameter:

```
configure replication server
        set config_param to 'value'
```

The *config_param* string must match an entire parameter name. You may have to restart SAP Replication Server for the new parameters to take effect.

Example 1

For example, to change the maximum number of messages allowed in the SAP Open Server message queue to 5, log in to the source SAP Replication Server and:

1. Execute the **configure replication server** command:
   ```
   configure replication server set num_msgs to '5'
   ```
2. Restart the SAP Replication Server.

Example 2

This example uses **configure replication server** to change the **ha_failover** parameter to enable Failover support for all non-RSSD connections from an SAP Replication Server to SAP ASEs.

1. Execute **configure replication server**. Log in to the SAP Replication Server for which you want to enable Failover support and enter:
   ```
   configure replication server
   set ha_failover to 'on'
   ```
   See *Configure the Replication System to Support SAP Failover* in the *Administration Guide Volume 2*.
2. Restart the SAP Replication Server.

Configuration changes take effect after you restart Replication Server.

See ***configure replication server*** in the *Reference Manual* .

Be aware of parameters affecting security and see *Performance Tuning* in the *Administration Guide Volume 2* for parameters affecting performance.

See also

- *Manage Replication Server Security* on page 207
- *Starting Replication Server* on page 64

Configure Dynamic Parameters

For dynamic configuration parameters, you do not need to restart the Replication Server for the new values to take effect. Use **configure replication server** to modify the parameter value.

Use **admin config** to retrieve the values of these parameters.

The **admin config** syntax is:

```
admin config [,”connection” |,“logical_connection” |,“route” ]
[,server
[,database]] [,configuration_name]
```

See the *Replication Server Reference Manual* for a detailed information in using this command.

Dynamic Configuration Parameters

Use **configure replication server** with dynamic configuration parameters to affect Replication Server behaviour without having to shut down and restart Replication Server.

Table 5. Dynamic Configuration Parameters

init_sqm_write_delay	**init_sqm_write_max_delay**
memory_limit	**num_concurrent_subs**
queue_dump_buffer_size	**sqm_recover_segs**
sqm_warning_thr_ind	**sqm_warning_thr1**
sqm_warning_thr2	**sqt_max_cache_size**
sqt_init_read_delay	**sqt_max_read_delay**
sts_cachesize	**sts_full_cache**_*system_table_name*

Manage the RSSD

The data in each Replication Server RSSD is essential in keeping the replication system running.

The replication system administrator or Adaptive Server system administrator manages the RSSD by monitoring the condition of the database and performing regular dumps. In the event of disaster recovery, you need to rely on up-to-date backups of the RSSD for full system recovery. Therefore, it is critical that you perform periodic backups of the replication system.

It is also important to back up the RSSD after performing tasks that change its state, such as adding routes, replication definitions, and subscriptions, or altering function strings for databases to which you are connected.

The system tables are loaded into the RSSD during Replication Server installation. You can query the system tables to find the status of the system, but in general, you should not make changes to the tables directly. Refer to the *Replication Server Reference Manual* for detailed descriptions of the system tables.

Enable Failover Support for an RSSD Connection

Use SAP Failover to configure two version 12.0 or later SAP ASEs as companions. If the primary companion fails, the devices, databases, and connections of the primary companion can be taken over by the secondary companion.

For more detailed information about how SAP Failover works in SAP ASE, see *Using SAP Failover in a High Availability System* which is part of the SAP ASE documentation set.

To enable Failover support for an RSSD connection, use either of the following methods:

- Use **rs_init** when you install a new SAP Replication Server.

  For instructions, see *Configure Replication Server and Add Databases Using rs_init* in the configuration guide for your platform.
- Edit the SAP Replication Server configuration file after you have installed the SAP Replication Server.
  1. Use a text editor to open the SAP Replication Server configuration file. The default file name is the SAP Replication Server name with a "`.cfg`" extension.

     The configuration file contains one line per entry.
  2. Find the line "`RSSD_ha_failover=no`" and change it to:
     ```
     RSSD_ha_failover=yes
     ```
  3. To disable Failover support for an RSSD connection, change the "`RSSD_ha_failover=yes`" to:
     ```
     RSSD_ha_failover=no
     ```

     These changes take affect immediately; that is, you do not have to restart SAP Replication Server to enable Failover support.

If you cannot recover the most recent database state of the RSSD, see *Recover from RSSD failure* in the *Administration Guide Volume 2*.

Note: It is not possible to migrate an RSSD database across platforms using commands such as, cross-platform **dump** and **load**, or **bcp**. To migrate, you must rebuild the replication system on the new platform.

For instructions on how to enable Failover support for non-RSSD SAP Replication Server connections to SAP ASE, see *Configure the Replication System to Support SAP Failover* in the *Administration Guide Volume 2*.

Manage the Embedded Replication Server System Database

Replication Server can run on either an Adaptive Server Enterprise Replication Server System Database (RSSD) or on an Embedded RSSD (ERSSD). ERSSDs are designed for users who do not want to use Adaptive Server Enterprise to manage the Replication Server RSSD.

Replication Server is easy to install and manage with ERSSD. ERSSD is automatically installed, configured, and started in the background if you specify that you want to use it. Backup procedures are automatic and preconfigured.

Remember: You cannot migrate from ERSSD to RSSD. To use ERSSD, you must select it when you install Replication Server. See the *Replication Server Installation Guide*.

SAP provides ERSSD as an option in Replication Server, implemented in SQL Anywhere. SAP continues to support the traditional RSSD, implemented in Adaptive Server Enterprise. All the ERSSD features discussed pertain to ERSSD only; they do not affect the behavior of the traditional RSSD in Adaptive Server Enterprise.

ERSSD runs on three operating system files:

- A database root file
- A transaction log file
- A transaction log mirror file

When you start **rs_init**, provide the directories for these files, and make sure that the name of your ERSSD is in the interfaces file.

Tip: For better performance and better protection against disk failure, put each one of these files on a different physical device.

Obtain Information on ERSSD Settings

Learn how to obtain configuration settings and other information on ERSSD.

ERSSD has a preconfigured backup time, backup interval, and backup directory. Unless you want to change these defaults, you need not configure ERSSD. There are four files in the backup directory. This directory is specified when you install Replication Server with ERSSD. To check the current default values, enter:

```
sysadmin erssd
```

In the Replication Server configuration file, you can find the:

- ERSSD database file path
- ERSSD transaction log file path
- ERSSD transaction log mirror file path

- Backup directory path

ERSSD Configuration Parameters and Command

Use the ERSSD configuration parameters to configure backup time and backup directory, and ERSSD routing.

Syntax

```
configure replication server
set
     {erssd_backup_start_time |
     erssd_backup_start_date |
     erssd_backup_dir |
     erssd_backup_interval | erssd_ra}
to 'value'
```

Warning! Do not update these values directly in the **rs_config** table.

Table 6. ERSSD Configuration Parameters

Parameter	Value	Default
erssd_backup_start_time	Time the backup starts. Specified as: “hh:mm AM” or “hh:mm PM”, using a 12-hour clock, or “hh:mm” using a 24-hour clock.	01:00 AM
erssd_backup_start_date	Date the backup begins. Specified as “MM/DD/YYYY”	Current date
erssd_backup_interval	Interval between backups of database and log. Specified as “nn hours” or “nn minutes” or “nn seconds”.	24 hours
erssd_backup_dir	Location of stored backup files. Should be a full directory path. Configuring this path causes an immediate, unscheduled backup.	Same directory as the transaction log mirror; initial value specified in **rs_init**
erssd_ra	Its value should be a server name. It is only used when when a user creates a route from the current site.	*erssd_name*_**ra** where *erssd_name* is the ERSSD name in the your replication system

Backup ERSSD

An automatic full backup, including both the database file and the transactional log file, is performed at the default or the configured time. You can perform an unscheduled backup for ERSSD.

There are four files in the backup directory. This directory is specified when you install Replication Server with ERSSD.

The transaction log is mirrored, providing extra protection for critical data, and enables complete recovery of the transaction log file.

To perform an unscheduled backup, enter:

```
sysadmin erssd, backup
```

ERSSD Backup Directory Files

The Replication Server backup directory contains backup files for the ERSSD database and transaction log. The backup directory is specified when you install Replication Server with ERSSD.

Table 7. Backup Directory Files for ERSSD

File name	File definition
erssd_name.**db**	Backup database file
erssd_name.**log**	Backup transaction log
erssd_name.**db.pre**	Previous backup database file
erssd_name.**log.pre**	Previous backup transaction log

ERSSD Routing

Use **create route** to create a route from Replication Server with ERSSD.

You can create a route from a Replication Server with ERSSD, as long as both the source and the destination servers are version 15.0 or later. Verify that the Replication Agent name is in the Replication Server interfaces file; an ERSSD Replication Agent is started as an open server during **create route** and if its name does not appear in the interfaces file, the command fails

The default ERSSD Replication Agent name is *erssd_name*_**ra**. To replace the default name with that of your Replication Agent server, enter:

```
configure replication server
set erssd_ra to 'value'
```

Note: SAP provides ERSSD in SQL Anywhere (SA) as an option, and continues to support the traditional RSSD in the Adaptive Server Enterprise.

Move ERSSD Files

Use **sysadmin erssd** to move the ERSSD database file, transaction log, or transaction log mirror.

Do not edit the configuration file itself. Moving the database file, transaction log, and transaction log mirror is an expensive operation. Only use it when you are sure it is necessary. For more information on **sysadmin erssd**, see the *Replication Server Reference Manual*.

ERSSD User Administration

You can change ERSSD user paswords, add users, and assign permissions.

There are only two users in the ERSSD, the primary user, who also acts as system administrator, and the maintenance user. You can find their names and passwords in the configuration file. You can do the following to change the user password:

- Use **alter user** to alter the primary user password.
- Use **alter connection** to alter the maintenance user password.

Both these commands alter the password at Replication Server as well as at ERSSD, and update the Replication Server configuration file.

For more information on these commands see the *Replication Server Reference Manual*.

To add a user at the ERSSD, use **isql** to access the ERSSD as the primary user and execute **grant connect to** *username* **identified by** *password*.

To give a user permission to read the Replication Server system tables, execute the command **grant membership in group rs_systabgroup to** *username*.

To grant **sa** privileges to a user, execute **grant dba to** *username*.

Reduce ERSSD File Size

Use **sysadmin erssd** with the **defrag** parameter to recover any unused space, shrink the ERSSD size, and rebuild the ERSSD database file.

When Replication Server deletes rows from the ERSSD, for example when Replication Server deletes exceptions from the exception log, the ERSSD database does not release the space back to the ERSSD filesystem. Therefore, you must defragment the ERSSD database to recover disk space.

The **defrag** parameter uses the **dbunload** SQL Anywhere command to rebuild the ERSSD.

Before defragmenting the ERSSD:

- Verify you have sufficient disk space in your ERSSD as defragmentation requires as much space as the original ERSSD for working space.
- Set your site version to 15.0 or later to allow you to use the **defrag** parameter.

- Verify the replication system is not busy.

Executing **sysadmin erssd, defrag**:

1. Shuts down eRSSD.
2. Shuts down **dbltm**, the ERSSD Replication Agent, if **dbltm** is running.
3. Calls **dbunload** to rebuild and defragment the ERSSD database file. **dbunload** saves the old transaction log as `erssdName.olg` in the transaction log directory.
4. Restarts ERSSD.

The dREC recovery daemon restarts the **dbltm** for the ERSSD.

Note: During the defragmentation process, more files may be generated in the transaction log directory. Do not delete these files. Replication Server and **dbltm** will remove the files when the files are not needed.

ERSSD Recovery Procedures

ERSSD automatically manages recovery from operating system crashes, database server crashes, and crashes caused by shutting down improperly. You can use several procedures designed for recover a database damaged by media failure and ensure a clean recovery after media failure.

See the Replication Server Reference Manual > Replication Server Commands > **sysadmin erssd**.

Prerequisites for Replication Server Recovery

Before using the recovery commands, set the relevant environment variables.

On UNIX platforms:

- Set your environment variable PATH to include `$SYBASE/$SYBASE_REP/ASA16/bin`:

  ```
  setenv PATH $SYBASE/$SYBASE_REP/ASA16/bin:$PATH
  ```
- Set your environment variable LD_LIBRARY_PATH (SHLIB_PATH on HP, LIB_PATH on AIX) to include `$SYBASE/$SYBASE_REP/ASA16/lib`:

  ```
  setenv LD_LIBRARY_PATH $SYBASE/$SYBASE_REP/ASA16/lib:
  $LD_LIBRARY_PATH
  ```

On Windows:

- Set your environment variable PATH to include `%SYBASE%\%SYBASE_REP%\ASA16\win32`:

  ```
  set PATH=%SYBASE%\%SYBASE_REP%\ASA16\win32;%PATH%
  ```

Recovering After Media Failure of the Database File

You can recover the ERSSD database file.

1. Make an extra backup copy of the current transaction log. If the database file is gone, the only record of changes since the last backup is in the transaction log.
2. Create a recovery directory to hold the files you use during the recovery process.
3. Copy the database file from the last full backup to the recovery directory. You can find the database file in the backup directory. It is named *erssd_name*`.db`.
4. Copy the backup transaction log into the recovery directory. The backup transaction log, named *erssd_name*`.log`, is in the backup directory.
5. Apply the transactions from the backup transaction log to the recovery database:

   ```
   dbsrv16 erssd_name.db -a erssd_name.log
   ```
6. Copy the online transaction log into the recovery directory. The online transaction log, named *erssd_name*`.log`, is in the log directory.
7. Apply the transactions from the online transaction log to the recovery database:

   ```
   dbsrv16 erssd_name.db -a erssd_name.log
   ```
8. Make a post-recovery backup by making an extra copy of the database file.
9. Move the database file to the production directory and restart the database. Use the command **dbspawn** from the Replication Server error log.
10. (Optional) Issue these commands if the location of the post-recovery Replication Server differs from the location of the pre-recovery Replication Server:

    ```
    dblog -t <fully_qualified_directory>erssd_name.log
    <fully_qualified_directory>erssd_name.db
    dblog -m <fully_qualified_directory>erssd_name.mlg
    <fully_qualified_directory>erssd_name.db
    ```
11. Perform validity checks on the recovery database:

    ```
    dbvalid -c
    "uid=primary_user_name;
    pwd=primary_user_password;eng=erssd_name;
    LINKS=tcpip
    (DOBROAD=NONE;HOST=localhost;PORT=port)"
    ```
12. Restart Replication Server.

Recovering from Media Failure on the Database Transaction Log

You can recover the ERSSD database transaction log.

1. Identify the corrupted file. You can do this by running the Log Translation utility on both the transaction log and its mirror to see which one generates an error message. In this example, the Log Translation utility, **dbtran**, translates a transaction log named *erssd_name*`.log`, saving the translated output in *db_name*`.sql`.

   ```
   dbtran erssd_name.log
   ```

The Log Translation utility translates the intact file with no errors, but reports an error when translating the corrupt file.

2. Copy the correct file over the corrupted file, so that the two files are identical.
3. Restart the database, using **command** from the Replication Server error log.
4. Restart Replication Server.

Resetting the Truncation Point in the ERSSD Transaction Log

You can only reset the truncation point if the Replication Agent for an SAP SQL Anywhere is running and there are existing routes.

ERSSD is an SAP SQL Anywhere database and you must execute the **dblog**, **dbsrv**, and **dbstop** SQL Anywhere commands at the system prompt. See the SAP SQL Anywhere documentation for the command syntax and to set the environment for the commands. SAP SQL Anywhere 16 is the current ERSSD used in Replication Server.

Warning! Only reset the secondary truncation point if the Replication Agent for SQL Anywhere Log Transfer Manager (LTM) is running and there are existing routes. Resetting removes the current secondary truncation point and moves the point to the most newly created spot in the database transaction log.

1. Shut down Replication Server using **shut down**.
2. Reset the ERSSD database log at a system prompt:

   ```
   dblog -il <fully_qualified_directory>erssd_name.db
   ```

   Use **dblog -il *<fully_qualified_directory>erssd_name*.db** to reset the Log Transfer Manager log offset that is kept for the SQL Anywhere **delete_old_logs** option, allowing transactions from the transaction log to be deleted when the transactions are not required. The **dblog -il <fully_qualified_directory>erssd_name.db** command performs on SAP SQL Anywhere databases, such as ERSSD, the same function that **dbcc settrunc('ltm', 'ignore')** performs on Adaptive Server databases.
3. Move the current database log file from the `translog` directory in Replication Server to another location.

   Retain the current log file for a few days in case you encounter problems with the new log file.
4. Start a new database log file.
   For example, in UNIX enter:

   ```
   dblog -t $SYBASE/REP_15-5/ASA16/translog/erssd_name.log
   $SYBASE/REP_15-5/ASA16/dbfile/errsd_name.db
   ```
5. Start the ERSSD database server at the system prompt:

   ```
   ERSSD start command: /sybase/REP-15_5/ASA16/bin/dbspawn
   -f -q /sybase/REP-15_5/ASA16/bin/dbsrv16
   -s none -ti 0 -x "tcpip(PORT=15501;DOBROAD=NO;BLISTENER=NO)"
   -o /sybase/REP-15_5/errorlog/rs157_prs_ERSSD.out
   /sybase/REP-15_5/dbfile/rs157_prs_ERSSD.db
   ```

6. Reset the ERSSD database locator value to 0:
    a) Start **isql**.
    b) Execute **rs_zeroltm** on the ERSSD database:

    ```
    rs_zeroltm erssd_name, erssd_name
    ```

    c) Exit **isql**.
7. Stop the ERSSD database at the system prompt:

    ```
    dbstop -c
    “eng=erssd_name;uid=primary_user_name;
    pwd=primary_user_password”
    ```

8. Start Replication Server.

See also

- *Starting Replication Server* on page 64
- *Stopping a Replication Server Using isql* on page 65

Quiesce Replication Server

To quiesce a replication system means to put the system in a state in which no Replication Servers have messages to send or receive.

You may need to quiesce all Replication Servers in the system to recover databases, alter routes, and troubleshoot the system. A Replication Server is quiescent when the following conditions are true:

- Subscription materialization queues do not exist.
- Replication Server has read all messages in all queues.
- Transaction caches for inbound queues contain no complete transactions.
- Messages in RSI queues have been sent and acknowledged.
- Messages in DSI queues have been applied and acknowledged.

Quiescing a Replication System

You can use a sequence of commands or SAP Control Center to quiesce a system consisting of several Replication Servers.

1. Execute the **suspend log transfer from all** command at each Replication Server. This prevents RepAgent from connecting to the Replication Servers.
2. Execute **admin quiesce_force_rsi** at each Replication Server.

    This command forces Replication Server to deliver all queued messages to other Replication Servers, then reports whether the system is successfully quiesced.

Quiescing occurs most efficiently if you follow the flow of the data. For example, if data flows from TOKYO_RS to MANILA_RS to SYDNEY_RS, quiesce the Replication Servers in that order.

3. Check that the Replication Server is quiescent using **admin quiesce_check**. If necessary, repeat steps 2 and 3 until all Replication Servers are quiescent.
4. After all Replication Servers are quiescent, execute **admin quiesce_force_rsi** once more at each Replication Server. Check that each Replication Server is quiescent using **admin quiesce_check**. If necessary, repeat this step until all Replication Servers are quiescent.

   This step is necessary because, although a Replication Server may be quiescent, it may have recently sent messages to another Replication Server. These messages may initiate more communication between these two Replication Servers or between several Replication Servers in the replication system. Repeating steps 2 and 3 ensures that you have quiesced the entire replication system.

Remove a Replication Server

How you remove a Replication Server from a replication system depends on whether or not the Replication Server is active (running). It is easiest to remove a Replication Server that is active. You must also drop routes and subscriptions when you remove a Replication Server.

See also

- *Manage Subscriptions* on page 373
- *Manage Routes* on page 141

Removing an Active Replication Server

Drop subscriptions, replication definitions, connections, routes, and perform other tasks in the correct sequence to ensure you can safely remove an active Replication Server from service.

1. Query the RSSD to determine what replication definitions are defined at the primary Replication Server (the server you are removing from service). You can use the **rs_helprep** stored procedure to do this. See *Replication Server Reference Manual > RSSD Stored Procedures >* **rs_helprep** and, see *Replication Server Reference Manual > Replication Server System Tables*
2. Drop subscriptions and replication definitions.
   a) For each replication definition defined at the primary Replication Server, execute the **drop subscription** command for each subscription on all Replication Servers that manage subscribing data.

      To retain data at the replicate, execute the **drop subscription** command **without purge**.

To delete data at the replicate, execute the **drop subscription** command **with purge**.

b) Drop all replication definitions for primary data managed by the Replication Server (determined in step 1).

   Wait for the replication definitions to disappear from the RSSDs of Replication Servers that the Replication Server has a route to.

c) At the Replication Server you are removing, drop all subscriptions to replication definitions on other Replication Servers.

   To retain data at the replicate, execute the **drop subscription** command **without purge**.

   To purge data at the replicate, execute the **drop subscription** command **with purge**.

3. If the Replication Server is the primary Replication Server for a function-string class or error class, execute the **move primary** command at another Replication Server to change the primary Replication Server for each class.

During a **move primary** operation, routes must exist from the old primary site to the new primary site, and from the new primary site to the old primary site. The Replication Server assuming the role of the primary site also must have routes to all of the same Replication Servers as the old primary site.

4. Drop database connections.

a) Stop all RepAgents connected to the Replication Server, using the **sp_stop_rep_agent** system procedure at Adaptive Server.

b) Remove connections to all databases managed by this Replication Server, using the **drop connection** command.

Note: If you want to continue to maintain the replicate data in databases previously managed by a Replication Server that has been removed from service, you must create connections to those databases from some other Replication Server and create new subscriptions.

5. Perform the following routing tasks:

a) If the Replication Server is an intermediate site in a route, use the **alter route** command so it is no longer an intermediate site.

b) Drop all routes *from* the Replication Server.

   To do this, execute the **drop route** command for each route from the Replication Server to another Replication Server.

c) Drop all routes *to* the Replication Server.

   To do this, execute the **drop route** command on each Replication Server that has a route to the Replication Server you are removing.

6. After all subscriptions and routes to and from the Replication Server are dropped, remove the Replication Server from the list maintained by the ID Server. To do this, execute the **sysadmin droprs** command on the ID Server:

```
sysadmin droprs, replication_server
```

See *Replication Server Reference Manual > Replication Server Commands >* ***sysadmin dropprs***.

7. Remove all databases managed by the Replication Server from the database list maintained by the ID Server. Include the RSSD. To remove databases, run the **sysadmin dropdb** command on the ID Server, for each database:

   ```
   sysadmin dropdb, data_server, database
   ```

   See *Replication Server Reference Manual > Replication Server Commands >* ***sysadmin dropdb***.

See also

- *drop subscription Command* on page 403
- *Manage Routes* on page 141

Removing an Inactive Replication Server

An inactive Replication Server is one that is not running. To take an inactive Replication Server out of service, you must drop and purge routes, and perform other tasks to safely remove the Replication Server from service.

1. Drop all routes to the Replication Server.

   To do this, execute the **drop route** command with the **with nowait** option on each Replication Server that has a route to the Replication Server. For example:

   ```
   drop route to OLD_RS with nowait
   ```

   This command also deletes information about subscriptions created at OLD_RS for data managed by this Replication Server.
2. If the Replication Server you are removing is primary for any function-string classes or error classes other than the system defaults, **rs_default_function_class** and **rs_sqlserver_error_class**, create a replacement for each class at a new primary. To do this:
   a) Choose a Replication Server that has routes to all other Replication Servers that use the class.
   b) Create a new class at that Replication Server containing the same function strings or error actions as the original class. See *Replication Server Administration Guide Volume 2 > Customize Database Operations* and *Replication Server Administration Guide Volume 2 > Handle Errors and Exceptions*.
   c) Alter each database connection that is using the original class to use the new class instead.
3. On each Replication Server that has a route from the Replication Server, purge the Replication Server route.

   To purge a route, execute the **sysadmin purge_route_at_replicate** command on each Replication Server to which the Replication Server had a route. For example:

```
sysadmin purge_route_at_replicate, OLD_RS
```

This command also removes:

- Subscription information for data originating at the Replication Server you are removing from service.
- Function-string and error classes defined at the Replication Server you are removing from service. If the Replication Server is the primary site for **rs_default_function_class**, **rs_sqlserver_function_class**, or **rs_sqlserver_error_class**, these classes are not removed but are reset to have no primary Replication Server.

4. Remove the Replication Server from the list maintained by the ID Server. To do this, execute the **sysadmin droprs** command on the ID Server:

   ```
   sysadmin droprs, replication_server
   ```

   See *Replication Server Reference Manual > Replication Server Commands >* ***sysadmin droprs***.
5. Remove all databases managed by the Replication Server from the database list maintained by the ID Server. Include the RSSD. To remove databases, run the **sysadmin dropdb** command on the ID Server, for each database:

   ```
   sysadmin dropdb, data_server, database
   ```

   See *Replication Server Reference Manual > Replication Server Commands >* ***sysadmin dropdb***.

This completes the removal of an inactive Replication Server from a replication system.

Next

Keep in mind these three additional points:

- If you want to continue to replicate any data in the databases previously managed by the Replication Server, you must reassign those databases to some other Replication Server.
- Since the subscriptions to the Replication Server data did not go through normal subscription dematerialization, replicate data has not been deleted from replicate Replication Servers.
- You may need to create additional routes to maintain the replication system—for example, if the Replication Server is an intermediate on an indirect route.

See also

- *Manage Database Connections* on page 165

Manage RepAgent and Support Adaptive Server

Learn about Replication Server support for Adaptive Server features, and how to set up, configure, and manage RepAgent, the Replication Agent for Adaptive Server.

RepAgent is an Adaptive Server thread; it scans the database transaction log and sends transaction information to the Replication Server for distribution to subscribing databases.

See *Replication Server Administration Guide Volume 2 > Performance Tuning > Replication Server Internal Processing > Processes in the Primary Replication Server > Replication Agent User Thread*.

See also

- *SAP Replication Server Technical Overview* on page 23

Set up RepAgent

After Replication Server and Adaptive Server are installed on your system, you must enable a RepAgent for each database the Replication Server manage.

Enable a RepAgent for each database the Replication Server manages if the database:

- Contains primary data, or
- Contains stored procedures marked for replication

In addition, if Replication Server is the source site for any route, you must enable RepAgent for the Replication Server RSSD.

In some scenarios for setting up RepAgent, you use **rs_init**, in other scenarios you must use command line options:

- If you install a new Replication Server or add a new database, use **rs_init** to set up RepAgent. This process enables RepAgent, set default parameters, and start RepAgent. See the *Replication Server Configuration Guide* for your platform for information about **rs_init**.
- To change an existing replicate database to a primary database, you must use command line options.

Multithreaded RepAgent

By default, the Adaptive Server RepAgent consists of a single thread that scans the primary database log, generates LTL, and sends the LTL to Replication Server. With multithreaded RepAgent, the scanning and sending activities are performed by separate threads. You can then configure multithreaded RepAgent to use additional paths from the primary database to support Multi-Path Replication™.

See *Replication Server Administration Guide Volume 2 > Performance Tuning > Multi-Path Replication*.

Configuring RepAgent Using Command Line Options

There are several basic steps for configuring RepAgent from the command line.

Prerequisites

Task

1. Define the local Adaptive Server using **sp_addserver**.
2. Enable the RepAgent feature on Adaptive Server using **sp_configure**.
3. Enable the RepAgent feature for each database using **sp_config_rep_agent**.
4. Enable log transfer on Replication Server using **alter connection**.
5. Start the RepAgent on Adaptive Server using **sp_start_rep_agent**.

Define the Local Adaptive Server

If you are starting Adaptive Server for the first time, you must execute the Adaptive Server system procedure **sp_addserver** to add an entry for the local server to the Adaptive Server `sysservers` table.

See the *Adaptive Server Enterprise Reference Manual* for information about using **sp_addserver**.

Enabling RepAgent on Adaptive Server

Use **sp_configure** to enable RepAgent on Adaptive Server.

You need to perform this task only once at each Adaptive Server.

sp_configure 'enable rep agent threads' is a dynamic option. It takes effect immediately. However, you may want to restart Adaptive Server after enabling RepAgent so that Adaptive Server allocates a fixed number of dedicated static process structures for the thread. Otherwise, RepAgent borrows process structures from the pool dedicated to user connections.

Log in to Adaptive Server and at the **isql** prompt, enter:

```
sp_configure 'enable rep agent threads', 1
```

Enabling RepAgent at the Primary Database

Execute **sp_config_rep_agent** to enable the RepAgent for each primary database and set default values for RepAgent configuration parameters.

You can reset the default values at a later time. In this example, *dbname* is the name of the database for which you are enabling RepAgent, *repserver_name* is the Replication Server to which RepAgent connects, and *repserver_username* and *repserver_password* are the name and password RepAgent uses to log in to Replication Server.

Note: Make sure that *repserver_username* is a valid Replication Server user and that it has Replication Server **connect source** permission. Try out the user name and password at the Replication Server before you use **sp_config_rep_agent**.

Log in to Adaptive Server. At the **isql** prompt, and enter:

```
use dbname
go
sp_config_rep_agent dbname, enable, 'repserver_name',
        'repserver_username', 'repserver_password'
```

See also

- *Configuring RepAgent* on page 89

Enabling Log Transfer for the Primary Database

Use **set log transfer on** to enable log transfer for each connection between Replication Server and a primary database.

Note: You must create a database connection between Replication Server and the data server using **rs_init** or **create connection** before you can turn on log transfer. See the *Replication Server Configuration Guide* for your platform for information about creating connections using **rs_init**.

Turn on log transfer for the database connection to the primary database using **alter connection**. For example, at the Replication Server, enter:

```
alter connection to TOKYO_DS.pubs2
    set log transfer on
```

See also

- *Manage Database Connections* on page 165

Configuring RepAgent

Use **sp_config_rep_agent** to change the default RepAgent configuration parameters.

The default RepAgent configuration parameters are set after enabling RepAgent using **rs_init** or **sp_config_rep_agent**. Configuration parameters affecting RepAgent are stored in the `sysattributes` table of the database for which RepAgent is enabled. You must restart RepAgent for the new parameters to take effect. There are also network security configuration parameters for RepAgent if your system supports network-based security.

To configure RepAgent:

1. Log in to Adaptive Server and specify the database.
   For example:

```
use dbname
go
```

2. Execute **sp_config_rep_agent** once for each parameter you want to configure.
   For example, to change the maximum number of log records sent to Replication Server in a batch to 2000:

   ```
   sp_config_rep_agent dbname, ‘scan batch size’, ’2000’
   go
   ```

3. Restart RepAgent for the new parameter to take effect.

   ```
   sp_start_rep_agent dbname
   go
   ```

In the *Replication Server Reference Manual*, see:

- *Adaptive Server Commands and System Procedures*
- *RepAgent Configuration Parameters*

See also

- *Manage Network-based Security* on page 237
- *Starting RepAgent* on page 90

Master Key and rs password

Set the master key password and **rs password** attributes to continue replication.

In Adaptive Server, when you create the syb_extpasswdkey service key with the master key and you have not set the master key password in memory manually or automatically, the Adaptive Server RepAgent is blocked at startup and **sp_who** shows "MASTER KEY SLEEP" until you set the master key password. Each replication path has one **rs password** attribute that RepAgent uses to log in to Replication Server. When you drop the syb_extpasswdkey service key, Adaptive Server resets all the existing RepAgent **rs password** attributes. If you enter **sp_encryption helpextpasswd**, you see "Needs Reset". You must reset all the **rs password** attributes to continue replication.

See *Adaptive Server Enterprise > Encrypted Columns Users Guide > Securing External Passwords and Hidden Text > Service Keys*.

Starting RepAgent

Use **sp_start_rep_agent** to start RepAgent on Adaptive Server.

Prerequisites

There must be an entry for Replication Server in the interfaces file of the Adaptive Server.

Task

Normally, you need to start a RepAgent thread only if you:

- Reconfigure the RepAgent parameters.
- Explicitly shut down the RepAgent.

RepAgent starts automatically when Adaptive Server restarts if you had:

- Started RepAgent at least once with **sp_start_rep_agent** and not stopped RepAgent with **sp_stop_rep_agent**.
- Set **auto start** to true with **sp_config_rep_agent**.

Note: RepAgent can be restarted only if its associated database is fully recovered and online and log transfer is on for the connection to the primary database.

See *Replication Server Reference Manual > Adaptive Server Commands and System Procedures* for detailed information about each option of **sp_start_rep_agent** and **sp_config_rep_agent**.

1. Log in to Adaptive Server
2. At the **isql** prompt, enter **sp_start_rep_agent**.
   For example, to enable RepAgent for the `pubs2` database:

   ```
   sp_start_rep_agent pubs2
   ```

   (Optional) To automatically start RepAgent whenever Adaptive Server restarts:

   ```
   sp_config_rep_agent 'auto start', 'true'
   ```

Stopping RepAgent

To shut down RepAgent, log in to Adaptive Server and execute **sp_stop_rep_agent**.

When RepAgent restarts, it scans records starting with the oldest transaction, but it only sends records following the last one processed. Replication Server determines if there are any duplicate records and discards the duplicates.

Once RepAgent has been shut down with **sp_stop_rep_agent**, it does not automatically start up when the database comes online during data server startup unless you previously set **auto start** to true with **sp_config_rep_agent**. Otherwise, you must execute **sp_start_rep_agent** to start RepAgent and resume automatic start-up.

For example, to stop RepAgent, enter:

```
sp_stop_rep_agent pubs2
```

If you shut down RepAgent in this way, Adaptive Server shuts down RepAgent gracefully at the end of the current batch of transactions.

You can also shut down RepAgent immediately using the **nowait** option. For example:

```
sp_stop_rep_agent pubs2, nowait
```

If you shut down RepAgent with the **nowait** option, Adaptive Server terminates the RepAgent without waiting for currently executing operations to finish.

Disable RepAgent

Use **sp_config_rep_agent** to disable RepAgent.

Note: You should disable RepAgent only when you change the replicate database to a primary database, or downgrade Replication Server to an earlier version.

Before disabling RepAgent using **sp_config_rep_agent**, you must first shut it down using **sp_stop_rep_agent**.

Normally, when you disable RepAgent, the process also disables the secondary truncation point. For example:

```
sp_config_rep_agent pubs2, 'disable'
```

Once the secondary truncation point is disabled, the log can get truncated past the secondary truncation point.

To disable RepAgent but keep the secondary truncation point, use the **preserve secondary truncpt** option.

```
sp_config_rep_agent pubs2, 'disable', 'preserve
        secondary truncpt'
```

Disable RepAgent in this way to disable RepAgent momentarily.

If you are changing the primary to a replicate database, you must also turn log transfer off. After disabling RepAgent, turn log transfer off using **alter connection**.

For example, log in to Replication Server and enter:

```
alter connection to TOKYO_DS.pubs2
    set log transfer off
```

Configure RepAgent for Network Security

You can secure the pathway between RepAgent and Replication Server using network-based security features.

Using **sp_config_rep_agent**, you can change settings for:

- The active security mechanism
- Unified login
- Mutual authentication
- Message confidentiality
- Message integrity

- Message replay detection
- Message origin check
- Message out of sequence check

See also

- *Manage Network-based Security* on page 237

Manage Log Transfer Activity

Use the log transfer commands to suspend and resume log transfer if you perform recovery, troubleshooting, or diagnostic tasks.

The log transfer commands are:

- **resume log transfer** and **suspend log transfer**
- **alter connection ... set log transfer on/off**

Note: RepAgent cannot connect to Replication Server unless log transfer has first been set on using **alter connection**.

See *Replication Server Administration Guide Volume 2 > Replication System Recovery* for information about starting the RepAgent thread in recovery mode so that it can replay database and transaction dumps.

Suspend Log Transfer

Execute **suspend log transfer** to disconnect one or all RepAgents and prevent RepAgents from connecting to Replication Server.

Log transfer to Replication Server remains suspended until you resume it using the **resume log transfer** command.

suspend log transfer command records information in the RSSD, so if you shut down Replication Server and restart it, log transfer to that Replication Server remains suspended.

Note: Suspending log transfer is the first step in quiescing the replication system.

To suspend log transfer, log in to Replication Server and execute **suspend log transfer** at the **isql** prompt by entering:

```
suspend log transfer from {data_server.database | all}
```

where:

- *data_server* – the data server with the database for which log transfer is to be suspended.
- *database* – the database for which log transfer is to be suspended.
- **all** – instructs Replication Server to suspend log transfer from all RepAgent and disallow future connections for all RepAgent.

These examples demonstrate the use of **suspend log transfer** .

- Suspend log transfer for the database named `pubs2`, managed by the TOKYO_DS data server:

  ```
  suspend log transfer from TOKYO_DS.pubs2
  ```
- Suspend log transfer to the current Replication Server from all RepAgents:

  ```
  suspend log transfer from all
  ```

In both examples, after the command is executed, affected RepAgent are not shut down and may continue to send some messages to Replication Server. To shut down a RepAgent immediately, log in to Adaptive Server and enter **sp_stop_rep_agent**, with the name of the database for which RepAgent is enabled, and the **nowait** option.

See also

- *Quiesce Replication Server* on page 81

Resume Log Transfer

To reconnect RepAgent to a Replication Server, log in to the Replication Server and enter the **resume log transfer** command at the **isql** prompt.

```
resume log transfer from {data_server.database | all}
```

where:

- *data_server* – the data server with the database for which log transfer is to be resumed.
- *database* – the database for which log transfer is to be resumed and for which the RepAgent connection is to be allowed.
- **all** – allows all RepAgents to connect to this Replication Server.

These examples demonstrate the use of **resume log transfer**:

- Resume log transfer for the database named `pubs2`, managed by the TOKYO_DS data server:

  ```
  resume log transfer from TOKYO_DS.pubs2
  ```
- Resume log transfer to this Replication Server from all RepAgents:

  ```
  resume log transfer from all
  ```

Use alter connection and the set log transfer Option

Use **alter connection** with the **set log transfer** option to shut down log transfer.

To shut down log transfer, turn the **set log transfer** option off. For example:

```
alter connection to TOKYO_DS.pubs2
   set log transfer off
```

When log transfer is off, Replication Server removes the DIST thread, and RepAgent can no longer log in to Replication Server.

When Replication Server no longer recognizes the primary database, you must reestablish this connection using **rs_init** or **create connection** before you can use **alter connection** to set log transfer on.

To set log transfer on, turn the **set log transfer** option on. For example:

```
alter connection to TOKYO_DS.pubs2
set log transfer on
```

Review RepAgent Status and Configuration Information

You can monitor RepAgent and see the values of configuration parameters using commands and system procedures. You can also use the Adaptive Server plug-in to SAP Control Center for Adaptive Server plug-in to monitor RepAgent.

View RepAgent Information

Use **sp_help_rep_agent** at Adaptive Server to monitor the RepAgent.

sp_help_rep_agent displays information about:

- Recovery – status and other information when you are restoring a database.
- Configuration parameters – the current settings for RepAgent configuration parameters for both single and multiple replication paths.
- Process – information about the RepAgent process, including state, sleep status, number of unsuccessful connection retries (if any), and the number of the last error message, for both single and multiple replication paths.
- Send buffers - the number of send buffers that you have allocated to RepAgent.
- Scanned transactions – information about the current batch of log transactions: start, end, and current markers; the number of records in the batch; and the oldest transaction.
- Security – the current settings of the network-based security mechanism.
- All – all of the above information.

Log in to Adaptive Server and execute **sp_help_rep_agent** at the **isql** prompt:

```
sp_help_rep_agent [dbname[, 'recovery' | 'config' | 'process' |
'send' | 'scan' | 'security' | 'all']]
```

dbname is the name of the database for which the RepAgent is enabled.

You can view current status information for one or all options, for example:

- To display information about the RepAgent process, log in to Adaptive Server and enter:
  ```
  sp_help_rep_agent pubs2, 'process'
  ```
- To display information about the RepAgent log scanning, enter:
  ```
  sp_help_rep_agent pubs2, 'scan'
  ```

See *Replication Server Reference Manual > Adaptive Server Commands and System Procedures* for detailed syntax, usage information, and example output for **sp_help_rep_agent**.

View RepAgent Configuration Parameter Values

To view a list of default, current, and runtime configuration parameter values for a particular RepAgent, log in to Adaptive Server and execute **sp_config_rep_agent** without options.

For example:

```
sp_config_rep_agent pubs2
```

If you do not specify a database name, **sp_config_rep_agent** displays configuration values for all RepAgent-enabled databases.

To view values for a specific parameter, include the parameter name. For example:

```
sp_config_rep_agent pubs2, 'scan batch size'
```

See *Replication Server Reference Manual > Adaptive Server Commands and System Procedures >* ***sp_config_rep_agent***.

View RepAgent Thread Information

Execute **sp_who** to view the RepAgent thread status on Adaptive Server.

In the display output, Adaptive Server shows the RepAgent information in rows with “REP AGENT” in the “cmd” column.

For example, **sp_who** might display this row for RepAgent:

```
fid spid status loginame origname hostname blk_spid dbname  cmd
block_xloid
-----------------------------------------------------------------------
----------
...
0   23 background NULL    NULL       0        pubs2      REP AGENT   0
...
```

See the *Adaptive Server Enterprise Reference Manual* for detailed syntax and usage information for **sp_who**.

To view RepAgent thread user status on Replication Server, execute **admin who**. Replication Server displays RepAgent thread user information in rows with “REP AGENT” in the “name” column.

See *Replication Server Reference Manual > Replication Server Commands* for more information about **admin who** and output examples.

Check Log Files for RepAgent Information and Error Messages

Obtain RepAgent error and information messages that are recorded in the Adaptive Server errorlog file.

See the *Adaptive Server Enterprise System Administration Guide* for more information about the Adaptive Server error log.

For example, starting RepAgent generates this message in the Adaptive Server errorlog:

```
00:00000:00022:2003/09/18 12:16:39.15 server Started
RepAgent on database, ‘pubs2’ (dbid = 4).
```

Stopping RepAgent generates this message:

```
00:00000:00022:2003/09/18 12:17:17.07 server Shutting
down RepAgent for database, ‘pubs2’ (dbid=4).
```

Use Counters to Monitor RepAgent Performance

Adaptive Server provides several counters for monitoring RepAgent performance. You can monitor RepAgent performance data using **sp_sysmon**.

Invoking **sp_sysmon** clears all accumulated data from the set of counters to be used during the sample interval. At the end of the sample interval, the procedure reads the values in the counters, prints a report, and stops executing.

You can direct **sp_sysmon** to print information for RepAgent counters only or for all Adaptive Server counters. **sp_sysmon** displays RepAgent counter information for each database.

See the *Adaptive Server Enterprise Performance and Tuning Guide* for complete usage and syntax information for **sp_sysmon**.

See *Replication Server Administration Guide Volume 2 > Use Counters to Monitor Performance* to use counters to monitor Replication Server activity.

Invoke sp_sysmon

You can invoke **sp_sysmon** by using fixed time intervals, or by using the **begin_sample** and **end_sample** parameters.

Fixed Time Intervals

Use fixed time intervals to provide a sample for a specified number of minutes.

For example, you can run **sp_sysmon** for 10 minutes and print information for all counters:

```
sp_sysmon “00:10:00”
```

To print only the RepAgent section of the report, enter:

```
sp_sysmon “00:10:00”, repagent
```

begin_sample and end_sample

Use **begin_sample** and **end_sample** to invoke **sp_sysmon** to start and end sampling, issue queries, and print results at any point in time.

For example, to start and end the sample for the RepAgent group of counters, enter:

```
sp_sysmon begin_sample
go
execute proc1
go
sp_sysmon end_sample,repagent
```

Sample Output from sp_sysmon of RepAgent Activity

View a sample output of RepAgent counter activity from **sp_sysmon**.

Sample output from sp_sysmon

```
Replication Agent
-----------------
Replication Agent: pubs2
Replication Server: NY_RS
```

```

                        per sec     per xact    count    % of total
                        -------     --------    -----    ----------
```

```

Log Scan Summary
 Number of Log Scans       n/a         n/a           1        n/a
 Amount of Time
   for Log Scan (ms)       n/a         n/a        3822        n/a
   Longest Time
   for Log Scan (ms)       n/a         n/a        3822        n/a
   Average Time
   per Log Scan (ms)       n/a         n/a        3822        n/a
```

```
Log Scan Activity
   Updates                 n/a         n/a           5        n/a
   Inserts                 n/a         n/a           5        n/a
   Deletes                 n/a         n/a           5        n/a
   Store Procedures        n/a         n/a           0        n/a
   DDL Log Records         n/a         n/a           0        n/a
   Writetext Log Records   n/a         n/a           0        n/a
   Text/Image Log Records  n/a         n/a          10        n/a
   CLRs                    n/a         n/a           0        n/a
   Checkpoints Processed   n/a         n/a           0        n/a
```

```
Transaction Activity
    Opened                 n/a         n/a           7        n/a
    Commited               n/a         n/a           7        n/a
    Aborted                n/a         n/a           0        n/a
    Delayed Commit          n/a         n/a            0         n/a
    Maintenance User        n/a         n/a            0         n/a

Log Extension Wait
    Count                   n/a         n/a            3         n/a
    Amount of time (ms)     n/a         n/a         7822         n/a
    Longest Wait (ms)       n/a         n/a         5110         n/a
    Average Time (ms)       n/a         n/a       2607.3         n/a

Schema Cache

  Usage
    Max Ever Used           n/a         n/a            0         n/a
    Schemas reused          n/a         n/a            0         n/a

  Forward Schema Lookups
    Count                   n/a         n/a            0         n/a
    Total Wait (ms)         n/a         n/a            0         n/a
    Longest Wait (ms)       n/a         n/a            0         n/a
    Average Time (ms)       n/a         n/a          0.0         n/a

  Backward Schema Lookups
    Count                   n/a         n/a            0         n/a
    Total Wait (ms)         n/a         n/a            0         n/a
    Longest Wait (ms)       n/a         n/a            0         n/a
    Average Time (ms)       n/a         n/a          0.0         n/a

Truncation Point Movement
    Moved                   n/a         n/a            0         n/a
    Gotten from RS          n/a         n/a            0         n/a

Connections to Replication Server
    Success                 n/a         n/a            0         n/a
    Failed                  n/a         n/a            0         n/a

Network Packet Information
    Packets Sent            n/a         n/a            6         n/a
    Full Packets Sent       n/a         n/a            2         n/a
    Largest Packet          n/a         n/a         2048         n/a
    Amount of Bytes Sent    n/a         n/a         7695         n/a
    Average Packet          n/a         n/a       1282.5         n/a

I/O Wait from RS
    Count                   n/a         n/a            6         n/a
    Amount of Time (ms)     n/a         n/a          766         n/a
    Longest Wait (ms)       n/a         n/a          206         n/a
    Average Wait (ms)       n/a         n/a        127.7         n/a


-------------------------------------------------------------------
```

Description of Sample Output of RepAgent Counter Activity

Each section in the sample output of RepAgent counter activity from **sp_sysmon** describes a different activity.

Log Scan Summary

RepAgent scans all records in the transaction log, but not all scanned records need to be processed and sent to Replication Server. For example, RepAgent does not send records generated by data manipulation language (DML) on tables not marked for replication.

Log Scan Summary reports the number of log records:

- RepAgent has scanned
- RepAgent has processed and sent to Replication Server

Log Scan Activity

Log Scan Activity provides information about the different kinds of log records processed by RepAgent and sent to the Replication Server.

Log Scan Activity reports the number of:

- Rows affected by **update** statements
- Rows affected by **insert** statements
- Rows affected by **delete** statements
- Stored procedure executions
- Log records containing DDL to be replicated
- Log records processed generated by a **WriteText** command
- DML log records processed for a table with `text`, `unitext`, or `image` data
- Compensation log records (CLRs), which are generated when a transaction is partially or fully rolled back
- Checkpoint log records indicate that there was an active transaction at the time this log record was written.

Transaction Activity

Transaction Activity reports the number of transactions :

- Opened in the primary database
- Committed
- Aborted
- Found in prepare state
- Opened by the maintenance user

Log Extension Wait

During normal processing, RepAgent reaches the end of the transaction log. It then waits until further activity resumes in the primary database.

Log Extension Wait reports:

- The number of times RepAgent waited for extensions to the transaction log
- The total amount of time, in milliseconds (ms), that RepAgent waited for log extensions
- The longest amount of time, in ms, that RepAgent waited for log extensions
- The average amount of time, in ms, that RepAgent waited for log extensions

Schema Cache

When the structure of an object marked for replication is modified—by **alter table**, for example—Adaptive Server must log special records in the transaction log that later on will help RepAgent identify the correct schema for the object.

Schema Cache reports schema activity and RepAgent activity scanning forward and backward in the transaction log looking for object schema changes.

- Usage

  Usage reports:
  - The maximum number of active schemas in the Schema Cache since the last restart of Replication Agent
  - The number of times that a schema had to be removed from the Schema Cache to free space for a new one
- Forward Schema Lookups

  Forward Schema Lookups reports:
  - The number of times RepAgent performed forward scans
  - The total amount of time, in ms, that RepAgent spent performing forward scans
  - The longest amount of time, in ms, that RepAgent spent performing a forward scan
  - The average amount of time, in ms, that RepAgent spent performing a forward scan
- Backward Schema Lookups

  RepAgent performs a backward scan when DDL is performed inside a transaction. Backward Schema Lookups reports:
  - The number of times RepAgent spent performing backward scans
  - The total amount of time, in ms, that RepAgent performed backward scans
  - The longest amount of time, in ms, that RepAgent spent performing a backward scan
  - The average amount of time, in ms, that RepAgent spent performing a backward scan

Truncation Point Movement

Truncation Point Movement reports:

- The number of times RepAgent moved the secondary truncation point
- The number of times RepAgent asked Replication Server for a new truncation point

Connections to Replication Server

Connections to Replication Server reports:

- The number of successful connections to Replication Server
- The number of unsuccessful connections to Replication Server

Network Packet Information

Network Packet Information reports:

- The number of packets sent to Replication Server
- The number of full packets sent to Replication Server
- The largest packet sent to Replication Server
- The number of bytes sent to Replication Server
- The average packet size

I/O Wait from Replication Server

After RepAgent generates LTL, RepAgent sends it to Replication Server. To do this, it uses Open Client capabilities.

I/O Wait from Replication Server reports:

- The number of times RepAgent has sent a batch to Replication Server
- The total amount of time, in ms, that RepAgent has spent processing results from Replication Server
- The longest elapsed time, in ms, that RepAgent has spent processing results from Replication Server
- The average elapsed time, in ms, that RepAgent has spent processing results from Replication Server

Support for Extended Limits

Replication Server version 12.5 and later supports extended limits for replication definitions.

Supported extended limits are:

- More columns, to a maximum of 1024
- Wide columns and parameters, to a maximum of 32768 bytes
- Wide data rows to the width of the data page on the data server
- Wide messages larger than 16K

If the Replication Server site version is 12.5 or later, Replication Server sets the LTL version automatically to 400 or higher. If RepAgent is running on Adaptive Server 12.5 or later, RepAgent sends data with extended limits only if Replication Server specifies an LTL version of 400 or higher at connect source time.

If the Replication Server site version is 12.1 or earlier, the LTL version is earlier than 400. If RepAgent is running on Adaptive Server 12.5 or later, SAP recommends that you do not send extended-limits data to Replication Server 12.1 and earlier. You can specify how RepAgent handles extended-limits data by using the **data limits filter mode** parameter with **sp_config_rep_agent**

See also

- *Configuring RepAgent* on page 89

Support for Longer Identifiers

Replication Server version 15.0 and later increases the maximum length of replication object identifiers to 255 bytes.

Affected replication object identifiers include:

- Table name and column name
- Stored procedure name and parameter name
- Functions and parameters – for function replication definitions and internal use only
- Function string name
- Replication definitions – including table replication definitions, function replication definitions, and database replication definitions
- Article name
- Publication name

If the Replication Server site version is 15.0, Replication Server sets the LTL version automatically to 700. If RepAgent is running on Adaptive Server 15.0 or later, RepAgent sends data with extended size only if Replication Server specifies an LTL version of 700 or higher at connect source time.

If the Replication Server site version is 12.6 or earlier, the LTL version is earlier than 700. If RepAgent is running on Adaptive Server 15.0 or later, SAP recommends that you do not send data with longer identifiers to Replication Server 12.6 and earlier.

You can specify how RepAgent handles data with longer identifier by using the **data limit filter mode** parameter with **config_rep_agent**.

Note: The **create function**, **alter function**, and **drop function** commands do not support long identifiers. The name of the function and the parameters of these commands cannot exceed 30 bytes.

See also

- *Configuring RepAgent* on page 89

Support for bigdatetime and bigtime Datatypes

SAP Replication Server supports replication of the `bigdatetime` and `bigtime` datatypes included with SAP ASE.

You can replicate these datatypes to replicate databases and warm standby databases by specifying the datatypes in replication definitions, function replication definitions, and subscriptions.

`bigdatetime` and `bigtime` allow SAP ASE to store data and time data up to microsecond precision. `bigdatetime` corresponds to the `TIMESTAMP` datatype, and `bigtime` corresponds to the `TIME` datatype in SAP IQ.

See *Date/time, and date and time Datatypes* in the *Reference Manual* for descriptions of the datatypes.

You can use **rs_helprep** to display information about `bigdatetime` and `bigtime`.

rs_subcmp supports `bigdatetime` and `bigtime`.

See the *Reference Manual* for descriptions of the commands.

These examples show how to use `bigdatetime` and `bigtime` in a replication definition, a function replication definition, and a subscription.

In these examples:

- PDS – primary data server
- `pdb1` – primary database
- RDS – replicate data server
- `rdb1` – replicate database
- `tb1` – table
- `col1`, `col2`, `col3` – columns
- **rep1** – replication definition
- **func1** – function replication definition
- **sub1** – subscription

Replication Definition

```
create replication definition rep1
with primary at PDS.pdb1
with all tables named tb1
(col1 int, col2 bigdatetime, col3 bigtime)
primary key (col1)
```

Function Replication Definition

```
create function replication definition func1
with primary at PDS.pdb1
```

```
(@par1 int, @par2 bigdatetime, @par3 bigtime)
searchable parameters (@par1)
```

Subscription

```
create subscription sub1 for rep1
with replicate at RDS.rdb1
where col3 = '14:20:00.010101'
without materialization
```

System Table Support for bigdatetime and bigtime

The `rs_columns`, `rs_datatypes`, and `rs_objects` system tables are extended to support the replication of the `bigdatetime` and `bigtime` datatypes.

rs_columns

Column	Datatype	Description
`coltype`	`tinyint`	Datatype of the column or parameter: • 35 – `bigdatetime` • 36 – `bigtime`

rs_datatype

Column	Datatype	Description
`base_coltype`	`tinyint`	ID of base datatype for the datatype. Can be: • 35 – `bigdatetime` • 36 – `bigtime`

rs_objects

Column	Datatype	Description
`attributes`	`int`	Mask, can be one or more of the following: • 0x02 – replication definition has `bigdatetime` or `bigtime` columns and can be propagated only to Replication Server 15.5 or later.

Mixed-Version Information for bigdatetime and bigtime

Only Adaptive Server versions 15.5 and later support `bigdatetime` and `bigtime`.

If the primary data server is at least Adaptive Server 15.5, and:

- Primary and replicate Replication Server are version 15.5 or later, and the replicate Adaptive Server does not support the datatypes, you can create a replication definition containing a mapping for each of the two datatypes to the `varchar` datatype. Alternatively, use the `varchar` datatype instead of the two datatypes in the replication definition.
- Primary Replication Server is version 15.5 or later, and the replicate Replication Server and Adaptive Server do not support the datatypes, use the `varchar` datatype instead of the two datatypes in the replication definition.
- Primary and replicate Replication Server, and the replicate Adaptive Server do not support the datatypes, RepAgent automatically sends the `varchar` datatype to Replication Server.

Adaptive Server Shared-disk Cluster Support

Replication Server and RepAgent thread both support the Adaptive Server shared-disk cluster environment.

In a shared-disk cluster, a database can be either a replication source or a replication destination. You can perform all of the tasks, such as configuring RepAgent or marking tables for replication, from any instance in the cluster. Replication status is coherent across the entire cluster.

When adding new connections from or to an Adaptive Server cluster environment, the *servername* in the connection syntax must be the *clustername* and not the *instancename*. Use select @@servername to retrieve the *clustername*.

By default, the RepAgent starts on the cluster coordinator; However, you can configure it to start on any instance in the cluster. For example, to configure the RepAgent on the primary database `pdb` to always start on the “ase2” instance, enter:

```
sp_config_rep_agent pdb, "cluster instance name", "ase2"
```

For a new configuration to take effect, restart the RepAgent using **sp_start_rep_agent**. To return to the default behavior with the RepAgent starting on the cluster coordinator, enter:

```
sp_config_rep_agent pdb, "cluster instance name",
"coordinator"
```

When an instance starts, it checks if there are RepAgents configured to start on its node. If there are, and if the database is marked to start automatically, the RepAgent starts.

When the cluster coordinator starts, it also starts all RepAgents that are not configured to start on a specific instance. If the coordinator node fails, or is stopped with a graceful shutdown, a RepAgent starts on the new coordinator node.

If the RepAgent is configured to start on an instance other than the coordinator node, and this instance fails, the RepAgent starts on the coordinator.

See the *Replication Server Reference Manual > Adaptive Server Commands and System Procedures >* ***sp_config_rep_agent*** for information about the **cluster instance name** configuration parameter.

Deferred Name Resolution

Deferred name resolution lets you create stored procedures in Adaptive Server without resolving the objects used internally by these stored procedures. Adaptive Server postpones the object resolution phase to the first time you execute the stored procedure in Adaptive Server.

Stored procedures execute normally when you execute them after the first time.

In Replication Server versions earlier than 15.5, you can set up a warm standby application and enable **sp_reptostandby** at the active database to allow replication of supported data definition language (DDL) commands to the standby database. See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications*.

However on a standby database or a replicate database in a non-Warm Standby environment, you cannot create a stored procedure that references a temporary table because Replication Server does not replicate temporary tables. The create stored procedure process must resolve the objects used internally by the stored procedure. However since there is no temporary table in the replicate or standby database, Replicate Server does not create the stored procedure in the replicate or standby database.

With support for deferred name resolution, Replication Server allows the replication of stored procedures that refer to temporary tables, tables that do not exist, and procedures that do not exist, to replicate or standby databases.

See *Adaptive Server Enterprise Transact-SQL Guide*, *Adaptive Server Enterprise System Administration Guide: Volume 1*, and *Adaptive Server EnterpriseReference Manual: Commands*.

Configure Replication Server to Support Deferred Name Resolution

To enable or disable deferred name resolution in Replication Server, use the **deferred_name_resolution** parameter with **alter connection** for a physical connection or **alter logical connection** for a logical connection in a warm standby application.

For example, to enable deferred name resolution on the *pubs2* warm standby database of the SYDNEY_DS data server:

```
alter logical connection to SYDNEY_DS.pubs2
set deferred_name_resolution to 'on'
```

After you execute **deferred_name_resolution** with **alter connection** or **alter logical connection**, suspend and resume the connection. By default, **deferred_name_resolution** is off.

Note: Enable deferred name resolution support in Adaptive Server before you configure deferred name resolution support in Replication Server.

Adaptive Server Data Compression

Replication Server supports the Adaptive Server data compression feature.

Adaptive Server data compression lets you use less storage space for the same amount of data, reduce cache memory consumption, and improve performance by lowering I/O demands. Adaptive Server can compress large object (LOB) datatypes such as `text`, `image`, and `unitext`, and non-LOB datatypes. See the *Adaptive Server Enterprise Compression Users Guide*.

Adaptive Server stores data in-row or off-row. Adaptive Server stores in-row, data columns that are located contiguous to all other columns for that row. Adaptive Server stores LOB data off-row in other locations because of the size of the data. There is an in-row pointer to the actual location of off-row data.

System Requirements

- Adaptive Server – version 15.7 ESD #1 and later for both primary and replicate databases.
- Replication Server – version 15.7.1 and later for the primary and replicate Replication Server.

SAP Replication Server Support for Compressed Data

SAP Replication Server decompresses compressed SAP ASE data before sending it to the replicate database.

Support for replication of compressed data between an SAP ASE primary database and an SAP ASE or heterogeneous replicate database depends on whether the data is in-row or off-row:

- Replication Server supports replicating in-row non-LOB compressed data between databases.
- SAP Replication Server supports replicating compressed off-row LOB columns between an SAP ASE primary database and an SAP ASE or heterogeneous replicate database. SAP Replication Server decompresses LOB data before sending it to a heterogeneous replicate database. SAP Replication Server sends compressed LOB data directly to an SAP ASE replicate database only if the replicate has the same LOB schema, character set,

endianness, version, and page size as the primary SAP ASE database. Otherwise, SAP Replication Server decompresses LOB data before sending it to the replicate SAP ASE database.

The Replication Server **dsi_do_decompression** parameter must be on for SAP Replication Server to decompress LOB data. This parameter is set to on in connection profiles for connecting to a heterogeneous replicate database.

For the LOB data decompression feature, the primary and replicate SAP Replication Servers and the primary SAP ASE must be version 15.7.1 SP100 or later.

Only SAP ASE 15.7 ESD #1 and later and Replication Server 15.7.1 and later support compressed large object (LOB) column replication. All intermediate SAP Replication Servers in the route from SAP ASE must also be version 15.7.1 and later.

Subscription Materialization of LOB Compressed Data

Adaptive Server 15.7 and later supports LOB compression.

Support for subscription materialization of LOB compressed data depends on:

- How you specify the column datatype in the replication definition
- Whether there is at least one version 15.7.1 SP100 or later Replication Server, and the position of this Replication Server relative to the other Replication Server in a replication system with multilple Replication Servers

If the Replication Server version is earlier than 15.7.1 SP100, Replication Server supports materialization of LOB compressed and uncompressed data if the datatypes of the LOB columns you define in the replication definition are the same as the datatypes of the corresponding LOB columns in the primary table schema.

Table 8. Replication Server Versions Earlier Than 15.7.1 SP100

Column Datatype in Primary Table Schema	Column Datatype in Replication Definition	Materialization Supported
`image`	`image`	Yes
`text`	`text`	Yes
`unitext`	`unitext`	Yes
`image`	`text` or `unitext`	No
`text`	`image` or `unitext`	No
`unitext`	`text` or `image`	No

If the Replication Server version is 15.7.1 SP100 and later, Replication Server supports materialization of LOB:

- Compressed data – if you define the datatypes of the LOB columns in the replication definition as `image`

Column Datatype in Primary Table Schema	Column Datatype in Replication Definition	Materialization Supported
`image`	`image`	Yes
`text`	`image`	Yes
`unitext`	`image`	Yes

- Uncompressed data – if the datatypes of the LOB columns you define in the replication definition are the same as the datatypes of the corresponding LOB columns in the primary table schema.

Column Datatype in Primary Table Schema	Column Datatype in Replication Definition	Materialization Supported
`image`	`image`	Yes
`text`	`text`	Yes
`unitext`	`unitext`	Yes
`text`	`image`	Yes **Warning!** Although materialization completes, do not define the column datatype as `image` in the replication definition as this results in data corruption during replication. See *Replication Server Troubleshooting Guide > RepAgent Problems > Errors from the Replication Server > Error 32044 > Solution* to fix data corruption if you have incorrectly defined the datatypes in the replication definition.

Column Datatype in Primary Table Schema	Column Datatype in Replication Definition	Materialization Supported
`unitext`	`image`	Yes **Warning!** Although materialization completes, do not define the column datatype as `image` in the replication definition as this results in data corruption during replication. See *Replication Server Troubleshooting Guide > RepAgent Problems > Errors from the Replication Server > Error 32044 > Solution* to fix data corruption if you have incorrectly defined the datatypes in the replication definition.

Example of a replication definition specifying the `au_photo` LOB column as `image` datatype:

```
create replication definition pubs_copy_rep1
with primary at TOKYO_DS.pubs2
with primary table named 'publishers'
with replicate table named joe.'pubs_copy'
(pub_id, pub_name as pub_name_set, au_photo image)
primary key (pub_id)
```

Example of a replication definition specifying the `c_image`, `c_text`, and `c_unitext` columns as `image`, `text`, and `unitext` datatypes respectively, to match the original datatyes in the `pubs2` primary database:

```
create replication definition pubs_copy_rep2
with primary at TOKYO_DS.pubs2
with all tables named lob (c_key integer, c_image image null, c_text
text null, c_unitext unitext null )
primary key (c_key)
```

If you incorrectly define the column datatypes for the LOB columns in the replication definition, subscription materialization does not proceed and RepAgent shuts down. See *Replication Server Troubleshooting Guide > RepAgent Problems > Errors from the Replication Server > Error 32044* to purge the corrupted data that was replicated and to resume replication.

Maintaining Data Integrity

To maintain data integrity, use a customized function string to remove undesired data out of the queues if you do not disable replication of off-row compressed LOB columns.

1. Disable replication of compressed LOB columns:
   ```
   sp_setrepcol table_name, lob_column_name, ‘do_not_replicate’
   ```
2. If the DSI thread shuts down, use a customized function string to remove undesired data from the queue.
   For example, using the table schema in the `mytab5` table and a replication definition named **reptab5**, create a function string named **reptab5.rs_insert** based on the **rs_insert** function:
   - Table schema:
     ```
     create table mytab5
     (c1 int primary key, c2 text null compressed = 5)
     ```
   - Replication definition:
     ```
     create replication definition reptab5
     with primary at repl3_18540.pdb
     with all tables named mytab5
     (c1 int, c2 image null)
     primary key (c1)
     ```
   - Customized function string:
     ```
     alter function string reptab5.rs_insert
     for rs_sqlserver_function_class
     output language
     'insert mytab5(c1, c2) values(?c1!new? , '''')'
     ```

Support for Incremental Data Transfer

With Adaptive Server 15.5, you can transfer data incrementally from a table instead of having to transfer the whole table from one Adaptive Server to another. Replication Server supports the data definition language related to the Adaptive Server incremental data transfer feature.

Replication proceeds normally for data modification operations performed on a replicate table marked for incremental transfer.

If you load a replicate table with the **transfer table** command, and the table has an unique index command and the data on the incremental transfer already exists on the table, Adaptive Server internally converts an **insert** command into an **update** command.

The **transfer table** command applies only to the data server and database where you initiated the transfer the first time.

If you mark tables for incremental transfer in the active database within a warm standby or MSA environment, and then switch to the standby database if the active database terminates, incremental data transfer may not resume correctly at the standby database. This is because, unlike the active database, the standby database does not have a record of the incremental data transfer activity. Therefore, you must initialize the incremental data transfer on the standby database too.

See *Adaptive Server Enterprise Transact-SQL Users Guide > Adding, Changing, Transferring, and Deleting Data > Transfering data Incrementally*.

Predicated Privileges

There are several requirements for Replication Server support for Adaptive Server predicated privileges.

Adaptive Server 15.7 ESD #2 includes predicated privileges. Replication Servers in a mixed-version environment support predicated privileges.

To use predicated privileges in a replication system, the maintenance user on the replicate Replication Server must have nonpredicated privileges on the replicate tables and databases.

See *Predicated Privileges* in the *Adaptive Server Enterprise 15.7 ESD #2 New Features Summary*.

Stored Procedure Replication with Predicated Privileges

Executing a replicated stored procedure on the primary database by a user with predicated privileges for the DML statements in the procedure, may cause inconsistency between the primary and replicate data.

Suppose that you, as the Adaptive Server and Replication Server administrator, grant the **update** privilege on the `accounts` table to Marc:

```
grant update on accounts to Marc (1)
where owner = ‘Marc’
```

In addition, create the **balance_limit** stored procedure on the primary database and mark **balance_limit** for replication:

```
create procedure balance_limit
as
update accounts
set balance = 0
where balance < 0
```

When Marc executes **balance_limit** on the primary database, Adaptive Server applies the predicated privilege (1) that you defined earlier, and executes the resulting SQL statement, which is equivalent to:

```
update accounts Marc
set balance = 0
where balance < 0
and owner = ‘Marc’
```

Replication Server replicates the execution of **balance_limit** to the replicate database, using the maintenance user for the procedure execution on the `accounts` table. Since the maintenance user does not have any predicated privileges, the executed SQL statement at the replicate database is equivalent to:

```
update accounts Marc
set balance = 0
where balance < 0
```

In this example, the SQL statement executed at the primary database is different from the statement executed at the replicate database, resulting in an inconsistency between replicate and primary data.

Granular Permissions

Configure your replication system to ensure replication support for Adaptive Server granular permissions.

Adaptive Server granular permissions enable you to grant system privileges that allow you to construct site-specific roles with privileges to match your requirements, and restrict system administrators and database owners from accessing user data. See *Using Granular Permissions* in the *Adaptive Server Enterprise Security Administration Guide*.

Replication Server supports the replication of the Adaptive Server **sp_restore_system_role** system procedure which you can use to restore a system-defined role to its default privilege condition after applying granular permissions to the role.

With granular permissions in databases within a replication system, configure the replication system to ensure replication support if you:

- Use **rs_init** to:
  - Configure user database maintenance user IDs and RSSD primary user IDs.
  - Add a database to the replication system
  - Upgrade user databases
- Add an Adaptive Server master database as a replicate database into the replication system.
- Use a database replication definition to replicate DDL statements.

Granular Permissions and Replication Server Configuration

You must manually create the Replication Server maintenance user IDs for user databases and RSSD on Adaptive Server.

If you enable granular permissions for Adaptive Server primary and replicate user databases that are part of a replication system, and the user ID that you use to log in to Replication Server and run either the **rs_init** interactive mode or **rs_init** resources file does not possess the `sso_role`, **rs_init** cannot automatically create the:

- Maintenance user ID for the primary and replicate user databases
- Maintenance and primary user IDs for the RSSD if the RSSD resides on Adaptive Server

Instead, after installing Replication Server and before you use **rs_init** in interactive mode or an **rs_init** resource file, you must manually create the user IDs for the primary and replicate user databases and RSSD, and manually grant the relevant permissions that the user IDs require for replication. With the proper permissions, you can use **rs_init** to successfully install RSSD on Adaptive Server and add user databases to the replication system.

Creating and Enabling the Maintenance User Role

Create the maintenance user role and grant privileges that allow the role to apply operations to the user database the maintenance user is going to manage.

1. Start **isql** as the user with system security officer privileges on the Adaptive Server with the master database:
   isql –U*sso_user* -P*password* -S*data_server_name*
2. Create the maintenance user role in the Adaptive Server master database and grant the permissions that apply to all operations:
   ```
   use master
   go
   create role rs_maint_user_role
   go
   ```
3. Grant proxy authorization to the maintenance user role:
   ```
   grant set session authorization to rs_maint_user_role
   go
   ```
4. Grant database-wide privileges to allow the maintenance user acting as the database owner, to execute operations on the user database that the maintenance user is going to manage:
   ```
   use database_name
   go
   grant manange database permission to dbo
   go
   ```
   See the *Privileges Managed by manage database permissions Privilege* table in *Adaptive Server Enterprise Security Administration Guide > Using Granular Permissions > Permission Management > manage database permissions Privilege* for a list of the database-wide privileges.

Granting Required Permissions to Maintenance User Role

Grant to the maintenance user role, Adaptive Server permissions for specific operations.

Prerequisites

Create the maintenance user role.

Task

1. Start **isql** as the user with system administrator privileges on the Adaptive Server that the maintenance user logs into:
   isql –U*sa_user* -P*password* -S*data_server_name*
2. Grant the Adaptive Server permissions to the rs_maint_user_role to allow the Replication Server maintenance user the correct privileges to access and update the *database_name* database:

```
use database_name
go
grant delete any table to rs_maint_user_role
go
grant identity_insert any table to rs_maint_user_role
go
grant identity_update any table to rs_maint_user_role
go
grant insert any table to rs_maint_user_role
go
grant select any table to rs_maint_user_role
go
grant truncate any table to rs_maint_user_role
go
grant update any table to rs_maint_user_role
go
grant execute any function to rs_maint_user_role
go
grant execute any procedure to rs_maint_user_role
go
```

Permissions Required for Replication Server Maintenance User

After you install Replication Server and before you use **rs_init** for configuring your replication system, assign the appropriate Adaptive Server permisssions to the Replication Server maintenance user.

Table 9. Adaptive Server Permissions Required for Replication Server Maintenance User

Permission	Operations the Permission Authorizes
replication_role	Manage replication operations
delete any table	• **delete table** • **lock table**
execute any procedure	**execute *procedure_name***
execute any function	**execute *sql_function_name***

Permission	Operations the Permission Authorizes
identity_insert any table	**set identity_insert {on | off}**
identity_update any table	**set identity_update {on | off}**
insert any table	• **insert** • **lock table**
select any table	**select**
truncate any table	**truncate table**
update any table	• **update** • **lock table** • **writetext**

Creating the Maintenance User and Assigning Roles

Create the maintenance user and assign the relevant roles to the user.

1. Start **isql** as the user with system security officer privileges on the Adaptive Server with the user database that the maintenance user is going to manage:
   isql –U*sso_user* -P*password* -S*data_server_name*
2. Create the maintenance user login ID:
   ```
   create login maintenance_user_name with password
   maintenance_user_password
   go
   ```
3. Grant `replication_role` to the maintenance user ID:
   ```
   sp_role "grant", replication_role, maintenance_user_name
   go
   ```
   You see:
   ```
   Authorization updated.
   (return status = 0)
   ```
4. Grant `rs_maint_user_role` to the maintenance user ID:
   ```
   sp_role "grant", rs_maint_user_role, maintenance_user_name
   go
   ```
   You see:
   ```
   Authorization updated.
   (return status = 0)
   ```
5. Automatically activate `rs_maint_user_role` when the maintenance user logs in to the user database:

```
alter login maintenance_user_name add auto activated roles
rs_maint_user_role
go
```

6. Assign `dbo`, the user database owner, as an alias for the maintenance user to allow the maintenance user to manage the database with all the privileges of `dbo`:

   ```
   sp_addalias maintenance_user_name, dbo
   go
   ```

   Note: Do not execute **sp_addalias** if you are configuring master database replication.

   You see:

   ```
   Alias user added.
   (return status = 0)
   ```

Granular Permissions and Adding a User Database

If you enable granular permissions, and then manually configure the maintenance user permissions, you see an error message when you use the **rs_init** interactive mode to add a database to the replication system.

```
Sending the following SQL command to the server:
'sp_role "grant", replication_role, <maintenance user name>'.
SQL Server message: msg 10331, level 14, state 2
WARNING: "Permission denied, database master, owner dbo.
You need the following permission(s) to run this command: MANAGE
ROLES."
```

Since you have manually granted the required permissions to the maintenance user IDs, ignore the error message and press the Enter key to continue.

Granular Permissions and User Database Upgrade

If you use **rs_init** to upgrade Adaptive Server user databases, you see an error message.

If you enable granular permissions for Adaptive Server and then use **rs_init** to upgrade Adaptive Server user databases, **rs_init** attempts to grant the `replication_role` permission to the user ID that you used to execute **rs_init** and also to the maintenance user ID for the user databases. However, **rs_init** fails to grant the `replication_role` permission because since `dbo`, the master database owner, does not have have the `manage roles` permission, and you see an error message such as:

```
SQL Server message: msg 10331, level 14, state 2
WARNING: "Permission denied, database master, owner dbo.
You need the following permission(s) to run this command: MANAGE
ROLES."
```

Ignore the error message and press the Enter key to continue because the user database upgrade can still proceed.

Granular Permissions and Master Database Replication

Remove the maintenance user ID alias relationship to the `dbo` master database owner before you add the master database as a replicate database.

If you enable granular permissions for Adaptive Server and use **rs_init** to try to add an Adaptive Server master database to the replication system as a replicate database, you may see error messages such as:

```
2012/09/17 00:47:47 SQL Server message: msg 11105, level 11, state 1
2012/09/17 00:47:47 WARNING: "No such user/role 'xxxxxx' exists.
"2012/09/17 00:47:47 Unable to execute query 'grant execute on
 rs_update_lastcommit to xxxxxx' against server 'xxxxxx'.
```

The attempt to use **rs_init** to add the master database fails, because in the master database, the maintenance user ID is currently an alias of dbo. However, you cannot specify the maintenance user ID as the alias of dbo for the master database.

Use the **sp_dropalias** Adaptive Server system procedure to remove the alias at the master database:

```
sp_dropalias loginame
```

Granular Permissions and DDL Replication

Enable **dsi_replication_ddl** to replicate DDL statements.

If you enable granular permissions for SAP ASE and you use a database replication definition to replicate DDL statements, and the user who executes the DDL statement does not have the `execute` permission for the **rs_update_last_commit** stored procedure on the replicate database, the DDL statement fails with an error message such as:

```
Message from server: Message: 10330, State 1, Severity 14 --
'EXECUTE permission denied on object rs_update_lastcommit, database
rdb1, owner dbo
```

If you enable granular permissions, set **dsi_replication_ddl** on for the connection to the replicate database to allow Replication Server to use the maintenance user to execute **rs_update_last_commit**:

```
alter connection to dataserver.database set dsi_replication_ddl on
```

Stored Procedure Replication and the execute as Clause

Ensure support for stored procedure replication when you create stored procedures with the **execute as {owner | caller}** clause of the Adaptive Server **create procedure** command.

Adaptive Server Stored Procedure Creation

In Adaptive Server, you can create a stored procedure with the **execute as {owner | caller}** clause.

If you create a stored procedure:

- Without an **execute as** clause, Adaptive Server resolves the names of objects inside the stored procedure on behalf of the procedure owner. Adaptive Server evaluates permission checks for DML inside the stored procedure on behalf of the procedure caller, and then executes DDL inside the stored procedure on behalf of the procedure caller.
- With an **execute as owner** clause, Adaptive Server resolves the names of objects inside the stored procedure on behalf of the procedure owner. Adaptive Server evaluates permission checks for DML inside the stored procedure on behalf of the procedure owner, and then executes DDL inside the stored procedure on behalf of the procedure owner.
- With an **execute as caller** clause, Adaptive Server resolves the names of objects inside the stored procedure on behalf of the procedure caller. Adaptive Server evaluates permission checks for DML inside the stored procedure on behalf of the procedure caller, and then executes DDL inside the stored procedure on behalf of the procedure caller.

See *Executing a Procedure with execute as owner or execute as caller* in the *Adaptive Server Enterprise Security Administration Guide*.

Replication Server Function Replication Definitions

In Replication Server, you can use the **create applied function replication definition** or **create request function replication definition** commands to create function replication definitions that describe stored procedures that you want to replicate..

The difference between the applied function replication definition and the request function replication definition is that the function that Replication Server replicates through an applied function replication definition is executed at the replicate site by the maintenance user while the function that Replication Server replicates through a request function replication definition is executed at the replicate site by the same user who executes the primary function at the primary site. See *Manage Replicated Functions* in the *Replication Server Administration Guide Volume 1*, and **create applied function replication definition** and **create request function replication definition** in the *Replication Server Reference Manual*

To replicate a stored procedure in a non-warm standby or non-MSA environment, you must create a replication definition and a corresponding subscription. Replication of a stored procedure in a warm standby or MSA environment does not require a replication definition. Only one function replication definition can exist for a specific replicated stored procedure.

Ensuring Successful Stored Procedure Replication

If you use the **execute as {owner | caller}** clause to create procedures, the identity of the caller at the primary database is not always preserved at the replicate database.

If the identities differ, stored procedure replication may fail because:

- The DDL permissions at the replicate database are insufficient for Adaptive Sever to execute the stored procedure DDL.

- The replicate database cannot resolve the names of objects inside the stored procedure which results in the database accessing the wrong objects or not finding any objects.
- The DML cannot pass the replicate database permission evaluation checks.

For the successful replication of stored procedures:

- Carefully evaluate object name resolution or whenever possible, use fully qualified object names when you create stored procedures with the **execute as {owner | caller}** clause.
- Grant the relevant permissions to the:
  - Maintenance user if you are using an applied function replication definition.
  - Replicate procedure owner if you are using a request function replication definition.

Precomputed Result Sets

Replication Server supports the replication of precomputed result sets DDL commands between primary and replicate Adaptive Server databases that support precomputed result sets.

Adaptive Server 15.7 ESD #2 and later supports precomputed result sets. See *Precomputed Result Sets* in the *Adaptive Server Enterprise New Features Guide version 15.7 ESD #2*.

In Adaptive Server, you can create a precomputed result set on any query expression, together with a set of policies to maintain the preocomputed result set. Replication Server supports the replication of precomputed result set data definition language (DDL) commands between Adaptive Server databases in all environments, including multisite availability (MSA) and warm standby environments. However, you cannot mark precomputed result sets for replication, and the **update**, **delete**, **insert**, and **select into** data manipulation language (DML) commands cannot directly update the precomputed results set. This is because unlike a regular table, Replication Server does not replicate any maintenance changes occurring on data stored in a precomputed result set, whether the changes are:

- Initiated from a precomputed result set DDL, although the DDL can also be replicated, or
- From part of the base table update transaction initiated from the **immediate refresh** policy.

Replication Server only supports the replication of the Adaptive Server precomputed result set DDL commands:

- **alter {precomputed result set | materialized view}**
- **create {precomputed result set | materialized view}**
- **drop {precomputed result set | materialized view}**
- **refresh {precomputed result set | materialized view}**
- **truncate {precomputed result set | materialized view}**

Precomputed result sets are also called materialized views. See *Commands* in the *Adaptive Server Reference Manual: Commands*.

Adaptive Server requires four session-level **set** options to have the relevant settings before you can create and use precomputed result sets:

- **set ansinull on**
- **set arithabort on**
- **set arithignore off**
- **set string_rtruncation on**

To replicate the precomputed result set DDL commands, Replication Server includes the **rs_ddlsession_setting** system function to automatically set the Adaptive Server session-level options whenever the DSI thread processes these DDL commands, and therefore allow Replication Server to apply the commands to the replicate Adaptive Server database. To avoid affecting DML replication, Replication Server provides the **rs_ddlsession_resetting** system function to automatically reset the session-level options to their default values after processing the precomputed result set DDL commands:

- **set ansinull off**
- **set arithabort on**
- **set arithignore off**
- **set string_rtruncation off**

Remember: You do not have to execute the functions manually.

Tip: The **rs_ddlsession_resetting** function resets the options to the default values overwriting any values you previously set. You can create customized a function string for **rs_ddlsession_resetting** to ensure that the values revert to what you previously set.

See the descriptions of **rs_ddlsession_setting** and **rs_ddlsession_resetting** in the *Replication Server Reference Manual*.

Earlier versions of Replication Server that do not include the two functions can replicate precomputed result set DDL commands as long as both primary and replicate Adaptive Server databases support precomputed result sets and as long you can apply the relevant settings for the Adaptive Server session-level **set** options. To ensure that precomputed result set DDL commands can replicate even if your version of Replication Server version does not include the system functions, you can create a procedure in the default database that automatically configures the relevant **set** options when the original user for the replicate database logs into the database.

Enabling Precomputed Result Sets Replication for Earlier Versions of Replication Server

Create a procedure in the default database to automatically apply the relevant values for the session-level **set** options and ensure that precomputed result set DDL commands successfully replicate even if the Replication Server version does not include the **rs_ddlsession_setting** and **rs_ddlsession_resetting** system functions.

You must create the procedure in the default Adaptive Server database. See *Adaptive Server Enterprise Transact-SQL Users Guide > SQL Building Blocks > isql utility > Default*

Databases. If you do not specify a database, the default is the master database. You can include the procedure in the login script of the original user or in the login script of the maintenance user if **dsi_replication_ddl** is on. Once the user logs in to the database to apply transactions, the procedure applies the relevant values for the session-level options and all operations of the user are impacted by the session-level **set** options..

1. Create a procedure that applies the appropriate values to the Adaptive Server session-level set options that Adaptive Server requires for support of precomputed result sets.
   To create the **pcrs_proc** procedure at the `rdb1` replicate database, enter:

   ```
   create procedure pcrs_maint_login_proc
   as
   set ansinull on
   set arithabort on
   set arithignore off
   set string_rtruncation on
   go
   grant all on pcrs_proc to public
   go
   ```
2. Include the procedure that enables precomputed result set in the login script for the original user of the default replicate database.
   To include **pcrs_proc** in the login script for the rdb1_user1 database user who logs into the `rdb1` database, enter:

   ```
   sp_modifylogin rdb1_user1, 'login script', pcrs_proc
   ```

   If you use the maintenance user to define the login script, DML replication may not proceed properly.

Transfer of Database Object Ownership

Replication Server supports the transfer of database object ownership in Adaptive Server.

For employee life cycle management in Adaptive Server, database administrators, system security officers, or database owners can manage the assignment of database objects due to employee changes by transferring the ownership of database objects using the **alter... modify owner** Adaptive Server command. In addition, database administrators can can separate the creation of objects from the ownership of objects by using **alter... modify owner**. See *Adaptive Server Enterprise Security Administration Guide > Managing User Permissions > Changing database object ownership*.

Replication Server Support for Transferring Object Ownership

Replication Server replicates the DDL changes generated by **alter... modify owner** so that the transfers in object ownership at the primary Adaptive Server database are applied to the replicate Adaptive Server database. However, if there is a change in object ownership for an object qualified with an owner, in a replication definition where the owner name is required, Replication Server does not automatically alter the replication definition to reflect the change.

Suppose you create a replication definition for the `authors` table with Mario as the owner —`mario.authors`, and subsequently the database adminstrator transfers the table owner to Angela. As a result, Replication Server cannot replicate any **insert**, **delete**, or **update** operations to the replicate `authors` table because Replication Server receives these operations for replication to `angela.authors` but the replication definition still has `mario.authors`.

Coordination of Object Ownership Transfer and Replication Definition Changes

To ensure that data replicates continuously and correctly, coordinate any changes to object ownership with corresponding changes to affected replicated definitions and database replication definitions.

Executing **rs_send_repserver_cmd** at the primary database allows you to order the change to the replication definition to be always after executing **alter... modify owner**. It is more difficult to coordinate the transfer of object ownership with the modifications to the replication definition or database replication definition if you execute **alter replication definition** or **alter database replication definition** at the Replication Server.

At the primary database, immediately after using **alter... modify owner**, execute the **rs_send_repserver_cmd** stored procedure that in turn executes the **alter replication definition** or **alter database replication definition** command containing the **alter owner from** *curent_owner* **to** *new_owner* clause to change the object owner in the replication definition or database replication definition:

- **alter replication definition** –
  ```
  exec rs_send_repserver_cmd ‘alter replication
  definition replication_definition_name
  alter [primary] owner from current_owner to new _owner'
  ```
- **alter database replication definition** –
  ```
  exec rs_send_repserver_cmd ‘alter database replication
  definition database_replication_definition_name
  alter owner from current_owner to new _owner [for tablename]'
  ```

  Omit the **for *tablename*** option if you want to change the owners for all tables in the database replication definition .

Altering the owner in the replication definition creates a new version of the replication definition. If there are already multiple versions of the replication definition, Replication Server only modifies the current version to ensure that any data in the inbound queue replicates with the proper replication definition version. This allows for the transfer of table ownership to occur without having to drain the queues.

Wildcards for Changing Multiple Replication Definitions

If you use **alter... modify owner** to transfer the ownership of multiple tables, you can use the asterisk "*" wildcard character to replace the replication definition name in **alter replication definition** to modify the owner in multiple replication definitions affected by the ownership transfer, where *old_owner* is the same for all the replication definitions:

```
exec rs_send_repserver_cmd ‘alter replication
definition *
alter owner with primary at data_server.database
from old_owner to new _owner’
```

Check for Affected Replication Definitions

Before you use the wildcard to change multiple repliction definitions, execute the **rs_helpreptable** stored procedure in the RSSD with a wildcard "*" to list all the replication definitions at the primary database that have the same *current_owner* value:

```
 rs_helpreptable primary_database, current_owner, '*'
```

Scenario for Coordinating Replication Definition Changes with Transfers to Object Ownership

You must immediately follow any change to table ownership at the primary database with the corresponding changes to affected replication definitions to ensure replication proceeds correctly.

This example shows how to coordinate transfers to table ownership at an Adaptive Server primary database with the corresponding changes to affected table replication definitions.

1. Create the **authors_repdef** replication definition for the `authors` table at the `pubs2` database in the NY_DS data server with Mario as the table owner. At the primary Replication Server enter:

   ```
   create replication definition authors_repdef
   with primary at NY_DS.pubs2
   with primary table named mario.authors
   ```

2. Mark the table for replication and specify that the owner of the primary table must match the replicate table owner for replication to proceed. At `pubs2` primary database enter:

   ```
   sp_setreptable mario.authors, 'true', owner_on
   ```

3. The database administrator or owner transfers ownership of the `authors` table from Mario to Angela at `pubs2`:

   ```
   alter table mario.authors
   modify owner angela
   ```

4. Verify if **authors_repdef** is the only replication definition affected by the change in table ownership from Mario. At the Replication Server enter:

   ```
   rs_helpreptable pubs2, mario, *
   ```

   If there is more than one replication definition affected by the change in table ownership, you can modify all replication definitions in one commmad using the wildcard character.

5. You must change **authors_repdef** immediately to maintain seamless replication and data integrity at the replicate database. At `pubs2` enter:

   ```
   exec rs_send_repserver_cmd ‘alter replication
   definition authors_repdef
   alter primary owner from mario to angela’
   ```

Conditions and Limitations for Replication Server Support for Transfer Object Ownership

There several conditions and limitations for replication of objects affected by a transfer of object ownership.

- Site version – the Replication Server site version must be 1550 or later to support the transfer of object ownership in replication definitions.
- Owner status – if you use **sp_setreptable** to set the owner status for a primary table to:
  - **owner_on** – and subsequently there is a change in table owner, you must immediately make the corresponding change in affected replication definitions.
  - **owner_off** – and subsequently there is a change in table owner, do not make the corresponding change in affected replication definitions. Otherwise, the replication definition filters out all transactions for the table, resulting in no data replication.
- DDL replication – you must ensure that Replication Server can replicate DDL commands before you execute **alter... modify owner** and **rs_send_repserver_cmd**.

  Suppose you set **owner_on** but you do not enable DDL replication by setting **sp_setreptostandby** to **none** for warm standby systems, or by setting **set replication** to **off** for non-warm standby replication. Assuming that you do not make corresponding changes to the table replication definition, any change you make with **alter…modify owner** at the primary database does not replicate. As a result, the table owner of the affected table at the primary database is different from the owner of the replicate table. Therefore, data cannot replicate to the replicate table.

  Suppose you also alter the table replication definition to change the owner at the:
  - Primary and replicate tables with:

    ```
    alter replication definition replication_definition_name
    alter owner from old_owner to new_owner
    ```

    Replication Server forms SQL statements to replicate to *new_owner.table_name* which does not exist since the actual replicate table owner name was not changed. This causes an error in the replication process that suspends the DSI thread and the connection to the replicate database. You can then modify the table owner in the replicate database and resume the connection. Replication continues normally without data loss.
  - Primary table with:

    ```
    alter replication definition replication_definition_name
    alter primary owner from old_owner to new_owner
    ```

    Replication Server receives data for replication from the primary table that is owner-qualified as *new_owner.table_name* and replicates these changes to the *old_owner.table_name* replicate table.

  Warning! Data replication loss can result if you have an incorrect assumption about the status of DDL replication in your replication environment and alter your replication definitions incorrectly. Understand your replication environment before you make changes to replication definitions affected by changes to object ownership.

- Different table owners – Replication Server does not map tables owners from a primary owner to a different replicate owner
- Different table names – when you create replication definitions, you can specify table names at the replicate database that are different from the table names at the primary database:

  ```
  create replication definition replication_definition_name
  with primary at data_server.databasew
  with primary table named table_owner1.pri_table
  with replicate table named table_owner1.rep_table
  ```

  If there is a requirement for a transfer of object ownership, execute **alter…modify owner** at the primary database and then at the replicate database. Immediately after executing **alter…modify owner**, execute the **rs_send_repserver_cmd** stored procedure at the primary database or change the replication definition to modify the table names in the affected replication definition.

  However, replication fails if there is any data in the queue where tables have the old owner. To ensure that there is no data loss during replication, either:

  - Drain the queue before changing the owner of the replicate table, or
  - After changing the table owner, allow the DSI to suspend if the primary table receives new data and then execute **rs_send_repserver_cmd**
- Same table with multiple projections of the same replication definition – you can create multiple replication definitions for the same primary table and customize each one, called a projection, so each replication definition projection can be subscribed to by a replicate table whose characteristics are different from those of the primary table and other replicate tables. The other projections can replicate the same table using a subset of the commands or to a different replicate table.

  After a transfer of object ownership at the primary table, if you use **rs_send_repserver_cmd** with **alter replication definition** or **alter replication definition** by itself to modify the:

  - Primary table owner – Replication Server only modifies the primary table owner of the replication definition you specified.
  - Primary and replicate table owner – Replication Server modifies both the primary and replicate table owner of the replication definition you specified.

  Replication Server modifies all replication defintions and projectons if you use the wildcard "*" instead of replication definition name. If modifying a replication definition causes the replication definition and a projection to be identical, Replication Server does not proceed with the modification and returns an error instead.
- Mixed-version support – Replication Server does not allow you to change table ownership in a replication definition or database replication definition if there is a route to a replicate Replication Server with a route version earlier than 15.5
- Impact on HVAR and MSA – high-volume adaptive replication (HVAR) and multisite availability (MSA) cache replication definitions during processing. If you transfer object

ownership for a table and modify the affected replication definitions, you must invalidate the cached replication definition by disabling HVAR for the table or by stopping MSA.

Backlinking Pointers and Shrinking Databases

Replication Server supports backlinking pointers and shrinking databases in Adaptive Server.

Replication of the Transact-SQL **writetext** command requires access to the data row pointing to the text page where the database stores the LOB data. To allow access to this data row, Adaptive Server uses either a backlinking pointer in the first text page or indexes created for replication. The process of creating indexes at the column, table or database level requires an intensive operation to provide the information to support replication.

With an Adaptive Server version 15.7 SP100 and later database that you did not upgrade from an earlier version, **sp_reptostandby** takes effect immediately because by default, Adaptive Server creates and maintains LOB backlinking pointers to the database. Therefore, setting up replication for a table does not require the creation of indexes. Adaptive Server ignores the **use_index** parameter of **sp_reptostandby**, **sp_setrepcol**, and **sp_setreptable** if the information needed to replicate LOB columns is already available in the form of backlinkingpointers.

However, if you have upgraded from, or are using a database that you created with a version of Adaptive Server earlier than 15.7 SP100, setting up replication may take a longer time due to the creation of indexes. To reduce processing time, run **dbcc shrinkdb_setup** at the relevant level—column, table, or database, to create backlinking pointers and to ensure the backlinking status is up to date.

dbcc shrinkdb_setup marks as suspect, replication indexes of columns, tables, or databases that you previously marked with **use_index**. You can use **dbcc reindex** to drop indexes for these objects because these indexes are not needed after the execution of **dbcc shrinkdb_setup**.

See *Shrinking Databases* in the *Adaptive Server Enterprise 15.7 SP100 New Features Guide*.

Performance Enhancements for Adaptive Server Replication

Replication Server provides several features that enhance performance for Adaptive Server replication.

- SQL Statement Replication – Replication Server supports SQL statement replication in Adaptive Server which complements log-based replication and addresses performance degradation caused by batch jobs. SAP recommends that you use SQL statement replication when:

    - DML (data manipulation language) statements affect a large number of rows on replicated tables.
    - You have difficulty altering the underlying application to enable stored procedure replication.
- High Volume Adaptive Replication – Replication Server includes High Volume Adaptive Replication (HVAR) to enhance performance for replication to Adaptive Server.

  HVAR compiles and combines a larger number of transactions into a group, improving bulk operation processing. Therefore, replication throughput and performance also improves.

  HVAR is especially useful for creating online transaction processing (OLTP) archiving and reporting systems where the replicate databases have the same schemas as the primary databases.

See *Replication Server Administration Guide Volume 2 > Performance Tuning > SQL Statement Replication* and *Replication Server Administration Guide Volume 2 > Performance Tuning > Advanced Services Option > High Volume Adaptive Replicationn*.

In-memory and Relaxed-Durability Databases

Replication Server supports the in-memory and relaxed-durability database Adaptive Server feature.

In-memory databases (IMDB) reside entirely in cache and do not use disk storage for data or logs, and therefore do not require disk I/O. This results in potentially greater performance than a traditional disk-resident database (DRDB), amongst other advantages. Since an in-memory database exists only in cache, you cannot recover the database if the supporting host is shut down or the database fails.

With relaxed-durability databases, Adaptive Server extends the performance benefits of an in-memory database to disk-resident databases. Disk-resident databases perform writes to disk, and ensure that the transactional properties of atomicity, consistency, integrity, and durability, known as the ACID properties, are maintained. A traditional disk-resident database operates at full durability to guarantee transactional recovery from a server failure. Relaxed-durability databases trade the full durability of committed transactions for enhanced runtime performance for transactional workloads. A relaxed-durability database created with the **no_recovery** level is similar to an in-memory database: you cannot recover data or logs if the server terminates or is shut down. You can also create a relaxed-durability database with the **at_shutdown** level where transactions are written to disk if there is a proper shut down of the database.

See *Adaptive Server Enterprise In-Memory Database Users Guide*.

Replication Server Support

Replication Server supports as the primary and replicate database:

- In-memory databases
- Relaxed-durability databases set with durability at **no_recovery**

For convenience, relaxed-durability databases refers to relaxed-durability databases with durability set to **no_recovery**.

You can initialize an in-memory and a relaxed-durability database as a new primary or replicate database by obtaining data, object schema, and configuration information from one of:

- A template database that retains basic information.
- A database dump from another database and then load the dump to the target in-memory database or relaxed-durability database.

The dump source database can be another in-memory database, relaxed durability database, or a traditional disk-resident database.

Note: Replicating to or from an in-memory database may not be faster than replicating to or from a relaxed durability database. DML on in-memory databases depends on several factors.

In addition, there is no difference in performance when replicating to or from an in-memory or relaxed durability database compared to replication between primary and replicate databases which are traditional full durability disk-resident databases.

In-Memory Databases as Primary Databases for Replication

You can configure in-memory and relaxed-durability databases as primary databases in a replication system.

Using a Template Database to Set Up Replication for a Primary In-Memory Database

You can use the same disk-resident database as a template to initialize multiple in-memory or relaxed-durability databases as primary databases. The primary in-memory or relaxed-durability database inherits the configuration of the template database.

Note: After a shutdown or termination and a subsequent restart of Adaptive Server, Adaptive Server recreates the in-memory or relaxed-durability database automatically from the template.

1. Create the template database. The template database uses the name of the database with the inbound connection from Replication Server which is usually the primary database name.
   For example, to create the template database named `ny_db` in the NY_DS data server:
   ```
   create database ny_db on publicdev=10 log on publicdevlog=10
   go
   ```
2. Use **rs_init** to add the primary and replicate databases to the replication system.
3. Stop RepAgent on the template database:

```
sp_stop_rep_agent ny_db
go
```

4. Suspend the connection from Replication Server to the database.
5. Rename the template database to `template1`:

```
use master
go
sp_dboption ny_db, single, true
go
sp_renamedb ny_db, template1
go
sp_dboption template1, single, false
go
```

6. Create the in-memory or relaxed durability database with durability set to **no_recovery** using the template created in step 1:

```
create inmemory database ny_db
use template1 as template
on imdb_cache_dev = '50' log on imdb_cache_dev_log='50'
with DURABILITY=NO_RECOVERY
go
```

7. Configure RepAgent to start automatically after Adaptive Server shuts down and restarts:

```
use template1
go
sp_config_rep_agent template1, 'auto start', true
```

8. Resume the connection from Replication Server to the database.

Using a Database Dump to Set Up Replication for a Primary In-Memory Database

You can set up replication if you use a dump from another database to initialize the in-memory or relaxed-durability as a primary database. The primary in-memory or relaxed-durability database inherits the configuration of the database from which you obtained the dump.

1. Create the in-memory or relaxed-durability database:

```
create inmemory database ny_db
on imdb_cache_dev2 = '50' log on imdb_cache_dev_log2='50'
with DURABILITY=NO_RECOVERY
go
```

2. Use **rs_init** to add the primary in-memory database to the replication system.
3. Obtain a dump from the database that you want to use load the new in-memory database you created.
4. Load the in-memory database from the database dump.
   For example:

```
use master
go
sp_dboption ny_db, single, true
go
load database ny_db from '/remote/Based_on_loaddb/IMDB.dump'
go
```

```
online database ny_db
go
sp_dboption ny_db, single, false
go
```

5. Start RepAgent on the database:

   ```
   sp_start_rep_agent ny_db
   go
   ```

6. Optionally, resume the DSI connection from Replication Server to the primary database.

Shutdown or Termination of an In-Memory Database

After a shutdown or termination and a subsequent restart of Adaptive Server, Adaptive Server recreates the in-memory or relaxed-durability database automatically from the template.

When Replication Server resumes the connection to the in-memory or relaxed-durability database that you created, Replication Server may reapply commands, as the information used by Replication Server to detect the latest command that was applied is lost when you restart Adaptive Server.

In-Memory Databases as Replicate Databases for Replication

You can configure in-memory and relaxed-durability databases as replicate databases in a replication system.

Using a Template Database to set up Replication for a Replicate In-Memory Database

You can use the same disk-resident database as a template to initialize multiple in-memory or relaxed-durability databases.

Note: After a shutdown or termination and a subsequent restart of Adaptive Server, Adaptive Server recreates the in-memory or relaxed-durability database automatically from the template. When Replication Server resumes the connection to the replicate in-memory or relaxed-durability database that you created, Replication Server may reapply commands, as the information used by Replication Server to detect the latest command that was applied is lost when you restart Adaptive Server.

1. Create the template database. The template database uses the name of the database with the outbound connection to Replication Server which is usually the replicate database name.

   ```
   create database tokyo_db on publicdev=10 log on publicdevlog=10
   go
   ```

2. Use **rs_init** to add the replicate database to the replication system.
3. Suspend the DSI thread to the template database by stopping RepAgent on the template database. For example:

   ```
   suspend connection to TOKYO_DS.tokyo_db
   ```

4. Rename the template database to **template1**:

   ```
   use master
   go
   ```

```
sp_dboption tokyo_db, single, true
go
sp_renamedb tokyo_db, template1
go
sp_dboption template1, single, false
go
```

5. Create the in-memory or relaxed durability database with durability set to **no_recovery** using the template created in step 1:

   ```
   create inmemory database tokyo_db
   use template1 as template
   on imdb_cache_dev = '50' log on imdb_cache_dev_log='50'
   with DURABILITY=NO_RECOVERY
   go
   ```

6. Connect to Replication Server and resume the connection to the replicate database:

   ```
   resume connection to TOKYO_DS.tokyo_db
   ```

Using a Database Dump to set up Replication for a Replicate In-Memory Database

You can set up replication if you use a dump from another database to initialize the in-memory or relaxed-durability as a replicate database. The replicate in-memory or relaxed-durability database inherits the configuration of the database from which you obtained the dump.

1. Create the in-memory or relaxed-durability database:

   ```
   create inmemory database tokyo_db
   on imdb_cache_dev2 = '50' log on imdb_cache_dev_log2='50'
   with DURABILITY=NO_RECOVERY
   go
   ```

2. Create the objects such as, tables and stored procedures, users, and permissions required to receive replicate data, or you can load a database dump.
3. Use **rs_init** to create the Replication Server connection to the in-memory or relaxed-durability database.
4. Perform a dump to save the current state of the in-memory or relaxed-durability database:
   a) Suspend the connection to the in-memory or relaxed-durability database:

      ```
      suspend connection to RDS.imdb1
      go
      ```

   b) Obtain a database dump of the in-memory or relaxed-durability database:

      ```
      dump database imdb1 to '/databases/dump/tokyo_db.dump'
      go
      ```

   c) Resume the connection to the in-memory or relaxed-durability database:

      ```
      resume connection to RDS.imdb1
      go
      ```

Restoration of In-Memory and Relaxed-Durability Databases

Since in-memory and relaxed-durability databases exist only in cache, they lose their object definition, data, and RepAgent configuration once the host data server shuts down or restarts.

You must reinitialize or restore the in-memory or relaxed durability database after the host data server restarts.

You can reinitialize the in-memory or relaxed durability database from the template or you can restore the in-memory or relaxed durability database with a database dump using one of these methods:

- Recreating from a dump
- Database resynchronization
- Bulk materialization

Ensure that you have enough disk space and time to perform a database dump and load, and that the period of time during which Replication Server skips transactions is acceptable. You can estimate the acceptable period of time by monitoring the segments in the outbound queue with **admin who, sqm**. See *Replication Server Reference Manual > Replication Server Commands >* ***admin who***

Recreating In-Memory and Relaxed-Durability Databases From a Dump After an Adaptive Server Shutdown

You can restore the data from the dump because the in-memory and relaxed-durability databases are recreated when you restart Adaptive Server.

1. Repopulate the recreated replicate in-memory or relaxed-durability database with a new dump or from any archived dumps taken from the replicate database.

   Note: If the dump is not loaded from the dump of the source, there will be missing rows in the replicate tables.

   For example, to load the `tokyo_db` database from the original `tokyo_db.source` dump when the host Adaptive Server restarts:

   ```
   use master
   go
   sp_dboption tokyo_db, single, true
   go
   load database tokyo_db from '/databases/dump/tokyo_db.dump'
   go
   online database tokyo_db
   go
   sp_dboption tokyo_db, single, false
   go
   ```
2. Resume the connection to the recreated replicate in-memory or relaxed-durability database.

Resynchronizing Directly from a Primary Database

Resynchronize an in-memory database from a primary database.

1. Stop replication processing by RepAgent. In Adaptive Server, execute:

   ```
   sp_stop_rep_agent database
   ```

2. Suspend the Replication Server DSI connection to the replicate database:

   ```
   suspend connection to dataserver.database
   ```

3. Instruct Replication Server to remove data from the replicate database outbound queue and wait for a resync marker from the primary database RepAgent:

   ```
   resume connection to data_server.database skip to
   resync marker
   ```

4. Instruct RepAgent to start in resync mode and send a resync marker to Replication Server:

   - If the truncation point has not been moved from its original position, in Adaptive Server execute:

     ```
     sp_start_rep_agent database, 'resync'
     ```

   - If the truncation point has been moved from its original position, in Adaptive Server execute:

     ```
     sp_start_rep_agent database, 'resync purge'
     ```

5. In the Replication Server system log, verify that DSI has received and accepted the resync marker from RepAgent by looking for this message:

   ```
   DSI for data_server.database received and processed
   Resync Database Marker. Waiting for Dump Marker.
   ```

   Note: If you are resynchronizing multiple databases, verify that the DSI connection for each of the databases you want to resynchronize has accepted the resync marker.

6. Obtain a dump of the primary database contents. See *Adaptive Server Enterprise Reference Manual: Commands > Commands >* **dump database**. Adaptive Server automatically generates a dump database marker.

7. Verify that Replication Server has processed the dump database marker by looking for this message in the Replication Server system log:

   ```
   DSI for data_server.database received and processed
   Dump Marker. DSI is now suspended. Resume after database has been
   reloaded.
   ```

   When Replication Server receives the dump marker, the DSI connection automatically suspends.

8. Apply the dump of the primary database to the replicate database. See *Adaptive Server Enterprise Reference Manual: Commands > Commands >* **load database**.

9. After you apply the dump to the replicate database, resume DSI:

   ```
   resume connection to data_server.database
   ```

Resynchronizing a Replicate In-Memory or Relaxed-Durability Database with Bulk Materialization

You can use one of two bulk materialization methods to restore an in-memory or relaxed-durability database.

Prerequisites

Before you start bulk materialization, verify that the replication definitions and subscriptions exist.

Task

1. To quickly empty the inbound and outbound queues, deactivate the subscriptions that have the in-memory or relaxed-durability database:

   ```
   deactivate subscription subscription_name
   for {table_repdef_name | func_repdef_name |{publication pub_name |
   database replication definition db_repdef_name}
   with primary at dataserver.database}
   with replicate at dataserver.database
   go
   ```

   After you deactivate the subscriptions, Replication Server does not propagate all the transactions in the inbound queue to the outbound queue of the in-memory or relaxed-durability database.

   In contrast, when you drop a subscription, all the committed transactions that have been written into the inbound queue are distributed downstream of Replication Server. You can deactivate a subscription even if the DSI is not running because the deactivation only happens at the primary site. When the deactivate marker arrives at the outbound queue, you can see this entry in the Replication Server log:

   ```
   The deactivate marker for subscription subscription_name
   arrives at outbound queue: data_server_name.database_name.
   ```

   After the deactivate marker arrives at the outbound queue, use **sysadmin sqm_purge_queue** to purge the outbound queue at the replicate site to quickly empty the outbound queue. See *Replication Server Reference Manual > Replication Server Commands >* ***sysadmin sqm_purge_queue***.

2. Execute **check subscription** at both the primary and replicate Replication Servers to verify that the subscription status is DEFINED at the primary Replication Server and VALID at the Replication Server.
3. Use the "Simulate Atomic Materialization" or "Simulate Nonatomic Materialization" bulk materialization methods described in *Replication Server Administration Guide Volume 1 > Manage Subscriptions > Subscription Materialization Methods > Bulk Materialization*, to build the in-memory or relaxed-durability database. If you use:

- Simulate atomic materialization — execute steps 4 to 9
- Simulate nonatomic materialization — execute steps 4 to 13

Enable Autocorrection

Before you resume the connection to the replicate in-memory or relaxed-durability database, you must enable autocorrection for the replication definitions used for subscriptions to the replicate database, in order to convert any update or insert into a delete and insert pair.

Enabling autocorrection applies to replicate databases created using templates or dumps. Autocorrection allows Replication Server to continue replicating messages in the Replication Server queues even if the Adaptive Server hosting a replicate in-memory or relaxed-durability database shuts down or terminates.

Minimal DML Logging and Replication

Replication Server supports minimal DML logging in an in-memory or relaxed durability database acting as the replicate database.

To optimize the log records that are flushed to the transaction log on disk, Adaptive Server can perform minimal to no logging when executing some data manipulation language commands (DMLs)—**insert**, **update**, **delete**, and slow **bcp**—on all types of low-durability databases, such as in-memory databases and relaxed-durability databases set with durability of **at_shutdown** or **no_recovery**. You can perform minimal logging for DMLs on a per-database, per-table, and session-specific basis. See *Adaptive Server Enterprise In-Memory Database Users Guide > Minimally-logged DML*.

Note: Minimal DML logging session-level settings take precedence over database-level settings and table-level settings.

As replication uses full logging, replication and the minimal data manipulation language (DML) logging feature in Adaptive Server 15.5 are incompatible at the same level, such as database-level or table-level. However, you can take advantage of the performance enhancements from minimal logging on some tables while allowing replication on others as minimal DML logging and replication can coexist at different levels.

For example, if you set replication and minimal DML logging at the same level, such as table-level, setting replication status fails and an error message appears as described in these scenarios:

- If you create a database to use minimal DML logging:
  - And you mark the database for replication using **sp_reptostandby**, the attempt fails and you see:

    ```
    Cannot set replication for database database_name
    as it is minimally logged. Use ALTER DATABASE to
    set full DML logging and try again.
    ```
  - And you mark tables and stored procedures for replication to replicate a subset of tables, and mark a table in the database using minimally DML logging, you see this warning:

```
Warning: database_name is using minimal logging.
Replicated objects will continue to use full DML
logging.
```

- If a database is using full logging and you mark it for replication using **sp_reptostandby**, and you alter the database to set minimal DML logging, the attempt fails and you see:

  ```
  Cannot alter database database_name to set minimal
  logging because this database is marked for
  replication. Remove replication and try again.
  ```
- If a database is using full logging and has objects marked for replication, you can set minimal DML logging at the database-level but a message appears, warning you that objects marked for replication still use full logging:

  ```
  Warning: Database database_name has objects marked
  for replication. Replicated objects will continue to
  use full logging.
  ```
- If a database using full DML logging contains tables defined to use minimal logging, and you mark the database for replication, you see this warning:

  ```
  Warning: Database database_name has tables that use
  minimal DML logging. These tables will not be
  replicated.
  ```
- If you create a table using full logging and you mark the table for replication, and then you set minimal DML logging for the table, the attempt fails and you see:

  ```
  Cannot alter the table table_name to set minimal DML
  logging because this table is marked for
  replication. Remove replication and try again.
  ```
- If you create a table using minimal DML logging, and if you mark the table for replication, the attempt fails and you see:

  ```
  Cannot set replication for table table_name because
  it is using minimal logging. Use ALTER TABLE to set
  full logging and try again.
  ```

Replication Server Unsupported Operations

There are some limitations when using Replication Server unsupported operations.

These Adaptive Server operations may cause incorrect replication:

- Replication Server does not support nested transactions within replicated stored procedures.

  When you enable replication for a stored procedure using **sp_setrepproc**, Adaptive Server always runs the stored procedure within a transaction. If you have not explicitly run the replicated stored procedure within a transaction, Adaptive Server places an implicit **begin transaction** command at the start of the procedure.

  If the replicated stored procedure contains nested transaction commands such as **begin transaction**, **commit transaction**, or **rollback transaction**, you might get errors when you run the procedure. For example, a **rollback transaction** command rolls back to the start of the stored procedure, rather than to the nested **begin transaction** command, which was the intended rollback point.

- Data that is inserted into a primary table using an unlogged bulk copy operation is not replicated.
- To use the atomic method of subscription materialization:
    - The user who enters the **create subscription** command or the database owner must own the primary table. Alternatively, you must use user-defined function strings for **select** operations at the primary database.
    - If the database owner or maintenance user does not own the replicate table, use user-defined function strings for **select** operations at the replicate database. If the owner of the replicate table is different from the owner of the primary table, create a unique function string by using a distinct function-string class. See *Customize Database Operations* in the *Replication Server Administration Guide Volume 2*.

See also

- *Replicated Function Restrictions* on page 356
- *Manage Subscriptions* on page 373

Manage Routes

A route is a one-way message stream from a source Replication Server to a destination Replication Server.

From each source Replication Server, you create one route for each destination Replication Server, no matter how many databases are managed by the source or destination Replication Servers.

Routes carry:

- Data modification commands and applied functions or applied stored procedures from primary databases managed at the source Replication Server to replicate databases managed at the destination Replication Server
- System table modification commands from a source Replication Server RSSD to a destination Replication Server RSSD
- Request functions or request stored procedures from replicate databases to primary databases (in this case, the source is the replicate Replication Server and the destination is the primary Replication Server).

When you create a route, the source Replication Server:

- Creates an RSI outbound queue to hold messages for the destination site
- Starts an RSI thread that logs in to the destination Replication Server and transfers transactions from the RSI outbound queue to the destination Replication Server

Routing Preparation

Before you create or modify routes, you must verify that the relevant components of your replication system are running, and you have designed your routes.

Specifically, you need to:

- Ensure that you have carefully determined where routes are needed in your system. As part of the design process, you must know where each source Replication Server and its destination Replication Servers reside.
- Identify which routes are direct and which are indirect. Indirect routes carry messages to destination Replication Servers through one or more intermediate Replication Servers. Using direct versus indirect routes can have a noticeable effect on system performance.
- If you are creating a direct route, define the destination Replication Server in the interfaces file at the site of the source Replication Server.

  Verify you have an interfaces file entry for the RSSD of the destination Replication Server.

- Ensure the source, destination, and any intermediate Replication Servers in the route are running.
- Ensure that the RepAgent thread for the source Replication Server RSSD is running.

See the *Replication Server Design Guide*.

See also

- *Routing Schemes* on page 143

Routing Rules

After you have determined your routing scheme, you can set up the required routes based on the routing rules.

The routing rules are:

- Replication Servers that manage databases containing primary data require direct or indirect routes to the Replication Servers that manage databases with subscriptions for the data.
- Replication Servers that manage replicate databases where request functions originate require direct or indirect routes to the Replication Server managing the primary database. If no replicated functions originate in the replicate database, a route from a replicate to a primary Replication Server is not required.
- Each route in an indirect route must be a direct route.
- You customize function strings for system functions with class scope at the primary Replication Server for the function-string class. In this instance, you must create routes from the primary Replication Server to the Replication Server managing the databases that use the function strings.

  See *Replication Server Administration Guide Volume 2 > Customize Database Operations > Work with Functions, Function Strings, and Classes > Summary of System Functions > System Functions with Function-string-class Scope*.
- You customize error classes at the primary Replication Server. In this instance, you must create routes from the primary Replication Server to the Replication Server managing the databases that use the error mappings.
- A Replication Server that you plan to assign as the new primary site for a function-string class or error class, using the **move primary** command, has the following requirements:
  - It must have routes to and from the Replication Server that is the current primary site for the class, and
  - It must have routes to all the same Replication Servers as the Replication Server that is the current primary site for the class

  See *Replication Server Administration Guide Volume 2 > Handle Errors and Exceptions > Data Server Error Handling > Changing the Primary Replication Server for an Error Class* and *Replication Server Administration Guide Volume 2 > Customize Database Operations*

> Manage Function-string Classes > Create a Function-string Class > Primary Site for a Function-string Class.

Routing Schemes

Replication Server supports direct, indirect, and dedicated routes.

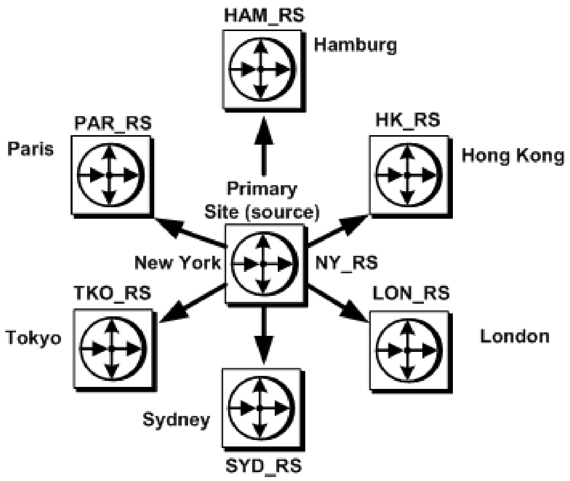
Direct Routes

A route with no intermediate sites is called a direct route. A system with direct routes results in network connections between source and destination Replication Servers.

For example, in this figure, a seven-site enterprise is shown in a star configuration, with one primary site and six replicate sites. Each replicate site has a route originating at the primary site. All six routes from the primary site are direct. Thus, the primary Replication Server has six stable queues and six RSI threads connected through the network to the six replicate sites.

If the replicate site TKO_RS is to submit request functions to the primary site NY_RS, your system would also require a direct route from TKO_RS to NY_RS, in addition to the direct route from NY_RS to TKO_RS.

Figure 10: Sites Connected with Direct Route Configuration



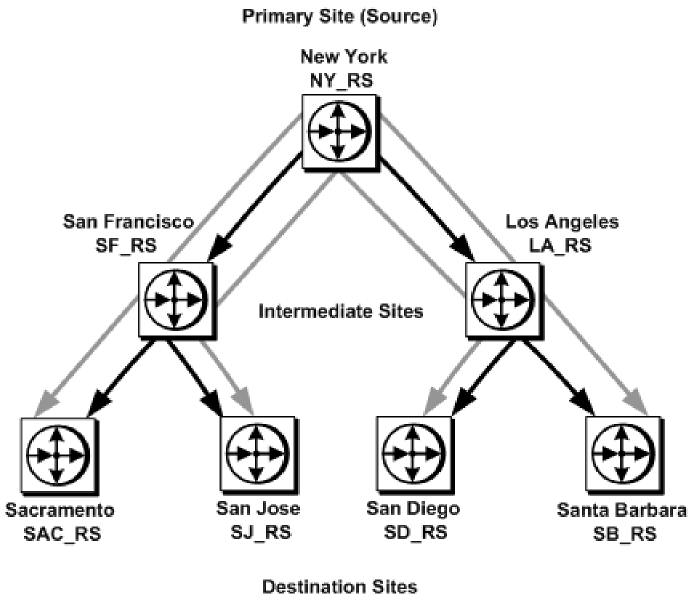
Indirect Routes

A route with intermediate sites is called an indirect route.

The example for indirect routes shows a seven-site enterprise with a single primary site and six replicate sites. Each replicate site has a route originating at the primary site. Only two routes from the primary site are direct; four are indirect. The two intermediate sites each have two direct routes.

In this example, NY_RS to SAC_RS is an indirect route, based on the direct routes NY_RS to SF_RS and SF_RS to SAC_RS. In an indirect route, the source Replication Server sends messages for the destination Replication Server to an intermediate Replication Server, which makes use of a route (direct or indirect) to the destination Replication Server.

Figure 11: Sites Connected with Indirect Routes in a Hierarchical Configuration



To create an indirect route, you create direct routes between each successive Replication Server along the intended indirect route. Once all the direct routes are in place, then you create the indirect route itself.

For example, to create the indirect route NY_RS to SAC_RS, first create the direct routes NY_RS to SF_RS and SF_RS to SAC_RS. Then create the indirect route based on the existing direct routes.

By setting up indirect routes, you reduce the amount of processing at the primary site and distribute the load among intermediate Replication Servers.

Table 10. Direct and Indirect Routes Between Sites in the Example

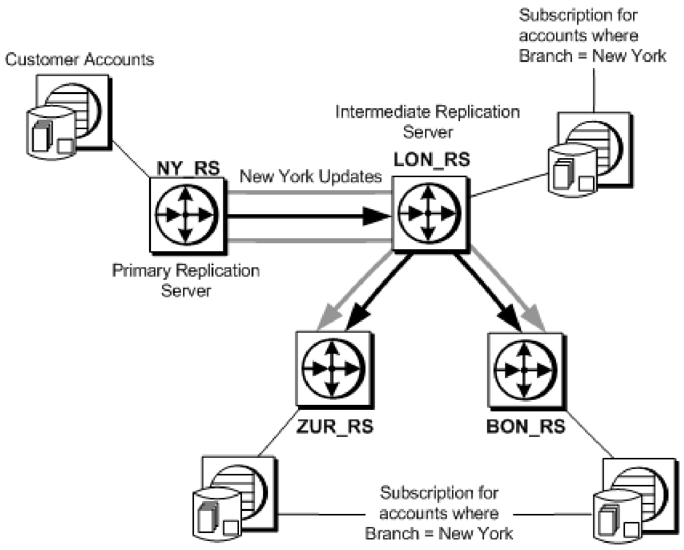
Direct Routes	Indirect Routes
NY_RS to SF_RS	NY_RS to SAC_RS
NY_RS to LA_RS	NY_RS to SJ_RS

Direct Routes	Indirect Routes
SF_RS to SAC_RS	NY_RS to SD_RS
SF_RS to SJ_RS	NY_RS to SB_RS
LA_RS to SD_RS	
LA_RS to SB_RS	

When you use indirect routes, the primary Replication Server can route portions of subscriptions that are common to destination sites through the same intermediate site. When subscriptions overlap, the primary Replication Server is required to send only one message per row modification to the intermediate Replication Server that is common to the destination sites.

In this example of sites with overlapping subscriptions, the intermediate Replication Server in LON_RS receives row modification changes for customer accounts whenever changes occur at the bank headquarters in New York. The New York modifications are also required at branch bank replicate sites in Zurich and Bonn. Because LON_RS is set up to distribute changes to ZUR_RS and BON_RS, the NY_RS primary Replication Server sends only one copy of each change to LON_RS. The number of direct routes is also reduced through the use of the two indirect routes, NY_RS to ZUR_RS and NY_RS to BON_RS.

Figure 12: Sites with Overlapping Subscriptions


Customer Accounts
Subscription for accounts where Branch = New York
Intermediate Replication Server
NY_RS
New York Updates
LON_RS
Primary Replication Server
ZUR_RS
BON_RS
Subscription for accounts where Branch = New York

Although indirect routes are helpful for distributing computing resources among sites on the network, overall propagation of data is slowed somewhat because messages are queued by more than one Replication Server. It is better to use direct routes when there are few replicate sites. When using indirect routes, minimize the number of intermediate sites to obtain the best propagation times.

Dedicated Routes

A dedicated route distributes only transactions for a specific primary connection. You can create a dedicated route to the replicate Replication Server to replicate high priority transactions or to maintain a less congested path for a specific primary connection.

Note: You can only create a dedicated route between two Replication Servers if there is a direct route between the two Replication Servers. You cannot create a dedicated route if there is only an indirect route between the Replication Servers.

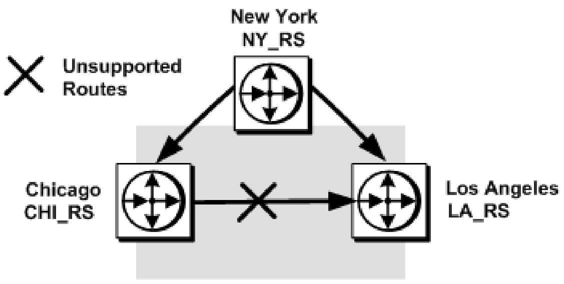
See *Replication Server Administration Guide Volume 2 > Performance Tuning > Multi-Path Replication > Dedicated Routes*.

Unsupported Routing Schemes

An intermediate Replication Server can accept transactions from one or more Replication Servers. Replication Server, however, does not support routing schemes in which routes diverge from the same source Replication Server, then converge at the same intermediate or destination Replication Server..

In this example, only one route from NY_RS to LA_RS can be supported. If the route from NY_RS to LA_RS is supported, then the route between CHI_RS to LA_RS is not supported.

Figure 13: Example of Supported and Unsupported Routes



Create Routes

Create routes at the source Replication Server.

As soon as you create a direct route between a source and destination Replication Server, the source Replication Server:

- Creates an RSI outbound stable queue to hold messages for the destination site, and
- Starts an RSI thread that logs in to the destination or next Replication Server in the route.

Note: You can create a route from a version 15.0 Replication Server to an older Replication Server (version 11.03 or later).

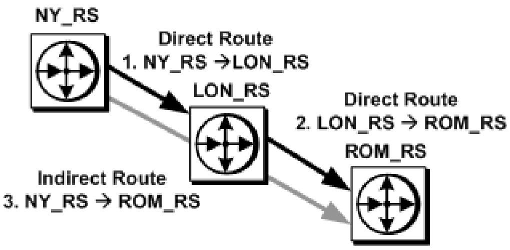
When you create either direct or indirect routes, the destination Replication Server creates and materializes subscriptions at the destination site for the replicated RSSD system tables. This process lets the destination Replication Server receive available replication definitions and function classes.

When you create an indirect route, Replication Server does not create an RSI queue. The indirect route uses the RSI outbound queues of the direct route segments that compose the indirect route.

For Replication Server to be able to begin transferring system information to the destination Replication Server, you must create direct routes before you create an indirect route.

For example, you cannot create an indirect route (1 to 3) unless you have already created two direct routes (1 to 2 and 2 to 3). You also must set up the routes in the correct order.

Figure 14: Order for Creating Direct and Indirect Routes



See also

- *SAP Replication Server Technical Overview* on page 23

create route Command

There are several prerequisites, guidelines, and configuration parameters for **create route**.

The syntax for the **create route** command is:

```
create route to dest_replication_server{
 with primary at dataserver.database|
    set next site [to] thru_replication_server|
    [set username [to] user]
    [set password [to] passwd]
    [set route_param to 'value']
    [set security_param to 'value']}
```

When creating routes:

- Supply the login name, password, and other parameters for direct routes only.
- Before you create a direct route, create its login name and password in the destination Replication Server. Optionally, you can have the **rs_init** utility create this user.

    - If you are enabling network-based security and unified login, user name and password are optional. The default user name is the principal user name, which is specified by the **-S** flag when you log in to Replication Server or start Replication Server.
    - If you create a route with a *user* and *passwd* that do not exist at the destination Replication Server, add or change the *user* and *password* at that destination.
    - If you are establishing a direct route from the current Replication Server to the destination Replication Server, do not use the **next site** clause.
- Use the **with primary at** clause to create a dedicated route.

  Note: You can only create a dedicated route between two Replication Servers if there is a direct route between the two Replication Servers. You cannot create a dedicated route if there is only an indirect route between the Replication Servers.
- Enter one **create route** command at a time, to ensure you have made no mistakes. Wait for a route to become valid before creating the next one.

  If you do make a mistake, drop the route and re-create it only as a last resort. Include the **with nowait** option with the **drop route** command. Since the route has not been created, its current state requires that you use the **with nowait** option to drop it.

When you create a route, you can accept the default values for configuration parameters that manage memory size, the size of the amount of data that can be sent over the route at one time, time-outs, and synchronization intervals. You can also set your own values when you create or alter the route.

If network-based security is enabled at your site, you can also configure security parameters for routes. See *Configuration Parameters that Affect Performance* in the *Replication Server Administration Guide Volume 2* for a list and discussion of route parameters that affect performance.

See also

- *Establish the Principal User* on page 253
- *Drop Routes* on page 160
- *Manage Network-based Security* on page 237
- *Changing an Indirect Route to a Direct Route* on page 155

Configuration Parameters Affecting Routes

There are several parameters you can use to configure routes.

Table 11. Configuration Parameters Affecting Routes

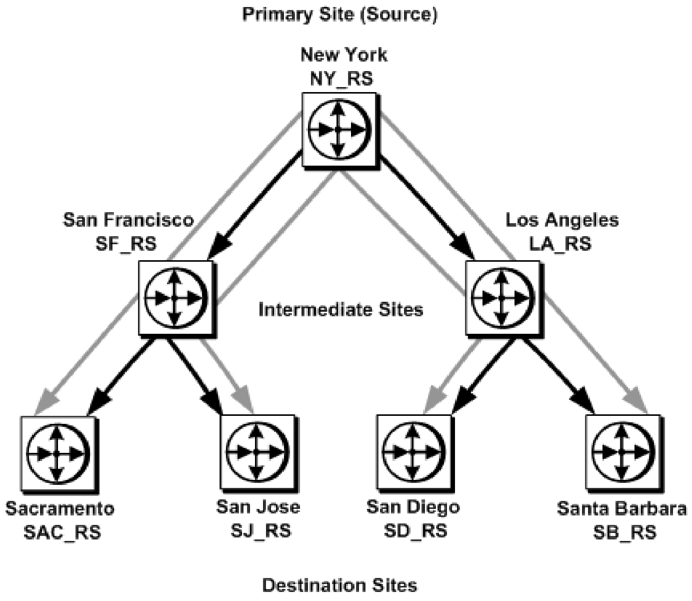
route_param	*value*
disk_affinity	Specifies an allocation hint for assigning the next partition. Enter the logical name of the partition to which the next segment should be allocated when the current partition is full. Values are "*partition_name*" and "off." Default: off
rsi_batch_size	The number of bytes sent to another Replication Server before a truncation point is requested. Default: 256K Minimum: 1K Maximum: 128MB
rsi_fadeout_time	The number of seconds of idle time before Replication Server closes a connection with a destination Replication Server. Default: -1 (Replication Server does not close the connection)
rsi_packet_size	Packet size, in bytes, for communications with other Replication Servers. The range is 1024 to 16384. Default: 4096 bytes
rsi_sync_interval	The number of seconds with no new messages in the RSI queue, before a truncation point is requested. Values must be greater than 0. Default: 60 seconds
rsi_xact_with_large_msg	Specifies route behavior if a large message is encountered. This parameter is applicable only to direct routes where the site version at the replicate site is 12.1 or earlier. Values are "skip" and "shutdown." Default: shutdown
save_interval	The number of minutes that the Replication Server saves messages after they have been successfully passed to the destination Replication Server. Default: 0 minutes

Examples of Creating Direct and Indirect Routes

Use the examples to learn to create direct and indirect routes, and set configuration parameters.

You need to create the direct routes from the primary Replication Server to the intermediate Replication Server and from the intermediate Replication Server to the destination Replication Server before you can create an indirect route.

Figure 15: Sites Connected with Indirect Routes in a Hierarchical Configuration



Example 1

To create the direct route from NY_RS, the primary Replication Server, to SF_RS, enter in NY_RS:

```
create route to SF_RS
set username SF_rsi_user
set password SF_rsi_ps
```

Example 2

To create the direct routes SF_RS to SAC_RS and SF_RS to SJ_RS, enter in the intermediate Replication Server, SF_RS:

```
create route to SAC_RS
set username SAC_rsi_user
set password SAC_rsi_ps
```

```
create route to SJ_RS
set username SJ_rsi_user
set password SJ_rsi_ps
```

Example 3

After the direct routes are created, you can create indirect routes through them.

The following example creates the indirect routes from the primary site NY_RS to sites SAC_RS and SJ_RS, through the intermediate site, SF_RS. Enter these commands in the primary Replication Server, NY_RS:

```
create route to SAC_RS
set next site SF_RS
```

```
create route to SJ_RS
set next site SF_RS
```

Example 4

You can create a route and configure parameters at the same time.

To set the **rsi_packet_size** to 4096 bytes for the route to SF_RS, enter:

```
create route to SF_RS
set username SF_rsi_user
set password SF_rsi_ps
set rsi_packet_size to '4096'
```

See also

- *Indirect Routes* on page 143

Configuring a Replication Server to Manage Primary Tables

You can add a route from a Replication Server that was previously configured as a replicate-only Replication Server.

You must first set up the RepAgent for the Replication Server RSSD. Any database that functions as a primary database also requires a RepAgent.You must configure RepAgent at the Replication Server and at the primary Adaptive Server database.

1. Configure RepAgent at the Replication Server:
   a) Create a RepAgent user so that RepAgent can log in to Replication Server. Use the **create user** command where *ra_user_name* is the name of the RepAgent user and *ra_password* is the RepAgent password:

      ```
      create user ra_user_name
      set password {ra_password | null}
      ```
   b) Grant this user **connect source** permission, using the **grant** command:

      ```
      grant connect source to ra_user_name
      ```

      If the Replication Server already manages a primary database, you can use the "RepAgent user" that already exists for the new primary database.
   c) Execute **alter connection** using the **log transfer on** option:

      ```
      alter connection to data_server.database
      set log transfer to 'on'
      ```
2. Configure RepAgent at the Adaptive Server database:
   a) If the name of the Adaptive Server has not yet been defined, you must define it using the following command where *lname* is the RSSD name:

      ```
      sp_addserver lname, local
      ```

b) If RepAgent threads have not been enabled for the Adaptive Server, you must enable them:

```
sp_configure 'enable rep agent threads'
```

c) Configure RepAgent for the RSSD with the **sp_config_rep_agent** system procedure:

```
sp_config_rep_agent dbname, 'enable', 'rs_name',
          'rs_user_name', 'rs_password'
```

Note: The value for *rs_user_name* and *rs_password* configured at the Adaptive Server must be the same for *ra_user_name* and *ra_password* created at the Replication Server in step 1.

d) Start RepAgent:

```
sp_start_rep_agent dbname
```

See also

- *Configuring RepAgent* on page 89

Suspend and Resume Routes

When you alter a direct route, change its topology, or perform some other maintenance to a remote site, you must suspend the route so that messages are no longer sent to the destination Replication Server. After maintenance is completed for the route, you can then reactivate the route to resume activity.

You can suspend and resume routes in SAP Control Center or with the **suspend route** and **resume route** RCL commands.

You can suspend and resume dedicated routes with **suspend route** and **resume route**. See *Replication Server Administration Guide Volume 2 > Performance Tuning > Multi-Path Replication > Dedicated Routes*.

suspend route

suspend route suspends a route to another Replication Server.

While a route is suspended, no messages are sent to the destination Replication Server, and the messages for the Replication Server are held in a stable queue. The syntax for the **suspend route** command is:

```
suspend route to dest_replication_server
[with primary at dataserver.database]
```

Include the **with primary at** *dataserver.database* clause in the command to specify a dedicated route, where *dataserver.database* is the primary connection name.

For example, to suspend the route to the CHI_RS Replication Server, enter:

```
suspend route to CHI_RS
```

resume route

resume route resumes a suspended route.

Resuming a route allows the source Replication Server to begin sending queued messages to the destination Replication Server. You can also use this command to resume a route that was suspended automatically as the result of an error. The syntax for the **resume route** command is:

```
resume route to dest_replication_server
[with primary at dataserver.database |
skip transaction with large message]
```

Include the **with primary at** *dataserver.database* clause in the command to specify a dedicated route, where *dataserver.database* is the primary connection name.

For example, to resume the route to the CHI_RS Replication Server, enter:

```
resume route to CHI_RS
```

Change Routes

Use **alter route** to change the topology, user name, password, and certain configuration parameters of a direct route.

Note: You cannot change the parameters of an indirect route with **alter route.**

The syntax for **alter route** is:

```
alter route to dest_replication_server{
    set next site [to] thru_replication_server |
    set username [to] 'user' set password [to] 'passwd' |
    set password [to] 'passwd' |
    set route_param [to] 'value' |
    set security_param [to] 'value' |
    set security_services [to] 'default'}
```

To alter a route, you must:

1. Suspend the route.
2. Execute **alter route** with the relevant configuration parameters.
3. Resume the route for the changes to take effect.

See also

- *Manage Network-based Security* on page 237

Change Route Topolgy

You can modify the route topology by changing a direct route to an indirect route, changing an indirect route to a direct route, or changing the next intermediate site for an indirect route.

Changing a Direct Route to an Indirect Route

Change an existing direct route to an indirect route.

1. **1.** At the source Replication Server, from which the direct route originates, enter:

   ```
   suspend route to dest_replication_server
   ```

2. **2.** At each Replication Server that manages a database with a RepAgent, enter:

   ```
   suspend log transfer from all
   ```

   and then quiesce the replication system so that messages will be redirected to your new routing configuration without error.

3. **3.** Create any additional routes that the new indirect route will use.
   - If the current Replication Server does not already have a direct route to the Replication Server that you will specify as the intermediate site for the new indirect route, create the route.
   - If the Replication Server that you will specify as the intermediate site for the new indirect route does not already have a direct or indirect route to the destination site, create the route.

4. **4.** For the direct route you are changing to an indirect route, enter the following command at the source Replication Server where *dest_replication_server* is the destination Replication Server for the route you are altering, and *thru_replication_server* is the intermediate Replication Server for the route:

   ```
   alter route to dest_replication_server
   set next site [to] thru_replication_server
   ```

5. **5.** Resume log transfer connections by entering the following command at each Replication Server where you previously suspended log transfer:

   ```
   resume log transfer from all
   ```

6. **6.** At the source Replication Server, resume the suspended route by entering the following command:

   ```
   resume route to dest_replication_server
   ```

See also

- *Quiescing a Replication System* on page 81

Changing the Next Intermediate Site for an Indirect Route

Change the next intermediate site for an existing indirect route.

1. **1.** Enter the following command at the source Replication Server, from which the direct route originates:

   ```
   suspend route to dest_replication_server
   ```

2. **2.** At each Replication Server that manages a database with a RepAgent, enter:

   ```
   suspend log transfer from all
   ```

and then quiesce the replication system so that messages will be redirected to your new routing configuration without error.

3. Create any additional routes that the indirect route will use.
    - If the current Replication Server does not already have a direct route to the Replication Server that you will specify as the new intermediate site for the indirect route, create the route.
    - If the Replication Server that you will specify as the new intermediate site for the indirect route does not already have a direct or indirect route to the destination site, create the route.
4. For the indirect route for which you are specifying a new intermediate Replication Server, enter the following command at the source Replication Server where *dest_replication_server* is the destination Replication Server for the route you are altering, and *thru_replication_server* is the new intermediate Replication Server for the route:
    ```
    alter route to dest_replication_server
    set next site thru_replication_server
    ```
5. Resume log transfer connections by entering the following command at each Replication Server where you previously suspended log transfer:
    ```
    resume log transfer from all
    ```
6. Resume the suspended route by entering the following command at the source Replication Server:
    ```
    resume route to dest_replication_server
    ```

See also

- *Quiescing a Replication System* on page 81

Changing an Indirect Route to a Direct Route

Change an existing indirect route to a direct route.

1. Enter the following command at the source Replication Server, from which the indirect route originates:
    ```
    suspend route to dest_replication_server
    ```
2. At each Replication Server that manages a database with a RepAgent, enter:
    ```
    suspend log transfer from all
    ```
    and then quiesce the replication system so that messages will be redirected to your new routing configuration without error.
3. For the indirect route you are changing to a direct route, enter the following command at the source Replication Server where *dest_replication_server* is the destination Replication Server for the route you are altering, and *user* and *passwd* are the RSI user login name and password to use for the direct route:
    ```
    alter route to dest_replication_server
    set username user set password passwd
    ```

4. Resume log transfer connections by entering the following command at each Replication Server where you previously suspended log transfer:

   ```
   resume log transfer from all
   ```

5. Resume the suspended route by entering the following command at the source Replication Server:

   ```
   resume route to dest_replication_server
   ```

See also

- *Quiescing a Replication System* on page 81

Changing the Password for the RSI User for a Direct Route

Use **alter route** with **set password** to change the RSI user password for an existing direct route.

1. Suspend each direct route from the source Replication Server by entering:

   ```
   suspend route to dest_replication_server
   ```

2. At the source Replication Server, enter the following command where *dest_replication_server* is the destination Replication Server for the route you are altering, and *passwd* is the password to use for the RSI user login name:

   ```
   alter route to dest_replication_server
   set password passwd
   ```

3. Resume each suspended route from the source by entering:

   ```
   resume route to dest_replication_server
   ```

Changing Parameters Affecting Direct Routes

Use **alter route** or SAP Control Center to change parameters for a specific direct route after you create the route.

Configuration parameters set for individual routes with **alter route** override default parameters set with **configure replication server**. Thus, you can set default parameters with **configure replication server** and then customize settings for individual routes with **alter route**.

For example, to change the **rsi_sync_interval** parameter to 120 seconds using **alter route**, log in to the source Replication Server and:

1. Suspend the route:

   ```
   suspend route to dest_replication_server
   ```

2. Execute the **alter route** command:

   ```
   alter route to dest_replication_server
   set rsi_sync_interval to '120'
   ```

3. Resume the suspended route:

   ```
   resume route to dest_replication_server
   ```

Configuration changes take effect after you resume the route.

See also

- *Configuration Parameters Affecting Routes* on page 149
- *Changing Configuration Parameters for All Routes* on page 157

Changing Configuration Parameters for All Routes

Use the **configure replication server** command to set default configuration parameters for all routes originating at the source Replication Server.

Configuration parameters set for individual routes with **alter route** override default parameters set with **configure replication server**. Thus, you can set default parameters with **configure replication server** and then customize settings for individual routes with **alter route**.

The syntax for changing route parameters with **configure replication server** is:

```
configure replication server
 set route_param to 'value'
```

Here is an example of using **configure replication server** to change the **rsi_save_interval** parameter to 2 minutes. To execute the command, log in to the source Replication Server and perform these steps:

1. Suspend all routes from the source Replication Server. For each route, enter:
   ```
   suspend route to dest_replication_server
   ```
2. Execute the **configure replication server** command:
   ```
   configure replication server
    set rsi_save_interval to '2'
   ```
3. Resume suspended routes from the source Replication Server. For each route, enter:
   ```
   resume route to dest_replication_server
   ```

Configuration changes take effect after you resume the routes.

See also

- *Configuration Parameters Affecting Routes* on page 149

Routing Modification Example

Learn how to change a routing scheme.

This example shows how to change the routing scheme from the scheme in the "Sites Connected with Indirect Routes in a Hierarchical Configuration" diagram to the scheme in the "Indirect Routes Altered" diagram, where LA_RS becomes an intermediate site between NY_RS and SF_RS, while direct and indirect routes to SB_RS are dropped:

Figure 16: Sites Connected with Indirect Routes in a Hierarchical Configuration

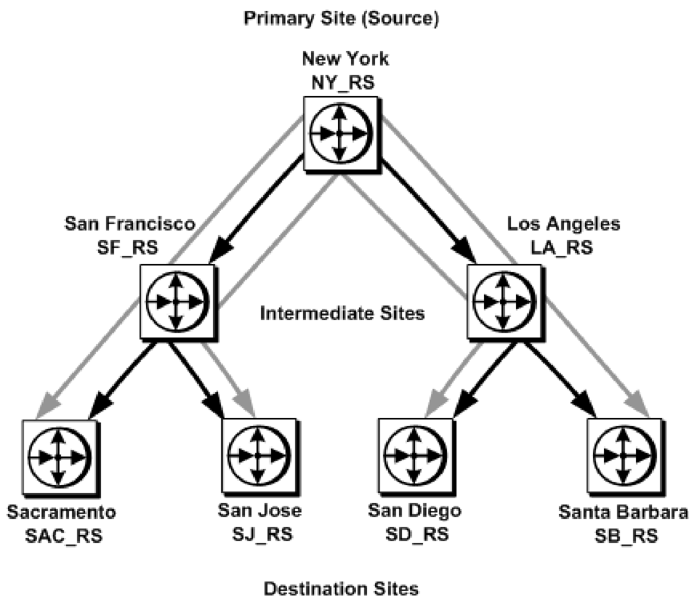
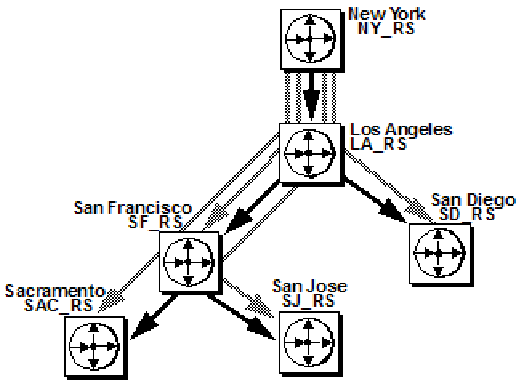


Figure 17: Indirect Routes Altered



1. At each Replication Server that manages a database with a RepAgent, enter:

   ```
   suspend log transfer from all
   ```

   and then quiesce the replication system so that messages will be redirected to your new routing configuration without error.
2. LA_RS needs a direct route to SF_RS; create one by entering the following command at Replication Server LA_RS:

```
create route to SF_RS
set username SF_rsi_user
set password SF_rsi_ps
```

3. LA_RS requires indirect routes to SAC_RS and SJ_RS, through SF_RS.

   Creating these routes instructs LA_RS to send messages to SF_RS that are destined for SAC_RS and SJ_RS. SF_RS already has direct routes to SAC_RS and SJ_RS. Enter the commands in Replication Server LA_RS:

   ```
   create route to SAC_RS
   set next site SF_RS
   ```

   ```
   create route to SJ_RS
   set next site SF_RS
   ```

4. The primary Replication Server, NY_RS, was previously configured with indirect routes through SF_RS to SAC_RS and SJ_RS. Alter those routes so that Replication Server LA_RS is the next Replication Server. Enter these commands in Replication Server NY_RS:

   ```
   alter route to SAC_RS
   set next site LA_RS
   ```

   ```
   alter route to SJ_RS
   set next site LA_RS
   ```

5. The direct route from the primary Replication Server, NY_RS, to SF_RS needs to be changed to an indirect route, with LA_RS as the intermediate Replication Server. Enter these commands in Replication Server NY_RS:

   ```
   alter route to SF_RS
   set next site LA_RS
   ```

6. At each Replication Server where you previously suspended log transfer, resume log transfer connections to each Replication Server by entering:

   ```
   resume log transfer from all
   ```

7. Remove the indirect route from NY_RS to SB_RS. Enter this command in NY_RS:

   ```
   drop route to SB_RS
   ```

8. Remove the direct route from LA_RS to SB_RS. Enter this command in LA_RS:

   ```
   drop route to SB_RS
   ```

   The indirect route from NY_RS to SD_RS, through LA_RS, is intact.

See also

- *Resume Log Transfer* on page 94
- *Quiescing a Replication System* on page 81

Drop Routes

Dropping a route closes the route from the Replication Server where you execute the command to a specified remote Replication Server.

Dropping a route performs the following actions on participating Replication Servers:

- Drops system table subscriptions.
- If the route is direct, the outbound stable queue is dropped and the RSI thread is stopped.
- Deletes information regarding the route.

You cannot drop the route if:

- It is a direct route used by any indirect routes to additional destination Replication Servers.
- The source Replication Server has replication definitions that are subscribed to by the destination Replication Server.
- The source Replication Server is designated as the primary site of a function-string class or error class. The primary site of a derived function-string class is the same as its parent class.

You can monitor the status of the route while it is being dropped by one of:

- In SAP Control Center, view status information in the Replication Server Monitor Routes view.
- From the command line, execute the **rs_helproute** stored procedure.

drop route Command

Use the **drop route** command to drop routes.

The syntax for the **drop route** command is:

```
drop route to dest_replication_server
 [with primary at dataserver.database]
 [with nowait]
```

Include the **with primary at** *dataserver.database* clause in the command to specify a dedicated route, where *dataserver.database* is the primary connection name. You must drop the dedicated route before you drop a shared route. After you drop a dedicated route, transactions from the specified primary connection to the destination Replication Server go though the shared route. See *Replication Server Administration Guide Volume 2 > Performance Tuning > Multi-Path Replication > Dedicated Routes*.

The **with nowait** option instructs Replication Server to close the route even if it is unable to communicate with the destination Replication Server.

Warning! Use the **with nowait** clause only as a last resort. Use the **with nowait** clause only if you do not intend to ever use the destination Replication Server, or if you must drop the route from the source Replication Server while the destination Replication Server is unavailable, or if you are attempting to add or change login names and passwords for direct routes. Avoid using the **with nowait** clause whenever possible.

The clause forces Replication Server to drop a route even if the route contains transactions in the outbound queue of the route. As a result, Replication Server may discard some transactions from the primary connections. The clause instructs Replication Server to drop the dedicated route even if the route cannot communicate with the destination Replication Server.

After you use the **with nowait** clause, use the **sysadmin purge_route_at_replicate** command to remove all references to a primary Replication Server such as subscriptions and route information, from the system tables at the replicate Replication Server.

sysadmin purge_route_at_replicate Command

sysadmin purge_route_at_replicate removes all subscriptions and route information originating from a specified primary Replication Server after a route is dropped from that Replication Server.

Before you execute this command, drop the route from the replicate Replication Server to the primary Replication Server, if it exists. The Replication Server performs a validation check before it processes the command.

Execute **sysadmin purge_route_at_replicate** at the replicate Replication Server, using the following syntax where *replication_server* is the primary Replication Server:

```
sysadmin purge_route_at_replicate, replication_server
```

Upgrade Routes

Upgrading the route allows the Replication Servers to exchange information about newer software features.

The route version is the earliest site version of the source and destination Replication Server. After you upgrade the source and destination Replication Servers on either end of a route and also set their site versions to a higher Replication Server version, you need to upgrade the route.

Upgrading a route rematerializes data in system tables, making information associated with new features available to a newly upgraded Replication Server. After upgrading, new types of information that were not previously allowed can be exchanged.

To display the current version number of routes that originate or terminate at a Replication Server, use the **admin show_route_versions** command.

To report the routes that you need to upgrade that originate or terminate at the Replication Server that you are upgrading, use **admin version, "route"**.

There are two possible scenarios for route upgrade:

- You must use **sysadmin upgrade, "route"** to upgrade routes if new features have been used at the source Replication Server.
- You can use **sysadmin fast_route_upgrade** to upgrade routes only if you are sure no new features have been used at the source Replication Server.

Use **sysadmin upgrade, "route"** if you are not sure if new features have been used at the source Replication Server.

You cannot downgrade a route after you have upgraded it, and there are restrictions if you have mixed-version replication systems.

See:

- *Commit a Local Site to a New Version Level* in the *Replication Server Configuration Guide* for information on system, site, and route versions
- *Upgrading Routes* in the *Replication Server Configuration Guide* to use the commands in the proper sequence to upgrade routes
- *Replication Server Reference Manual* for complete command syntax and usage information.

See also

- *Mixed-Version Replication Systems* on page 17

Monitor Routes

Routes may display different statuses at different times. Acquire an overview of the utilities you can use to monitor the status of routes.

When you create a route, the destination Replication Server subscribes to the source Replication Server system tables. Depending on the volume of your data, it may take several minutes for subscriptions to materialize. Dropping a route also may take some time.

- You can use the **admin who** command to display thread status information.
- For comprehensive status information, including the current state of routes you are creating, use **rs_helproute**.

Display RSI Thread Status Using admin who

Use **admin who** to view RSI thread information.

- **admin who** displays all threads in the system, including RSI threads.
- **admin who, rsi** displays the status of the RSI thread, which Replication Server starts to submit information to other Replication Servers.

See *Replication Server Reference Manual > Replication Server Commands >* ***admin who*** for detailed thread status information.

Use rs_helproute Stored Procedure

Use **rs_helproute** to obtain comprehensive route status information, including the current state of routes you are creating.

Execute the **rs_helproute** stored procedure in the RSSD at the source or destination Replication Server for the route. The syntax for the **rs_helproute** stored procedure is:

```
rs_helproute [replication_server]
```

If you specify the name of a Replication Server, **rs_helproute** returns information only for routes for which the named Replication Server is a source or destination. Otherwise, it returns information for all routes for which the current Replication Server is a source or destination.

rs_helproute returns two types of information:

- Route status, which reflects the state of the route at the site where **rs_helproute** is executed. A route is valid when **rs_helproute** at both source and destination returns "Active."

  Other route status values are:
  - Being created
  - Being dropped
  - Being dropped **with nowait**
- List of system table subscriptions, which tells you the system table subscriptions that are being created. If a route is being dropped, it tells you which subscriptions are being dropped.

  If no system table subscriptions are listed, the route has been created and is in working order.

See *Replication Server Reference Manual > RSSD Stored Procedures >* ***rs_helproute***.

Refer to the *Replication Server Troubleshooting Guide* for information about correcting route creation problems.

Manage Database Connections

Managing database connections includes preparing databases for replication, creating connections to the databases, and configuring the connections for optimal replication performance.

Prepare Databases for Replication

Before you can add databases to a replication system, you need to prepare them so that Replication Server can distribute the primary data and maintain the replicated data stored in them.

- If your databases are managed by Adaptive Servers:

  Use **rs_init** to prepare Adaptive Server databases for use with Replication Server.

  See the *Replication Server Installation Guide* and *Replication Server Configuration Guide* for more information on **rs_init**.
- If your databases are managed by non-ASE data servers:

  Refer to the *Replication Server Design Guide* for required preparations. In addition, to find out how to prepare your database for the heterogeneous datatype support (HDS) feature, see the *Replication Server Configuration Guide* for your platform. HDS enables the translation of primary database column values of one datatype to another datatype acceptable to the replicate database.

When you are connecting a new database to an existing system, always conduct a careful review and analysis of how the database will fit into your system. Determine which other processes are required for the database, and designate required names and login names for these processes.

If you anticipate that an existing “replicate-only” database may in the future be the source of replicated function delivery or contain primary data, you can set up the database so that it can manage primary tables. You can then avoid upgrading the replicate-only database in the future.

See also

- *Translate Datatypes Using HDS* on page 349

Preparation of Adaptive Server Databases for Replication

To prepare Adaptive Server databases for replication, use **rs_init**.

rs_init:

1. Creates the `rs_lastcommit` system table.

2. Loads the **rs_update_lastcommit** and **rs_get_lastcommit** stored procedures (for both primary and replicate databases) and the **rs_marker** stored procedure (for primary databases only).
3. Creates the `rs_threads` system table.
4. Loads the **rs_initialize_threads** and **rs_update_threads** stored procedures for the database.
5. Creates the maintenance user login name and verify that the maintenance user can log in to the database.
6. Creates a connection from Replication Server to the database, allowing Replication Server to manage the database.

If the database has primary data, **rs_init** additionally:

- Enables RepAgent at the Adaptive Server.
- Enables and configures RepAgent at the database.
- Sets the secondary truncation point to "valid" in the Adaptive Server database, preventing Adaptive Server from truncating database log records before RepAgent has read them.
- Creates the RepAgent user name and password in the Replication Server, if necessary.
- Starts RepAgent.

Refer to the Replication Server installation and configuration guides for your platform for details on each step.

See also

- *Manage the Maintenance User* on page 168

Preparation of Non-ASE Servers for Replication

With Replication Server 15.2, you can use connection profiles to connect to non-ASE servers with simplified installation and configuration.

To prepare non-ASE databases for replication, see the *Replication Server Heterogeneous Replication Guide*.

You do not need to edit and execute scripts to install datatype definitions, function strings, and class-level translations for heterogeneous (non-ASE) datatype support. The functions provided by the scripts are included as part of the Replication Server installation, or are included in connection profiles that are installed with Replication Server. These enhancements simplify installation and configuration for heterogeneous and non-ASE environments. See *Replication Server Configuration Guide > Install and Implement Non-ASE Support Features*.

In addition, Replication Server 15.2 and later provides error class support for non-ASE replicate databases. See *Replication Server Administration Guide Volume 2 > Handle Errors and Exceptions > Data Server Error Handling*.

Connection Profiles

Connection profiles contain connection configurations and replicate database object definitions relevant to each type of actively supported non-ASE data server.

You can use these connection profiles together with simple syntax to create connections between actively supported data servers such as Adaptive Server Enterprise, HANA DB, IBM DB2, Microsoft SQL Server, and Oracle. Replication Server uses the connection profile to configure the connection and create replicate database objects for you.

Connection profiles specify the function-string class, error class, and class-level translations to be installed. You can also use connection profile options to specify other actions such as whether commands should be batched and the command separator to use.

Note: When you create a connection using a connection profile, the system table services (STS) caches are refreshed so that you do not need to restart Replication Server.

See *Replication Server Administration Guide Volume 2 > Customize Database Operations > Manage Function Strings > Command Batching for non-ASE Servers*.

See also

- *Create Database Connections* on page 170

Upgrade an Existing Adaptive Server Database

You may need to upgrade a database to work with the latest version of Replication Server so that you can use newer features. Use **rs_init** to upgrade a database.

Upgrading a database ensures that the database maintenance user has the Replication role and the necessary permissions (**update**, **insert**, and **delete**) in the database. The Replication role gives the maintenance user authorization to execute any necessary replication-related Adaptive Server commands.

You can check the authorizations that have been granted to a database by using the **sp_displaylogin** system procedure in the database.

Granting Replication Role to the Maintenance User

Use **sp_role** to grant replication role to the maintenance user.
In the database, execute:

```
sp_role "grant", replication_role, maintenance_user
```

Granting Permissions on Tables

Use **grant all** to grant permissions on tables in the database
For each table, execute in the database:

```
grant all on table_name to maintenance_user
```

Manage the Maintenance User

To update replicated data, Replication Server logs in to the data server as the maintenance user. The database owner or the system administrator must grant to the maintenance user the permissions required to insert, delete, and update rows in replicated tables and to execute replicated stored procedures.

Initially, **rs_init** creates the login name for the maintenance user and adds the user to the replicate database. For details, refer to the Replication Server installation and configuration guides for your platform.

The maintenance user login name and password are provided to Replication Server with the **create connection** command for the database. **rs_init** program executes this command automatically. If you change the password for the login name in the data server, use **alter connection** command to change the password for the Replication Server connection.

You cannot use the **rs_init** utility for non-ASE databases. You must create and manage maintenance user login names in the non-ASE database server. See the *Replication Server Heterogeneous Replication Guide* for information related to non-ASE servers.

For Adaptive Server databases, you can protect the maintenance user with additional security measures.

See also

- *Maintenance User Security* on page 211

Find the Current Maintenance User

Use **rs_helpuser** to determine the login name that is currently assigned as maintenance user for a database.

Enter the **rs_helpuser** Adaptive Server stored procedure at the RSSD, where *user* is the login name about which you want information:

```
rs_helpuser [user]
```

Grant Permissions in the Database

Use **rs_init** to grant the maintenance user permission to access the `rs_lastcommit` system table and the stored procedures that use it. Use **grant all** to grant permissions for tables and stored procedures involved in replication.

rs_init does not grant permissions to the maintenance user for user tables and stored procedures. You must grant permissions on replicated tables and stored procedures before you can either replicate transactions for replicated tables or replicate executions of the replicated stored procedures.

For each table that is replicated in the database, and for each stored procedure that is executed due to replication, execute this **grant** command:

```
grant all on table_name to maint_user
```

Note: Among the permissions granted to the maintenance user is **replication_role**. If you revoke this permission, you will not be able to replicate **truncate table** unless the maintenance user has been granted **sa_role**, owns the table, or is aliased as the database owner.

See the *Replication Server Heterogeneous Replication Guide* for the permissions to grant the maintenance user for non-ASE replicate databases.

Grant Permissions for a Primary Database

If a replicate database holds primary data, then it is also a primary database. In a primary database, special permissions are necessary on two replication objects: subscriptions and request functions.

When subscriptions are created, the **rs_marker** stored procedure is executed at the primary database. Any database user who can create subscriptions must have permission to execute **rs_marker**.

A primary database may also receive transactions via request function delivery from clients at replicate sites. These transactions are executed at the primary site as if by the user executing the request function. Any user login name with permission to execute request functions must also have permission to execute **rs_update_lastcommit**, which executes in every DSI transaction.

The permission requirements are the same for request functions and request stored procedures.

The following **grant** commands allow any user in the database to execute **rs_marker** and **rs_update_lastcommit**:

```
grant execute on rs_marker to public
grant execute on rs_update_lastcommit to public
```

These stored procedures should only be executed by Replication Server on behalf of users. **rs_init** grants these permissions to “public.” You may want to restrict permissions to the database users who are allowed to create subscriptions, execute request functions, or request stored procedures.

See also

- *Manage Replicated Functions* on page 355

Create Database Connections

A connection defines a database to the SAP Replication Server. An SAP Replication Server is designated to manage the database and, if it is a replicate database, to distribute transactions to the database.

The database connection provides SAP Replication Server with:

- The name of the data server and database the connection is for
- The error class used to process errors returned from the data server
- The function-string class to use with the database
- The maintenance user login name and password
- Information about whether there is an SAP ASE RepAgent thread for the database connection
- Options for creating active and standby databases for warm standby applications
- Configuration parameters that affect connections

To create:

- A standard connection to an SAP ASE database, use **rs_init** or **create connection**.
- Alternate connections to an SAP ASE database, use **create alternate connection**. For example, you can create alternate connections to build multiple replication paths. See:
  - **create alternate connection** in *Replication Server Commands* in the *Reference Manual*
  - *Multi-Path Replication* in the *Administration Guide Volume 2*
- Connection to a non-SAP database, use **create connection** with the **using profile** clause. See **create connection using profile** in the *Reference Manual*.

Information Required to Add a Database Connection

You need to specify several items when you add a database connection.

The Replication Server installation and configuration guides for your platform describe how you use **rs_init** to add databases.

When you add a database, you specify:

- Replication Server name
- Replication Server System Administrator user name and password
- Adaptive Server name
- Adaptive Server System Administrator user name and password
- Database name
- Whether the database requires a RepAgent
- Maintenance user name and password

- Database Owner user name and password
- Whether the physical connection is for an existing logical connection

You cannot use the **rs_init** utility for non-ASE databases. You must create and manage maintenance user login names in the non-ASE database server, and you can create connections to non-ASE databases using connection profiles.

See the *Replication Server Heterogeneous Replication Guide* and the Replication Server Options documentation to configure access to non-ASE databases.

See also

- *Connection Profiles* on page 167

Add Databases for Logical Connections

If you are adding a physical connection for an existing logical connection, which you create with **create logical connection** command, you must specify additional information.

Specify:

- Active or standby connection
- Logical data server name
- Logical database name

In addition, if you are adding a standby connection, in **rs_init** you specify:

- Active data server name
- Active database name
- Active database system administrator user name and password
- Whether to initialize standby database using dump and load method
- Whether to use dump marker to start replication

See *Manage Warm Standby Applications* in the *Replication Server Administration Guide Volume 2*.

Add a Database that Requires a RepAgent Thread

If you are adding an Adaptive Server primary database that requires a RepAgent, you must specify the Replication Server user name and password.

Use the create connection Command

To add a database for a non-ASE data server, use the **create connection** command with a connection profile specific to your non-ASE data server. To add a database for an Adaptive Server data server, you use SAP Control Center or **rs_init**, both of which prepare the database for replication.

You can also use **create connection** for Adaptive Server data servers.

If you use **create connection** without a connection profile, you must prepare the database for replication yourself.

Enter **create connection** at the Replication Server that is to manage the database. The syntax is:

```
create connection to data_server.database
    using profile connection_profile;version
    set username [to] user
    [set error class [to] error_class]
    [set function string class [to] function_class]
    [set password [to] passwd]
    [set database_param [to] 'value']
    [set security_param [to] {‘required’ | ‘not_required’}]
    [with {log transfer on, dsi_suspended}]
    [as active for logical_ds.logical_db |
    as standby for logical_ds.logical_db]
    [use dump marker]
    [display_only]
```

You must use the **with dsi_suspended** clause, which starts the connection with the DSI suspended, when you create a connection to a database that will not be a replicate database.

The **as active**, **as standby**, and **use dump marker** clauses are used only when you create physical connections for a logical connection for a warm standby database. Only Adaptive Server and Oracle databases may be used in warm standby applications.

If your system supports network-based security, use the **set** *security_param* command.

See also

- *Prepare Databases for Replication* on page 165
- *Manage Network-based Security* on page 237

using profile Clause

Use the **using profile** clause with **create connection** to specify one of the connection profiles installed with Replication Server for your non-ASE database.

The **using profile** clause uses predefined information in the connection profile you specify, to configure the connection between Replication Server and a non-Adaptive Server database, and, if needed, to modify the RSSD and the named *data_server.database*

Since the connection profile specifies the function string class, error class, and class-level translations, you do not need to specify the corresponding clauses in the **create connection** command for non-ASE databases. Use *version* to specify the particular version of the connection profile you want to use.

For example, to create a connection to an Oracle replicate database with the **rs_ase_to_oracle** connection profile:

```
create connection to oracle_db.ORACLE_DS
using profile rs_ase_to_oracle;eco
set username to ora_maint
set password to ora_maint_pwd
```

Use the **admin show_connection_profiles** command to list the connection profile name, version, and comments for each profile defined in Replication Server, and use the *match_string* option to display only the connection profiles whose names contain the string you provide in the option:

```
admin show_connection_profiles[, “match_string”]
```

You can only use the **ase_to_ase** profile to create a connection to a replicate Adaptive Server database.

See *Replication Server Reference Manual > Replication Server Commands >* ***create connection using profile***.

See *Replication Server Heterogeneous Replication Guide > Heterogeneous Warm Standby for Oracle > Setting Up Warm Standby Databases > Creating Connection to the Standby Database*.

Altering Database Connections

Use SAP Control Center or **alter connection** to change the attributes of a database connection at the Replication Server where the connection was created.

If you use **alter connection**, you must suspend and resume the connection for the changes to take effect.

1. Use **suspend connection** to suspend activity on the connection.
2. Execute the **alter connection** command with the relevant parameters.

   Note: Using the **set log transfer off** clause for the **alter connection** command drops the RepAgent connection from a primary site. Before using this clause, be sure there are no replication definitions defined for data in the database.
3. Use **resume connection** to resume activity on the connection.

See also

- *Suspend Database Connections* on page 173
- *Set and Change Parameters Affecting Physical Connections* on page 174
- *Resume Database Connections* on page 199

Suspend Database Connections

You must suspend a database connection before you alter it or when you remove a data server from service for maintenance.

If you have **sa** permission, you can temporarily suspend access to a data server.

While data server access is suspended, the Replication Server queues transactions for the data server so they can be applied when the connection is resumed.

You can temporarily suspend access to a data server using SAP Control Center or you can enter:

```
suspend connection to data_server.database
    [with nowait]
```

By default, **suspend connection** completes the current transaction before suspending. Use the **with nowait** clause to suspend the connection in mid-transaction. This may be appropriate if a large transaction is responsible for a failure in a replicate database.

Set and Change Parameters Affecting Physical Connections

You set configuration parameters for a connection when you create it. Later, you can update those parameters with SAP Control Center, the **alter connection** command.

You can change the configuration of either a single database connection or of all database connections that originate from a single Replication Server. If you are adding many database connections to a Replication Server, you may want to change configuration parameters affecting all connections in order to fine-tune server performance.

To change configuration parameters for all connections originating at the current Replication Server, use the **configure replication server** command.

Configuration parameters that are set for individual connections with **alter connection** override parameters that are set with **configure replication server**. Thus, you can set default parameters with **configure replication server** and then customize settings for specific connections with **alter connection**.

Replication Server provides different types of configuration parameters that affect database connections. There are configuration parameters for:

- Physical database connections.
- Logical database connections. See *Change Parameters Affecting Logical Connections* in the *Replication Server Administration Guide Volume 2*.
- Network-based security.
- Setting up and tuning parallel DSI connections. See *Use Parallel DSI Threads* in the *Replication Server Administration Guide Volume 2*.
- Tuning Replication Server performance. See *Connection Parameters that Affect Performance* in the *Replication Server Administration Guide Volume 2* .

See also

- *Change Parameters Affecting All Connections* on page 176
- *Manage Network-based Security* on page 237

Change Parameters Affecting a Single Connection

After a connection is created, you can change its configuration parameters with the **alter connection** command.

alter connection lets you change the attributes of a database connection. Use this command, for example, if you have added an Adaptive Server database connection using SAP Control

Center or **rs_init**, and then decide that you want the database connection to use a derived function-string class instead of a system-provided class. The syntax for **alter connection** is:

```
alter connection to data_server.database {
    set function string class [to] function_class |
    set error class [to] error_class |
    set password [to] passwd |
    set log transfer [to] {on | off} |
    set database_param [to] 'value'} |
    set security_param to {‘required’ | ‘not_required’} |
    set security_services [to] “default’
}
```

You indicate the data server and database that is connected to the Replication Server and specify one or more of the attributes to change. These include:

function_class – the function-string class to use with the database connection.

error_class – the error class to use for handling database errors.

passwd – the new password to use with the login name for the database connection.

log transfer on – allows transactions to be sent, using this connection, to the Replication Server.

log transfer off – stops transactions from being sent, using this connection, from a primary database to the Replication Server.

database_param – updates a configuration parameter that affects connections.

security_param – updates a network security configuration parameter that affects connections.

set security_services [to] ‘default’ – resets all network-based security features for the connection to “not required.”

*An Example of Using **alter connection***

To change the function-string class for the `pubs2` database in the SYDNEY_DS data server to **sqlserver_derived_class**, in the SYDNEY_RS Replication Server enter:

```
suspend connection to SYDNEY_DS.pubs2
alter connection to SYDNEY_DS.pubs2
    set function string to class
      sqlserver_derived_class
resume connection to SYDNEY_DS.pubs2
```

See **alter connection** in the *Replication Server Reference Manual*.

See also

- *Manage Network-based Security* on page 237

Change Parameters Affecting All Connections

Use the **configure replication server** command to set default configuration parameters for all connections originating at the source SAP Replication Server.

The syntax for **configure replication server** is:

```
configure replication server
 set database_param to 'value'
```

Configuration changes take effect after you resume the connections.

Changing the dsi_fadeout_time Value

This example shows how to use **configure replication server** to change the **dsi_fadeout_time** parameter so that the DSI connection does not close. Log in to the source SAP Replication Server to execute the commands.

1. Suspend all connections from the source SAP Replication Server. For each connection, enter:
   ```
   suspend connection to data_server.database
   ```
2. Execute **configure replication server**. Enter:
   ```
   configure replication server
   set dsi_fadeout_time to '-1'
   ```
3. Resume suspended connections from the source SAP Replication Server. For each connection, enter:
   ```
   resume connection to data_server.database
   ```

Enabling SAP Failover Support

This example shows how to use **configure replication server** to change the **ha_failover** parameter to enable Failover support for all non-RSSD connections from an SAP Replication Server to SAP ASEs.

1. Execute **configure replication server**. Log in to the SAP Replication Server for which you want to enable Failover support and enter:
   ```
   configure replication server
   set ha_failover to 'on'
   ```
   See *Configure the Replication System to Support SAP Failover* in the *Administration Guide Volume 2*.

Configuration Parameters Affecting Physical Database Connections

Use **alter connection** with the parameter to change the attributes of a single connection or **configure replication server** to change the attribute of the parameter for all connections to SAP Replication Server.

Table 12. Configuration Parameters Affecting Database Connections

Parameter *(database_param)*	Value *(value)*
batch	The default, "on," allows command batches to a replicate database. Default: "on" for SAP ASE and "off" for non-SAP ASE databases. See *Command Batching for Non-SAP ASE Servers* in the *Administration Guide Volume 2*.
batch_begin	Indicates whether a **begin transaction** can be sent in the same batch as other commands (such as **insert** and **delete**). Default: on See *Command Batching for Non-SAP ASE Servers* in the *Administration Guide Volume 2*.
command_retry	The number of times to retry a failed transaction. The value must be greater than or equal to 0. Default: 3
db_packet_size	The maximum size of a network packet. During database communication, the network packet value must be within the range accepted by the database. You may change this value if you have SAP ASE that has been reconfigured. Allowable range: 512 bytes to 2,147,483,647 bytes within the limits for the replicate data server Maximum SAP ASE limit: 16384 bytes Default: 512-byte network packet for all SAP ASE databases

Parameter *(database_param)*	Value *(value)*
deferred_name_resolution	Enable deferred name resolution in SAP Replication Server to support deferred name resolution in SAP ASE. You must ensure that deferred name resolution is supported in the replicate SAP ASE before you enable deferred name resolution support in SAP Replication Server. Default: off
disk_affinity	Specifies an allocation hint for assigning the next partition. Enter the logical name of the partition to which the next segment should be allocated when the current partition is full. Values are "*partition_name*" and "off." Default: off
dsi_alt_writetext	Controls how large object updates are sent to the replicate database. Values are: • **dcany** – generates a **writetext** command that includes primary key columns. This setting prevents full table scans when populating non-SAP ASE replicate databases using Enterprise Connect™ Data Access as an interface. • **off** (default) – generates an SAP ASE **writetext** command that includes a text pointer.
dsi_bulk_copy	Turns the bulk-copy-in feature on or off for a connection. If **dynamic_sql** and **dsi_bulk_copy** are both on, SAP Replication Server applies bulk-copy-in when appropriate and uses dynamic SQL if SAP Replication Server cannot use bulk-copy-in. Turn **dsi_bulk_copy** on to improve performance if you have large batches of inserts. Default: off **Note:** You must set **dsi_bulk_copy** to **off** before you enable real-time loading (RTL) replication to SAP IQ.

Parameter *(database_param)*	Value *(value)*
dsi_bulk_threshold	The number of consecutive **insert** commands in a transaction that, when reached, triggers SAP Replication Server to use bulk copy-in. When Stable Queue Transaction (SQT) encounters a large batch of **insert** commands, it retains in memory the number of **insert** commands specified to decide whether to apply bulk copy-in. Because these commands are held in memory, SAP suggests that you do not configure this value much higher than the configuration value for **dsi_large_xact_size**. SAP Replication Server uses **dsi_bulk_threshold** for real-time loading (RTL) replication to SAP IQ and high volume adaptive replication (HVAR) to SAP ASE. If the number of commands for an **insert**, **delete**, or **update** operation on one table is less than the number you specify after compilation, RTL and HVAR use language instead of bulk interface. Minimum: 1 Default: 20 **Note:** You must set **dsi_compile_enable** to 'on' to use **dsi_bulk_threshold**.
dsi_charset_convert	The specification for handling character set conversion. This parameter applies to all data and identifiers to be applied at the DSI in question. The values are: • "on" (default) – convert from the primary SAP Replication Server character set to the replicate SAP Replication Server character set; if character sets are incompatible, shut down the DSI with an error. • "allow" – convert where character sets are compatible; apply any unconverted updates to the database, as well. • "off" – do not attempt conversion. This option is useful if you have different but compatible character sets and do not want any conversion to take place. During subscription materialization, a setting of "off" behaves as if it were "allow."
dsi_check_lock_wait	The number of milliseconds before the DSI executor thread executes the **rs_thread_check_lock** function string, which queries the replicate database about lock status. Default: 3000 milliseconds (3 seconds)

Parameter *(database_param)*	**Value *(value)***
dsi_cmd_batch_size	The maximum number of bytes that SAP Replication Server places into a command batch. Default: 8192 bytes
dsi_cmd_prefetch	Allows DSI to pre-build the next batch of commands while waiting for the response from data server, and therefore improves DSI efficiency. If you also tune your data server to enhance performance, it is likely that you will gain an additional performance increase when you use this feature. Default: off When you set **dsi_compile_enable** to ‘on’, SAP Replication Server ignores what you set for **dsi_cmd_prefetch**.

dsi_cmd_separator	The character that separates commands in a command batch. For example, if you have specified a different separator character and want to change it back to the default character, enter:
	
	`alter connection to data_server.database`
	`set dsi_cmd_separator to '<Return>'`
	
	Press the Return key, and no other characters, between the two single-quote characters.
	
	Default: newline (\n)
	
	Note: Pressing the Return key is effective only in an interactive update; it is not applicable to executing a script, such as a DDL generated script. You must update this parameter in an interactive mode. You cannot reset it from within a script.

Parameter *(database_param)*	**Value *(value)***
dsi_command_convert	Specifies how to convert a replicate command. A combination of these operations specifies the type of conversion: • **d** – delete • **i** – insert • **u** – update • **t** - truncate • **none** – no operation Combinations of operations for **dsi_command_convert** include **i2none**, **u2none**, **d2none**, **i2di**, **t2none**, and **u2di**. You must type the number “2”. The operation before conversion precedes the “2” and the operations after conversion are after the “2”. For example: • **d2none** – do not replicate the delete command. • **i2di**,**u2di** – convert both insert and update to delete followed by insert, which is equivalent to an auto-correction. • **t2none** – do not replicate **truncate table** command. Default: None. You can also configure this parameter at the table-level. For setting, use **alter connection** for database-level, or **alter connection** with the **for replicate table named** clause for table-level configuration.
dsi_commit_check_locks_intrvl	The number of milliseconds (ms) the DSI executor thread waits between executions of the **rs_dsi_check_thread_lock** function string. Used with parallel DSI. See *Use Parallel DSI Threads* in the *Administration Guide Volume 2*. Default: 1000 ms (1 second) Minimum: 0 Maximum: 86,400,000 ms (24 hours)

Parameter *(database_param)*	Value *(value)*
dsi_commit_check_locks_max	The maximum number of times a DSI executor thread checks whether it is blocking other transactions in the replication database before rolling back its transaction and retrying it. Used with parallel DSI. See *Use Parallel DSI Threads* in the *Administration Guide Volume 2*. Default: 400 Minimum: 1 Maximum: 1,000,000
dsi_commit_control	Specifies whether commit control processing is handled internally by SAP Replication Server using internal tables (on) or externally using the `rs_threads` system table (off). Used with parallel DSI. See *Use Parallel DSI Threads* in the *Administration Guide Volume 2*. Default: on

Parameter *(database_param)*	Value *(value)*
dsi_compile _enable	Enables or disables RTL or HVAR at the server-level, database-level, or table-level. For setting, use **configure replication server** for server-level, **alter connection** for database-level, or **alter connection** with the **for replicate table named** clause for table-level configuration. Default: • off – server and database-level. SAP Replication Server uses continuous log order row by row change replication. • on – table-level Set **dsi_compile_enable** to 'off' for an affected table if replicating new row changes causes problems, such as when there is a trigger on the table which requires all the operations on that table to be replicated in log order, and therefore compilation is not allowed. **Note:** Set **dsi_compile _enable** to 'on' at the server- or database-level before you set **dsi_compile_enable** to 'on' at the table-level. When you set **dsi_compile_enable** to 'on', SAP Replication Server ignores what you set for **replicate_minimal_columns** and **dsi_cmd_prefetch**. After you execute **dsi_compile_enable** at the server, database, or table-level, suspend and resume the connection. See *High Volume Adaptive Replication to Adaptive Server* in the *Administration Guide Volume 2* for HVAR. See *SAP IQ as Replicate Data Server* in the *Heterogeneous Replication Guide* for RTL. License: Separately licensed under the Advanced Services Option. See *Advanced Services Option* in the *Administration Guide Volume 2*.

Parameter *(database_param)*	Value *(value)*
dsi_compile_max_cmds	Specifies, in number of commands, the maximum size of a group of transactions. When HVAR or RTL reaches the maximum group size for the current group that it is compiling, HVAR or RTL starts a new group. If there is no more data to read, and even if the group does not reach the maximum number of commands, HVAR or RTL completes grouping the current set of transactions into the current group. For setting, use **configure replication server** for server-level or **alter connection** for database-level. Minimum: 100 Default: 10,000 **Note:** You must set **dsi_compile_enable** to 'on' to use **dsi_compile_max_cmds**.
dsi_dataserver_make	Specifies the data server type that contains the replicate database that you want to connect to. Set to: • **ase** – to replicate to SAP ASE • **ase** – to replicate to IBM DB2 on z/OS • **hdb** – to replicate to SAP HANA • **iq** – to replicate to SAP IQ • **ase** – to replicate to Microsoft SQL Server • **ora** – to replicate to Oracle • **udb** – to replicate to IBM UDB Use **dsi_dataserver_make** and **dsi_connector_type** to identify the connector that is associated with the connection. You can configure **dsi_dataserver_make** at the database level. If you do not specify this parameter, SAP Replication Server deduces the data server type from the function-string class name of the database connection. If the functions-string class is customized, SAP Replication Server cannot deduce the data server type and defaults to 'ASE'.
dsi_exec_request_sproc	Turns on or off request stored procedures at the DSI of the primary SAP Replication Server. Default: on

Parameter *(database_param)*	Value *(value)*
dsi_fadeout_time	The number of seconds of idle time before a DSI connection is closed. A value of -1 specifies that the connection should not fade out. Default: 600 seconds
dsi_ignore_underscore_name	When the transaction partitioning rule is set to **name**, specifies whether or not SAP Replication Server ignores transaction names that begin with an underscore. Values are "on" and "off." Default: on
dsi_isolation_level	Specifies the isolation level for transactions. The ANSI standard and SAP ASE supported values are: • 0 – ensures that data written by one transaction represents the actual data • 1 – prevents dirty reads and ensures that data written by one transaction represents the actual data • 2 – prevents nonrepeatable reads and dirty reads, and ensures that data written by one transaction represents the actual data • 3 – prevents phantom rows, nonrepeatable reads, and dirty reads, and ensures that data written by one transaction represents the actual data • default – use the transaction isolation level of the replicate data server Data servers supporting other isolation levels are supported as well through the use of the **rs_set_isolation_level** function string. Support is not limited to the ANSI standard only. SAP Replication Server can support any isolation level the replicate data server may use.
dsi_keep_triggers	Specifies whether triggers should fire for replicated transactions in the database. "off" – causes SAP Replication Server to **set triggers off** in the SAP ASE database, so that triggers do not fire when transactions are executed on the connection. Use this setting for standby databases. on" – specifies all databases except standby databases. Default: on (except standby databases)

Parameter *(database_param)*	**Value *(value)***
dsi_large_xact_size	The number of commands allowed in a transaction before the transaction is considered to be large. Default: 100 Minimum: 4 Maximum: 2,147,483,647 SAP Replication Server ignores **dsi_large_xact_size** when you turn on **dsi_compile_enable**.
dsi_max_cmds_in_batch	Defines maximum number of source commands for which output commands can be batched. You must suspend and resume the connection for any change in the parameter to take effect. Range: 1 – 1000 Default: 100
dsi_max_cmds_to_log	The number of commands to write into the exceptions log for a transaction. Default: -1 (all commands) Valid values: 0 to 2147483647
dsi_max_xacts_in_group	Specifies the maximum number of transactions in a group. Larger numbers may improve data latency at the replicate database. Range of values: 1 – 1000. Default: 20 This parameter is ignored when **dsi_compile_enable** is turned on.
dsi_max_text_to_log	The number of bytes to write into the exceptions log for each **rs_writetext** function in a failed transaction. Change this parameter to prevent transactions with large `text`, `unitext`, or `image` columns from filling the RSSD or its log. Default: –1 (all `text`, `unitext`, or `image` columns)

Parameter *(database_param)*	Value *(value)*
dsi_non_blocking_commit	Specifies the number of minutes to extend the period of time SAP Replication Server saves messages after a commit. Range of values: 0 – 60 minutes. Default: 0 – non-blocking commit is disabled. Enable this parameter to improve replication performance when the delayed commit feature is available in SAP ASE 15.0 and later or the equivalent feature is available in Oracle 10g v2.
dsi_num_large_xact_threads	The number of parallel DSI threads to be reserved for use with large transactions. The maximum value is one less than the value of **dsi_num_threads**. Default: 0
dsi_num_threads	The number of parallel DSI threads to be used. The maximum value is 255. Default: 1
dsi_partitioning_rule	Specifies the partitioning rules (one or more) the DSI uses to partition transactions among available parallel DSI threads. Values are **origin**, **origin_sessid**, **time**, **user**, **name**, and **none**. See *Partitioning Rules: Reducing Contention and Increasing Parallelism* in the *Administration Guide Volume 2* for detailed information. Default: none This parameter is ignored when **dsi_compile_enable** is turned on.

Parameter *(database_param)*	Value *(value)*
dsi_proc_as_rpc	Specifies how SAP Replication Server applies stored procedure replication. • Set on to use remote procedure call (RPC) calls. • Set off to use language calls. Default: off When the replicate database is SAP ASE, **dsi_proc_as_rpc** can be on or off. When the replicate database is Oracle, set **dsi_proc_as_rpc** on if you use ExpressConnect for Oracle (ECO). ECO only supports stored procedure replication using RPC. By default, SAP Replication Server sets **dsi_proc_as_rpc** on if you use one of the Oracle ECO connection profiles when you create the connection to the Oracle database from SAP Replication Server. See *Configuring ExpressConnect for Oracle* in the *Replication Server Options > ExpressConnect for Oracle Installation and Configuration Guide ExpressConnect for Oracle Microsoft Windows, UNIX, and Linux >* .

Parameter *(database_param)*	Value *(value)*
dsi_quoted_identifier	Enables or disables quoted identifier support in the Data Server Interface (DSI). • **on** – enables quoted identifiers if you mark the table as quoted in a replication definition or if the LTL that is sent by SAP ASE RepAgent from SAP ASE 15.7 marks the table as quoted • **off** – disable quoted identifier support • **always** – always surrounds identifiers with double quotes, regardless of primary database configuration or replication definition setting. You can use the **al-ways** option for a specific table or for all tables. Default: **off** You can set **dsi_quoted_identifier** at the table level, connection level, or at the server level. The table-level **dsi_quoted_identifier** setting takes precedence over any existing connection-level **dsi_quoted_identifier** setting and the connection-level setting takes precedence over the server-level **dsi_quoted_identifier** setting. See *Quo-ted Identifier Replication at the Table Level* on page 291 If you set **dsi_quoted_identifier** to **on** for an SAP ASE database connection , you must not include double quotes in any stored procedure you want to replicate. Otherwise, the DSI thread shuts down. Enable this parameter to: • Create or modify a connection that allows quoted identifiers to be forwarded to data servers. Use **create connection** or **alter connection** to set **dsi_quoted_identifier**. Use **admin config** to check the value of **dsi_quoted_identifier**. • Support marking of identifiers in a replication defi-nition as quoted. Quoted identifiers are not supported in mixed version environments. For replication of a quoted identifier to succeed, the primary SAP Replication Server and the SAP Replication Server that connects to the replicate data server version must be 15.2 and later. However, intermediate SAP Replication Servers in a route can be of lower versions.

Parameter *(database_param)*	Value *(value)*
dsi_replication	Specifies whether or not transactions applied by the DSI are marked in the transaction log as being replicated. When **dsi_replication** is set to "off," the DSI executes **set replication off** in the SAP ASE database, preventing SAP ASE from adding replication information to log records for transactions that the DSI executes. Since these transactions are executed by the maintenance user and, therefore, usually not replicated further (except if there is a standby database), setting this parameter to "off" avoids writing unnecessary information into the transaction log. **dsi_replication** must be set to "on" for the active database in a warm standby application for a replicate database, and for applications that use the replicated consolidated replicate application model. Default: on ("off" for standby database in a warm standby application)
dsi_row_count_validation	If you have table rows that are not synchronized, and you want to bypass the default error actions and messages, you can set **dsi_row_count_validation** to **off** to disable row count validation. Default: **on** to enable row count validation. You need not suspend and resume a database connection when you set **dsi_row_count_validation** for the connection; the parameter takes effect immediately. However, the new setting affects the batch of replicated objects that SAP Replication Server processes after you execute the command. Changing the setting does not affect the batch of replicated objects that SAP Replication Server is currently processing.

Parameter *(database_param)*	Value *(value)*
dsi_serialization_method	Specifies the method used to determine when a transaction can start, while still maintaining consistency. In all cases, commit order is preserved. These methods are ordered from most to least amount of parallelism. Greater parallelism can lead to more contention between parallel transactions as they are applied to the replicate database. To reduce contention, use the **dsi_partition_rule** option. • **no_wait** – specifies that a transaction can start as soon as it is ready—without regard to the state of other transactions. • **wait_for_start** – specifies that a transaction can start as soon as the transaction scheduled to commit immediately before it has started. • **wait_for_commit** – specifies that a transaction cannot start until the transaction scheduled to commit immediately preceding it is ready to commit. • **wait_after_commit** – specifies that a transaction cannot start until the transaction scheduled to commit immediately preceding it has committed completely. **Note:** You can only set **dsi_serialization_method** to **no_wait** if **dsi_commit_control** is set to “on”. These options are retained only for backward compatibility with older versions of SAP Replication Server: • **none** – same as **wait_for_start**. • **single_transaction_per_origin** – same as **wait_for_start** with **dsi_partitioning_rule** set to **origin**. **Note:** The **isolation_level_3** value is no longer supported as a serialization method but it is the same as setting **dsi_serialization_method** to **wait_for_start** and **dsi_isolation_level** to 3. Default: **wait_for_commit**

Parameter *(database_param)*	**Value *(value)***
dsi_sqt_max_cache_size	Maximum SQT (Stable Queue Transaction interface) cache memory for the database connection, in bytes. The default, "0," means that the current setting of **sqt_max_cache_size** is used as the maximum cache size for the connection. Default: 0 For 32-bit SAP Replication Server: • Minimum – 0 • Maximum – 2147483647 For 64-bit SAP Replication Server: • Minimum – 0 • Maximum – 2251799813685247
dsi_stage_all_ops	Prevents compilation for specified tables when you configure SAP Replication Server and SAP IQ InfoPrimer integration. If table history must be preserved, as in the case of slowly changing dimension (SCD) tables, set **dsi_stage_all_ops** to on. See *Parameters >* ***dsi_stage_all_ops*** in the *Heterogeneous Replication Guide*.
dsi_text_convert_multiplier	Changes the length of `text` or `unitext` datatype columns at the replicate site. Use **dsi_text_convert_multiplier** when `text` or `unitext` datatype columns must expand or contract due to character set conversion. SAP Replication Server multiplies the length of primary `text` or `unitext` data by the value of **dsi_text_convert_multiplier** to determine the length of `text` or `unitext` data at the replicate site. The value type is `float`. • If the character set conversion involves expanding `text` or `unitext` datatype columns, set **dsi_text_convert_multiplier** equal to or greater than 1.0. • If the character set conversion involves contracting `text` or `unitext` datatype columns, set **dsi_text_convert_multiplier** equal to or less than 1.0. Default: 1

Parameter *(database_param)*	Value *(value)*
dsi_timer	Use the **dsi_timer** configuration parameter to specify a delay between the time transactions commit at the primary database and the time transactions commit at the standby or replicate database. SAP Replication Server processes transactions in the outbound queue in commit order after the period of delay is over. After you execute **dsi_timer** with **alter connection** or **alter logical connection**, suspend and resume the connection. Specify the delay in the hh:mm format. • Maximum: 24 hours. • Default: 00:00, which means there is no delay. **Note:** SAP Replication Server does not support time zone differences between the Replication Agent at the primary database and the SAP Replication Server with the DSI connection where you want to execute **dsi_timer**.

Parameter *(database_param)*	**Value *(value)***
dsi_top1_enable	For SAP ASE databases, set **dsi_top1_enable** to on to enable replication of tables that do not have unique keys. If a table does not have a unique key, it is possible that there are two or more rows with the same values. However, DSI shuts down if it cannot find a unique row to apply an operation. The **dsi_top1_enable** parameter instructs DSI to select and update only the first instance of multiple similar rows by setting *unsigned_integer* to 1 in the **top *unsigned_integer*** clause of the SAP ASE **select** statement. Default: off Use **configure replication server** to set the parameter for all replicate connections. Do not use **configure replication server** to set **dsi_top1_enable** to on if there are connections to non-SAP ASE replicate databases. Instead, use **alter connection** to set the parameter individually for each SAP ASE replicate database connection. SAP Replication Server does not support replication of a table without unique keys if: • There is a customized function string for the table. • There is a table replication definition for the table. • Transactions use updates and deletes with the **like** option in the **where** clause at the primary database. • The replicate database is not SAP ASE.
dsi_xact_group_size	The maximum number of bytes, including stable queue overhead, to place into one grouped transaction. A grouped transaction is a set of transactions that the DSI applies as a single transaction. A value of –1 means no grouping. SAP recommends that you set **dsi_xact_group_size** to the maximum value and use **dsi_max_xacts_in_group** to control the number of transactions in a group. **Note:** Obsolete for SAP Replication Server version 15.0 and later. Retained for compatibility with older SAP Replication Servers. Maximum: 2,147,483,647 Default: 65,536 bytes This parameter is ignored when **dsi_compile_enable** is turned on.

Parameter *(database_param)*	Value *(value)*
dump_load	Set to “on” at replicate sites only to enable coordinated dump. See *Loading from Coordinated Dumps* in the *Administration Guide Volume 2*. Default: off
exec_cmds_per_timeslice	Specifies the number of LTL commands an LTI or SAP ASE RepAgent Executor thread can process before it must yield the CPU to other threads. The range is 1 to 2,147,483,647. Default: 2,147,483,647
dynamic_sql	Turns dynamic SQL feature on or off for a connection. Other dynamic SQL related configuration parameters will take effect only if this parameter is set to on. **Note:** If **dynamic_sql** and **dsi_bulk_copy** are both on, DSI applies bulk copy-in. Dynamic SQL is used if bulk copy-in is not used. Default: off **Note:** You must set **dynamic_sql** to **off** before you enable real-time loading (RTL) replication to SAP IQ.
dynamic_sql_cache_size	Gives the SAP Replication Server a hint on how many database objects may use the dynamic SQL statement for a connection. Minimum: 1 Maximum: 65536 Default: 100
dynamic_sql_cache_management	Manages the dynamic SQL cache for a DSI/E thread. Values: **mru** - keep the most recently used statements and deallocate the to allocate new dynamic statements when **dynamic_sql_cache_size** is reached. **fixed** (default)- SAP Replication Server stops allocating the new dynamic statements once **dynamic_sql_cache_size** is reached.

Parameter *(database_param)*	Value *(value)*
exec_nrm_request_limit	Specifies the amount of memory available for messages from a primary database waiting to be normalized. Set **nrm_thread** to 'on' with **configure replication server** before you use **exec_nrm_request_limit**. Minimum: 16,384 bytes Maximum: 2,147,483,647 bytes Default for: • 32-bit – 1,048,576 bytes (1MB) • 64-bit – 8,388,608 bytes (8MB) After you change the configuration for **exec_nrm_request_limit**, suspend and resume the Replication Agent. License: Separately licensed under the Advanced Services Option. See *Advanced Services Option* in the *Administration Guide Volume 2*.
exec_sqm_write_request_limit	Specifies the amount of memory available for messages waiting to be written to an inbound queue. Default: 1MB Minimum:16KB Maximum: 2GB
md_sqm_write_request_limit	Specifies the amount of memory available to the Distributor for messages waiting to be written to the outbound queue. **Note:** In SAP Replication Server 12.1, **md_sqm_write_request_limit** replaces **md_source_memory_pool**. **md_source_memory_pool** is retained for compatibility with older SAP Replication Servers. Default: 1MB Minimum: 16K Maximum: 2GB
rep_as_standby	When **rep_as_standby** is **on**, table subscriptions replicate tables marked by **sp_reptostandby**. For **rep_as_standby on** to succeed, the SAP ASE RepAgent parameters **send maint xacts to replicate** must be **false** and **send warm standby xacts** must be **true**. Default: off

Parameter *(database_param)*	Value *(value)*
replicate_minimal_columns	Specifies whether SAP Replication Server should send all replication definition columns for all transactions, or only those needed to perform update or delete operations at the replicate database. Values are On and Off. Default: On SAP Replication Server uses this connection-level parameter when a replication definition does not contain the **replicate minimal columns** clause, or if there is no replication definition at all Otherwise, SAP Replication Server ignores the value of this parameter. You can use **admin config** to display **replicate_minimal_columns** configuration information. When you set **dsi_compile_enable** to 'on', SAP Replication Server ignores what you set for **replicate_minimal_columns**. See *Use Replicate Minimal Columns with Dynamic SQL* in the *Administration Guide Volume 2*.
save_interval	The number of minutes that the SAP Replication Server saves messages after they have been successfully passed to the destination data server. Default: 0 minutes
stage_operations	Set to on for SAP Relication Server to write operations to staging tables for the specified connection when you configure SAP Replication Server and SAP IQ InfoPrimer integration. See *Parameters >* ***stage_operations*** in the *Heterogeneous Replication Guide*.
sub_sqm_write_request_limit	Specifies the memory available to the subscription materialization or dematerialization thread for messages waiting to be written to the outbound queue. Default: 1MB Minimum: 16K Maximum: 2GB

Parameter *(database_param)*	Value *(value)*
unicode_format	Supports sending unicode data in `U&"` format which removes the limitation of UTF-8 character set in SAP Replication Server. Set **unicode_format** to one of these values: • `string` – unicode characters are converted to character string format. For example, the `string` “hello” is sent out as “hello”. In this case SAP Replication Server requires UTF-8. • `ase` – unicode characters are sent out in `U&''` format. For example, the `string` “hello” is sent out as "U&'\0068\0065\006c\006c\006f' ". The two-byte unicode value is sent in network order as required by SAP ASE. In this case SAP Replication Server can use a character set other than UTF-8. Default: `string`
use_batch_markers	If **use_batch_markers** is set to **on**, the function strings **rs_batch_start** and **rs_batch_end** will be executed. **Note:** This parameter must be set to **on** only for replicate data servers that require additional SQL translation to be sent at the beginning and end of a batch of commands that are not contained in the **rs_begin** and **rs_commit** function strings. Default: off See *Command Batching for Non-SAP ASE Servers* in the *Administration Guide Volume 2* .

Change Replication Server Connection Parameters to Improve Performance

You can use configuration parameters to improve replication performance.

Replication Server sets default values for configuration parameters for average installations and usage. Depending on your system configuration and how Replication Server is used at your site, you may find that careful altering of certain default values may improve performance. See *Replication Server Administration Guide Volume 2 > Performance Tuning > Configuration Parameters that Affect Performance* for a general discussion of performance and configuration parameters. See also *Replication Server Administration Guide Volume 2 > Performance Tuning > Use Parallel DSI Threads*.

If you are adding many new connections, you may want to change the **memory_limit** or **num_threads** Replication Server parameters to improve performance.

See *Replication Server Reference Manual > Replication Server Commands >* ***configure replication server*** for more information about the **memory_limit** and **num_threads** parameters.

Increasing memory_limit

To increase the amount of memory specified for Replication Server, increase the value specified for the **memory_limit** parameter by using **configure replication server** at Replication Server.

For example, execute **configure replication server** in the following manner to increase **memory_limit** to 25MB:

```
configure replication server
    set memory_limit to '25'
```

Increasing num_threads

You may need to increase the number of Open Server threads that the Replication Server can use. To do this, increase the value specified for the **num_threads** parameter, using **configure replication server** at the Replication Server.

For example, execute **configure replication server** in the following manner to increase **num_threads** to 70:

```
configure replication server
        set num_threads to '70'
```

Resume Database Connections

After you have changed the attributes of a database connection, you can resume activity on the connection either in SAP Control Center or by using the **resume connection** command.

To resume a database connection from the command line, enter:

```

resume connection to data_server.database
[skip [n] transaction | execute transaction]
```

When the connection is resumed, Replication Server retrieves rows from the `rs_lastcommit` system table so that it can find the correct place in the transaction stream to begin submitting transactions.

The optional **skip [n] transaction** clause instructs Replication Server skip a specified number of transactions in the connection queue before resuming the connection. The first *n* transactions are written to the exceptions log.

The **skip [n] transaction** clause is necessary if the first *n* transactions cause Replication Server to suspend the connection and the cause of the failure cannot be corrected. For example, the transaction may have produced a data server error that is assigned the **retry_stop** or **stop_replication** error action. Or, perhaps it was necessary to use **suspend connection** and the **with nowait** clause to manually interrupt the transaction.

Warning! If you execute **resume connection** with the **skip transaction** clause, you must correct any inconsistency that results from the lost transaction. Only use the **skip transaction** clause when the condition causing the transaction to fail cannot be corrected.

The optional **execute transaction** clause instructs Replication Server to execute the first transaction in the connection's queue. Use this clause only when a system transaction has failed to execute. See *Replication Server Administration Guide Volume 2 > Errors and Exceptions Handling > Duplicate Detection for System Transactions* for information about error handling for system transactions.

Changing Replicate Databases to Primary Databases

Each primary database must have a Replication Agent that scans the database log and transfers data to the Replication Server for distribution to replicate databases. If you want to change an Adaptive Server database that is designated as replicate-only to be a source of replicated functions or to contain primary data, you must enable the RepAgent thread for the database.

1. Configuring RepAgent at the Replication Server
   a) Create a RepAgent user so that RepAgent can log in to Replication Server. Use the **create user** command where *ra_user_name* is the name of the RepAgent user and *ra_password* is the RepAgent password:

   ```
   create user ra_user_name
   set password {ra_password | null}
   ```

   b) Grant this user **connect source** permission, using the **grant** command:

   ```
   grant connect source to ra_user_name
   ```

   If the Replication Server already manages a primary database, you can use the "RepAgent user" that already exists for the new primary database.

   c) Execute **alter connection** using the **log transfer on** option:

   ```
   alter connection to data_server.database
   set log transfer to 'on'
   ```

2. Configuring RepAgent at the Adaptive Server database
   a) If the name of the Adaptive Server has not yet been defined, you must define it using the following command where *lname* is the Adaptive Server name:

   ```
   sp_addserver lname, local
   ```

   b) If RepAgent threads have not been enabled for the Adaptive Server, you must enable them:

   ```
   sp_configure 'enable rep agent threads'
   ```

   c) Configure RepAgent for the database with **sp_config_rep_agent**:

   ```
   sp_config_rep_agent dbname, 'enable', 'rs_name',
           'rs_user_name', 'rs_password'
   ```

Note: The value for *rs_user_name* and *rs_password* configured at the Adaptive Server must be the same for *ra_user_name* and *ra_password* created at the Replication Server in step 1.

d) Create the **rs_marker** stored procedure and use the **sp_setrepproc** system procedure with the **table** option to enable replication of **rs_marker**.

   You can find the **rs_marker** stored procedure in the file `rs_install_primary.sql` or `rsinssys.sql` in the `scripts` directory of the SAP Sybase release directory.

e) Start RepAgent:

```
sp_start_rep_agent dbname
```

See also

- *Configuring RepAgent* on page 89

Create the rs_marker Stored Procedure

Create the **rs_marker** stored procedure to check on replication status.

Replication Server executes the **rs_marker** system function in a primary database during subscription materialization. The function works by executing a replicated stored procedure that is also named **rs_marker**. The procedure checks to make sure it is marked replicated and issues a warning if it is not. Because the **rs_marker** stored procedure is replicated, Adaptive Server records its executions in the transaction log for the database, where they can be read by RepAgent.

rs_init creates **rs_marker** when you designate a database as having primary data. It is not required in databases that have no primary data. The exact text of the stored procedure can always be found in `rs_install_primary.sql` or `rsinssys.sql` in the `scripts` directory of the SAP Sybase release directory.

Here is a sample text:

```
create procedure rs_marker
    @rs_api varchar(255)
as
    declare @rep_constant smallint
    select @rep_constant = -32768
    if not exists (select sysstat from sysobjects
      where name = 'rs_marker'
        and type = 'P'
        and sysstat & @rep_constant != 0)
    begin
      print "Have your DBO execute
      ''sp_setreplicate'' on the procedure
      ''rs_marker''"
 return(1)
 end
```

rs_marker does not modify data in the database. Its purpose is to execute so that it can be recorded in the transaction log.

If **rs_marker** is not marked as replicated, you can mark it with **sp_setrepproc**:

```
sp_setrepproc rs_marker, 'true'
```

Changing Primary Databases to Replicate Databases

You can change the primary database to a replicate database.

At the:

1. Current replicate Replication Server.
   a) Drop all subscriptions and publication subscriptions to the replication definitions in this database.
2. Current primary Replication Server.
   a) Drop all replication definitions defined for this database.
3. Adaptive Server.
   a) Shut down RepAgent:

      ```
      sp_stop_rep_agent dbname
      ```
   b) Disable RepAgent:

      ```
      sp_config_rep_agent dbname, disable
      ```
4. Replication Server
   a) Log in to the Replication Server that manages the database and execute **alter connection** using the **log transfer off** option:

      ```
      alter connection to data_server.database
      set log transfer off
      ```
5. Adaptive Server
   a) Set the status of **rs_marker** to “false:”

      ```
      sp_setrepproc rs_marker, 'false'
      ```
   b) Set the replicate status of all replicated objects to “false”:
      1. Execute **sp_setreptable** and **sp_setrepproc** without arguments to generate a list of all replicated tables and stored procedures respectively, in the database.
      2. One by one, set the replicate status of each table and stored procedure to “false,” using **sp_setreptable** and **sp_setrepproc**.

Drop Database Connections

To remove a database from the replication system, use SAP Control Center or execute **drop connection**.

Before you execute the command, drop any subscriptions for replication definitions for data in the database. If you are dropping a connection to a primary database, first drop all replication definitions for tables in the database.

Note: drop connection removes database connection information from the Replication Server system tables. It does not remove replicate data from any database in the system. To remove replicate data, use **drop subscription** using the **with purge** option.

To drop a connection, specify the data server with the database whose connection is to be dropped. The syntax is:

```
drop connection to data_server.database
```

For example, to drop the connection to the `pubs2` database in the SYDNEY_DS data server, enter:

```
drop connection to SYDNEY_DS.pubs2
```

Note: If you are using RepAgent for log transfer, you should also stop (if necessary) and then disable RepAgent at the primary database.

For information about dropping logical connections, see *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications > Alter Warm Standby Database Connections > Drop Logical Database Connections*.

See also

- *Disable RepAgent* on page 92

Drop a Database from the ID Server

Use **sysadmin dropdb** to drop a database from the ID Server.

Replication system databases, data servers, and Replication Servers are listed in the `rs_idnames` system table in the RSSD for the ID Server. Occasionally, you may need to remove the entry for a database from this system table.

For example, the **drop connection** command fails and you want to reuse the connection name. You must force the ID Server to delete from the `rs_idnames` system table the row that corresponds to the database. (Physical database connections have a “P” in the `ltype` column in this system table.)

Log in to the ID Server and execute the **sysadmin dropdb** command to delete the entry for the specified database. The syntax for **sysadmin dropdb** is:

```
sysadmin dropdb, data_server, database
```

You must have **sa** permission to execute any **sysadmin** command.

Monitor Database Connections

Use SAP Control Center, or stored procedures and RCL commands to monitor database connections.

See *Replication Server Troubleshooting Guide* if you need to monitor connections for troubleshooting purposes.

See also

- *Manage a Replication System* on page 59

View Current Database Connections

To check the status of current database connections, use SAP Control Center or **admin show connections**.

admin show_connections displays information about all database connections from the Replication Server. **admin show_connections** also displays information about all routes from the Replication Server.

See **admin show_connections** in the *Replication Server Reference Manual* and the *SAP Control Center for Replication*.

List Databases Managed by a Replication Server

To list the databases that a Replication Server manages, use SAP Control Center or the **rs_helpdb** stored procedure at the Replication Server RSSD.

The `rs_databases` system table contains entries for all of the databases managed by the Replication Server, including databases managed by other Replication Servers that have a route to the Replication Server.

The syntax for **rs_helpdb** is:

```
rs_helpdb [data_server, database]
```

See **rs_helpdb** in the *Replication Server Reference Manual* for detailed usage and syntax information.

Display DSI Thread Status

To view DSI thread status, use SAP Control Center or the **admin who** commands to display thread status information.

- **admin who** displays all threads in the system, including DSI threads.
- **admin who, dsi** displays the status of the DSI thread, which Replication Server starts to submit transactions to the data server.

See **admin who** in the *Replication Server Reference Manual* for complete thread status listings and the *SAP Control Center for Replication*.

See also

- *Manage a Replication System* on page 59

Manage Replication Server Security

Careful management of login names, passwords, and permissions is essential to the security of the replication system.

Replication Server login names and specific permissions are required for:

- Each component of the replication system, such as the data server and the Replication Server.

  With Replication Server 15.2, you can use Replication Server gateway which allows to access components in the replication system with a single user name and password.
- Each user who is setting up replicated data or monitoring and managing the Replication Server.

You can set up encrypted passwords throughout the replication system and change passwords that are encrypted. Refer to the Replication Server installation and configuration guides for your platform for details on password encryption.

You can use RCL commands to manage Replication Server security, including creating and modifying login names, passwords, and permissions, and the dependencies involved in making modifications. In addition, Replication Server supports third-party security services that ensure secure message transmission over the network and enable user authentication for seamless login to Replication Servers in the replication system.

See also

- *Manage Network-based Security* on page 237

Manage Replication Server System Security

You must establish login names and passwords for the various components of the Replication Server system, including RSSDs, RepAgent, the ID Server, and Replication Server.

Often, one process must log in to another, remote process. In such cases, the login name and password assigned to the process logging in must also exist at the remote process. If a password used to log in to the remote process is changed at the current process only, login attempts fail.

As a general rule, if you are specifying or modifying system login names, keep the names unique. If you use the same login name for different roles, then any time you change the password, many of the dependencies described in this section are affected.

Replication System Login Names

There are several login names required for replication system components.

Table 13. Overview of Replication System Login Names

Source Server	Destination Server and Database	Login Name Description
Primary Replication Server	Primary Adaptive Server and RSSD	RSSD primary user
Replicate Replication Server	Replicate Adaptive Server and RSSD	RSSD maintenance user
Replicate Replication Server	Replicate Adaptive Server and replicate database	database maintenance user
RepAgent for RSSD	Replication Server	RepAgent user for RSSD
RepAgent for primary database	Replication Server	RepAgent user for primary database
Replication Servers	ID Server (Replication Server)	ID Server user
Replication Servers	Other Replication Servers	Replication Server user (RSI user)

RSSD Login Names and Passwords

Replication Server uses the primary user and maintenance user login names to manage security.

When you install Replication Server, the **rs_init** program creates the primary and maintenance Adaptive Server login names to maintain the RSSD.

Replication Server uses the primary user login name to modify the system tables in the RSSD for the primary Replication Server. Modifications may include route, replication definition, and function-string information changes to be replicated to RSSDs for other Replication Servers. You set up the primary user when you create the primary RSSD using **rs_init**.

Replication Server uses the maintenance user login name to apply modifications to replicate RSSDs. RepAgent filters out RSSD modifications made by the maintenance user to avoid replicating them to other RSSDs. You set up the maintenance user when you create the replicate RSSD using **rs_init**.

If the login name or password is changed for either the primary or maintenance user, edit the Replication Server configuration file to match these changes, and restart the Replication Server.

Guidelines for Changing RSSD Primary User Login Name and Password

Observe the guidelines when you change the RSSD primary user login name and password.

- Never change the RSSD primary user login name and/or password while routes are being created.

  While a route is being created, the destination Replication Server uses the primary user login name and password to create and materialize subscriptions at the destination site for replicated RSSD system tables.
- Be sure to also apply the same RSSD primary user login name and/or password changes to the Replication Server.
  - To change an encrypted or clear text password, use **alter user** with the **set password** clause.
  - To change both a login name and password (encrypted or clear text), use **drop user** to drop the old login name and **create user** to create the new login name and password. Then grant the user **primary subscribe** permission.
  - Update the Replication Server configuration file with the new login name and/or password. Use **rs_init** if the password is encrypted.
  - For the updates to take effect, restart the Replication Server.

  See *Replication Server Reference Manual > Replication Server Commands >* ***alter user*** for command syntax details.

See also

- *Manage Replication Server Permissions* on page 227
- *Replication Server Permissions* on page 227

Replication Server Login Name and Password for RepAgent

Learn the guidelines, commands, and procedures to change the Replication Server login name and password for RepAgent.

RepAgent retrieves information about changes to the replicated system tables in the RSSD or to the primary database from the database transaction logs and submits them to the Replication Server for distribution.

Replication Server needs a login name for RepAgent. The **rs_init** program uses the **create user** command to add this Replication Server user.

Observe these guidelines when you change the Replication Server login name and/or password for the RepAgent. The login name and password you create at the Replication Server must be the same as that used to configure the RepAgent at Adaptive Server.

At Replication Server:

- To change the password, use the **alter user** command with the **set password** clause.

- To change both the login name and password, use the **drop user** command to drop the old user login name and the **create user** command to create the new login and password. Then grant the user **connect source** permission.

At Adaptive Server:

- To change the login name and password, use the **sp_config_rep_agent** system procedure with the *dbname*, *rs_servername*, *rs_username*, and *rs_password* options.
  This updates the login name and password in the database `sysattributes` table. The password is always encrypted.
- For the updates to take effect, restart RepAgent.

See *Replication Server Reference Manual > Replication Server Commands >* ***alter user*** and, *Replication Server Reference Manual > Adaptive Server Commands and System Procedures >* ***sp_config_rep_agent*** for syntax details.

ID Server Login Name and Password

Learn the guidelines to change the ID Server login name and password.

The ID Server registers Replication Servers and databases in a replication domain. Replication Servers use the *ID_user* configuration parameter in the Replication Server configuration file to connect to the ID Server. For each Replication Server, the ID Server login name and password must match the ID Server entry.

The ID Server must be the first Replication Server installed. The ID Server login name and password are established using **rs_init**.

If you change the login name and/or password for the ID Server, be sure to modify *ID_user* in the Replication Server configuration file of each Replication Server that is defined to the ID Server, as well as the Replication Server configuration file for the ID Server itself. You can make password changes using **rs_init**.

You also must change the ID Server login name and/or password in the Replication Server.

See also

- *Manage Replication Server Login Names and Passwords* on page 219

Replication Server Login Name and Password for Replication Servers

Replication Servers log in to other Replication Servers to send operations.

The login name is created using **rs_init**. The login name is used when a direct route is created, from one Replication Server to another.

To change the password for a login name used for a direct route, execute the **alter route** command.

See also

- *Manage Routes* on page 141

Maintenance User Adaptive Server Login Name and Password

Replication Servers log in to Adaptive Server for the RSSD database or a user database using the maintenance user login name. When applying **insert**, **delete**, or **update** primary operations to replicate databases, Replication Server uses the maintenance user login name and password.

Note: Among the permissions granted to the maintenance user is **replication_role**. If you revoke maintenance user's **replication_role**, Replication Server will not replicate **truncate table** unless the maintenance user has been granted **sa_role**, owns the table, or is aliased as the database owner.

To change the password for the maintenance user, use the **alter connection** command.

Maintenance User Security

To increase security, prevent unauthorized access to the database, and restrict maintenance user access to Replication Server, secure the maintenance user with password encryption, and set an expiration interval for the password.

Replication Server defines the maintenance user ID and password with the Replication Server **create connection** command or system management tools such as **rs_init** that you use for creating a connection to the replicate database.

Replication Server logs in to the replicate data server as the maintenance user for replication. The maintenance user must have the permissions to execute replicated stored procedures, and to execute DML operations such as **insert**, **delete**, and **update** on replicate tables.To enable replication of DDL operations such as **create table** using the maintenance user, the maintenance user must have **set session authorization** permission to perform DDL operation as the original user.

Set **hide_maintuser_pwd** on to:

- Periodically generate a new password for the maintenance user for existing connections to a replicate Adaptive Server database.
- Generate and encrypt the password for any new database connections you create, and periodically regenerate and encrypt the password at the replicate Adaptive Server database.
- Change and encrypt any password you reenter for the maintenance user.

Use **maintuser_pwd_expiration** to set the password expiration interval for the maintenance user.

Maintenance User Password Protection

Use **hide_maintuser_pwd** to configure password protection for the maintenance user and restrict maintenance user access to Replication Server.

You can configure **hide_maintuser_pwd** for a specific Adaptive Server database connection controlled by the Replication Server or at the server level for all Adaptive Server database connections controlled by the Replication Server. To configure **hide_maintuser_pwd** at the:

- Connection level – use **create connection** or **alter connection**:
  - **create connection**:

    ```
    create connection to data_server.database
    set error class [to] error_class
    set function string class [to] function_class
    set username [to] user
    [set password [to] passwd]
    set hide_maintuser_pwd to ‘{on | off}’
    ...
    go
    ```
  - **alter connection**:

    ```
    alter connection to data_server.database
    set hide_maintuser_pwd to ‘{on | off}’
    go
    ```
- Server level – use **configure replication server**:

  ```
  configure replication server
  set hide_maintuser_pwd to ‘{on | off}’
  go
  ```

The default is off.

If multiple connections to the same or a different database controlled by Replication Server share the same maintenance user, Replication Server alters the maintenance user password for all the connections if you set **hide_maintuser_pwd** on.

Maintenance User Password Status

Use the **rs_helpuser** stored procedure to display the password status of the maintenance user.

Sample output for **rs_helpuser** for TOKYO_RS Replication Server:

```
Users and Privileges Known at Site repl_rs

   Primary Users
   User Name              Permission(s) Name
   ---------------------- ------------------------------
   TOKYO_RS_id_user       no grants
   sa                     sa
   TOKYO_RS_ra            connect source
   TOKYO_RS_rsi           connect source
   repuser                create object
   TOKYO_RSSD_prim        connect source, primary subscr
```

```
   Maintenance Users
   User name              Destination DS.DB      Password Status
   ---------------------- ---------------------- ---------------
   TOKYO_RSSD_maint        TOKYO_DS.TOKYO_RSSD    Initial
   pubs2_maint             TOKYO_DS.pubs2         Hidden
   pubs2_maint             SYDNEY_DS.pubs2sb      Hidden
```

Maintenance User Password Expiration Interval

Use **maintuser_pwd_expiration** to set the password expiration interval for the maintenance user at the server level.

Replication Server automatically changes the password when the password expires. Before you set a nonzero value for **maintuser_pwd_expiration**, you must enable maintenance user password protection by setting **hide_maintuser_pwd** to on

For example, to set **maintuser_pwd_expiration** to 14 days, enter:

```
configure replication server
set maintuser_pwd_expiration to 14
```

The range of values is 0 to 32,767 days. The default password expiration interval for the maintenance user is the value set in the Replication Server **password_expiration** option. The default for **password_expiration** is 0 days which means the password does not expire.

Guidelines and Limitations for Maintenance User Security Configuration

There are several considerations for maintenance user security configuration.

- Multiple connections – if there are connections from different databases in the same Adaptive Server to a Replication Server and these connections share the same Adaptive Server login for the maintenance user, turning on **hide_maintuser_pwd** for one connection affects all connections. Replication Server synchronizes any change of password across all the connections.

  However, if there are connections from databases controlled by different Replication Servers, turning on **hide_maintuser_pwd** for one connection does not affect the other connections as Replication Server does not support the synchronization of maintenance user passwords across multiple Replication Servers.
- Master database replication – Replication Server does not replicate the change in the maintenance user password when you enable maintenance user security with **hide_maintuser_pwd**. Each connection between a database and a Replication Server separately manages the random password change for the connection resulting from turning on **hide_maintuser_pwd**
- Database restrictions – you cannot use **hide_maintuser_pwd** for non-Adaptive Server databases or the Replication Server ERSSD or RSSD.
- External authentication methods – you cannot set **hide_maintuser_pwd** on if the Adaptive Server database uses external authentication methods such as LDAP, KERBEROS, or PAM for the maintenance user. Instead you must use ASE authentication.

  To use ASE authentication for the maintenance user, or verify that ASE authentication is in use, execute the Adaptive Server **alter login profile** command and the **modify authenticate**

with ASE clause and specify the maintenance user. If the command the is successful, you can configure **hide_maintuser_pwd** for the maintenance user.

See **alter login** in the *Adaptive Server Enterprise Reference Manual: Commands* and *Changing Login Accounts* in the *Adaptive Server Enterprise Security Administration Guide*.

Disabling Maintenance User Password Protection

Disable maintenance user password protection for the connection to a replicate Adaptive Server database.

1. At the Replication Server, set **hide_maintuser_pwd** off for the connection to the replicate Adaptive Server database:

   ```
   alter connection to data_server.database
   set hide_maintuser_pwd to ‘off’
   go
   ```
2. Log in with the sso_role privilege to **isql** at the Adaptive Server replicate database and disable replication:

   ```
   set replication off
   go
   ```
3. At the Adaptive Server replicate database change the maintenance user password to one that is known to the administrator:

   ```
   alter login maintenance user ID
   modify password new_maintenance_user_password
   go
   ```
4. Log in to Replication Server and change the password for all connections affected by the change to the maintenance user password to be the same as the password at the database:

   ```
   alter connection to data_server.database
   set password [to] new_maintenance_user_password
   ```
5. Enable replication. At the replicate Adaptive Server database, enter:

   ```
   set replication on
   go
   ```

Recovering from RSSD or Replicate Database Failure

If **hide_maintuser_pwd** is on and the RSSD, ERSSD or replicate Adaptive Server database fails, you may need to reset the maintenance user password after you use a backup to recover from the failure.

Prerequisites

Recover from the RSSD or ERSSD failure. See *Recovery from RSSD Failure* in the *Replication Server Administration Guide Volume 2*

Task

If you enable maintenance user password protection, the maintenance user password that was encrypted and stored in the RSSD that you restored from an earlier backup may not match the current encrypted password in the Adaptive Server replicate database. Similarly, the maintenance user password in the replicate Adaptive Server database that you restored may not match the current password in the RSSD. After a restore, you must reset the password before you reenable maintenance user password protection.

1. Disable maintenance user password protection for all database connections.

   ```
   configure replication server
   set hide_maintuser_pwd off
   ```

2. Log in with the sso_role privilege to **isql** at the Adaptive Server replicate database and disable replication:

   ```
   set replication off
   go
   ```

3. At the Adaptive Server replicate database change the maintenance user password to one that is known to the administrator:

   ```
   alter login maintenance user ID
   ...
   modify password new_maintenance_user_password
   ...
   go
   ```

4. Log in to Replication Server and change the password for all connections affected by the change to the maintenance user password to be the same as the password at the database:

   ```
   alter connection to data_server.database
   set password [to] new_maintenance_user_password
   ```

5. Enable replication. At the primary Adaptive Server database, enter:

   ```
   set replication on
   go
   ```

6. Enable maintenance user security for all database connections.

   ```
   configure replication server
   set hide_maintuser_pwd on
   ```

See also

- *Manage the RSSD* on page 72
- *ERSSD Recovery Procedures* on page 78

Password Encryption

Replication Server encrypts all passwords, and stores and transmits passwords in encrypted format.

Replication Server uses password encryption instead of clear text when storing all passwords for new Replication Server installations.

When you you specify or change passwords with **rs_init**, **create user**, **alter user**, **create connection**, **alter connection**, **create route**, and **alter route**, Replication Server uses an algorithm to encrypt all passwords in the `rs_users` and `rs_maintusers` RSSD system tables, and in the Replication Server configuration file. You cannot decrypt the passwords.

Replication Server uses the `rs_password_key` row in the `rs_encryptionkeys` RSSD system table, and the **RS_random** attribute in the configuration file to support password encryption and decryption. Replication Server automatically generates installation specific random values for the `rs_password_key` row in the system table and for the **RS_random** attribute when you start Replication Server and Replication Server does not find the values in the table or the configuration file.

You can regenerate random values for the password encryption key in the system table and configuration file with the **alter encryption key** *password_key_row_name* **regenerate** command. To regenerate the password encryption key in the `rs_password_key` row of `rs_encryptionkeys`, enter:

```
alter encryption key rs_password_key regenerate
```

Warning! Do not change or delete the **RS_random** attribute in the configuration file manually as this prevents Replication Server from starting.

Replication Server cannot retrieve the encrypted passwords and cannot start if:

- You do not backup and restore the configuration file with the corresponding RSSD or ERSSD.
- The **RS_random** attribute is lost or corrupted

If all users cannot log in because there is no valid **RS_random** attribute, remove the **RS_random** attribute in the configuration file if the attribute exists, and reset the sa user password. You can then log in to Replication Server and manually set the passwords for all users and maintenance users.

For upgrade and downgrade considerations, see *Replication Server Configuration Guide > Password Encryption*.

See also

- *Resetting a Lost or Forgotten sa User Password* on page 226

Send Encrypted Passwords for Replication Server Client Connections

Replication Server supports the **-X** option in **isql** that sends encrypted passwords through the network when making a client connection

To ensure that all Replication Server client connections—except the first connection to the RSSD—send encrypted passwords, set the Replication Server configuration parameter **send_enc_password** to “on.” For example, enter:

```
configure replication server
 set send_enc_password to 'on'
```

To ensure that all Replication Server client connections, including the first connection to the RSSD, send encrypted passwords, set the configuration parameter **RS_send_enc_pw** to “on” in the *rs_name*.`cfg` file using a text editor.

If **RS_send_enc_pw** is "on," all Replication Server connections to the RSSD send encrypted passwords—even if **send_enc_password** is "off."

Existing Encrypted Password Migration

Newly created passwords use the Federal Information Processing Standards (FIPS)-certified 140-2 encryption algorithm.

Use the commands in the table to migrate existing encrypted passwords in the Replication Server configuration file, and in the `rs_users` and `rs_maintusers` tables.

Table 14. Commands to Encrypt Passwords in New Algorithm

Task	Command/Step
Encrypt existing user passwords to the new algorithm	`alter user` *`user`* `set password` *`password`* where: • *user* is the login name of the existing user • *password* is the existing password you want to encrypt using the new algorithm.
Encrypt existing database maintenance user passwords to the new algorithm	`alter connection to` *`data_server.database`* `set password to` *`password`* where, *password* is the existing password you want to encrypt using the new algorithm.
Encrypt existing route user passwords to the new algorithm	`alter route to` *`dest_replication_server`* `set password to` *`passwd`* where: • *dest_replication_server* is the name of the destination Replication Server • *passwd* is the existing password you want to encrypt using the new algorithm.
Encrypt existing user passwords in the configuration file to the new algorithm	• Use **rs_init** to encrypt the passwords using the new algorithm.

Extended Password Encryption Support

With version 15.1 and later, SAP Replication Server uses SAP Common Security Infrastructure (CSI) to provide server or client authentication, provide key-pair generation to support extended password encryption, and provide cryptography for encryption and decryption of passwords that are transmitted in the network between SAP Replication Servers, and between SAP Replication Server and the primary and replicate data servers.

Extended password encryption uses asymmetric key encryption, which allows Open Client applications with connection property **CS_SEC_EXTENDED_ENCRYPTION** enabled to connect to the SAP Replication Server. It also allows SAP Replication Server to enable **CS_SEC_EXTENDED_ENCRYPTION** when connecting to other servers.

Asymmetric key encryption uses a public key to encrypt the password and a private key to decrypt the password. The private key is not shared across the network, and is therefore secure.

Note: To use the extended password encryption feature, you must have a server that supports extended password encryption, such as ASE 15.0.2 ESD #2 or later.

Replication Server Object Creation Dependencies

Login name and password dependencies also apply when you create Replication Server objects, specifically subscriptions and replicated functions (applied and request functions) that are executed at primary or replicate Replication Servers.

Subscriptions

When you create a subscription, the login name that you used to log in to the replicate Replication Server must exist on both the primary Replication Server and the primary Adaptive Server. The login name must have the same password on all three servers.

When you drop a subscription, the replicate Replication Server logs in to the primary Replication Server using the login name and password you used to log in to the replicate Replication Server. Do not change the password of this login name on the primary Replication Server before the **drop subscription** process is complete.

The RSSD “primary” user login name that is automatically created on the Replication Server is used as the “subscribing user” when routes are created. The rules for a user creating a subscription apply to the RSSD primary user.

Suggestions for subscriptions:

- Do not create subscriptions as the **sa** user.
- The **select** command, issued at the primary Replication Server when creating the subscription, does not include a table owner name unless an owner name is specified in the replication definition. If no owner name is specified, make sure that either the user owns the table or the table is owned by the “dbo” user.
- Do not change passwords while subscriptions are materializing or dematerializing.

Replicated Functions and Stored Procedures

When a primary Replication Server receives a request function or a request stored procedure from a replicate Replication Server, it logs in to the primary data server with the login name and password of the user who initiated the request function or request stored procedure at the replicate site.

Therefore, to execute a request function or request stored procedure at a replicate data server, the user must have the same login name and password at the primary data server, and must have **execute** permission for the stored procedure at the primary data server.

When a replicate Replication Server receives an applied function or applied stored procedure from a primary site, the replicate Replication Server uses the maintenance user login name and password to execute the stored procedure in the replicate database.

Manage Replication Server User Security

Replication Server has its own set of login names, which are separate from data server login names. Replication Server login names are required so that administrative users of the system can execute Replication Server commands.

Users do not need Replication Server login accounts to access data replicated by Replication Server. Replicated data is available to users if they have permissions to access specific databases. The Database Administrator is responsible for creating databases and authorizing access to them.

Password encryption for users can be enabled or disabled.

See also

- *Examine Users, Passwords, and Permissions* on page 233

Manage Replication Server Login Names and Passwords

The replication system administrator, or any other user who has **sa** permission, can manage login names, and implement and administer password security.

Table 15. Commands for Managing Login Names

Command	Task
create user	Create a new login name.
alter user	Change the password for a login name.
drop user	Drop a user login name.

Concealing Password Input

Use the **isql --conceal** option, with the ":?" wildcard characters, to conceal the passwords you set when you create or alter users.

1. Start **isql** with the **--conceal** option before you create a user or change a password for a user.
   For example, at the ny_rs Replication Server for the test_2 user, enter:
   ```
   isql -Sny_rs -Utest_2 --conceal
   Password:
   ```
2. Enter the **alter user** or **create user** command, and instead of typing a password in clear text, enter the :? wildcard pair of characters at the beginning of the command line for password entry.

For example, to change the password for the test_2 user:

```
alter user test_2
set password
:?
verify password
:?
go
```

Optionally, use the double wildcard character pair ":?:?" within the same line to prompt for confirmation of the new password. For example:

```
alter user test_2
set password
:?:?
verify password
:?
go
```

isql prompts you for the information to replace the wildcard pair of characters. Each :? wildcard character pair you enter results in a separate :? prompt. Replication Server does display any characters you type at the :? prompt.

3. Enter the new password at the first :? prompt, which corresponds to the **set password** clause, and enter the old password at the second :? prompt, which corresponds to the **verify password** clause.

```
:? new_pasword
:? old_pasword
```

If you use the double ":?:?" character pairs option in the command, you see:

```
:?
Confirm :?
:?
```

Enter the new password at the first :? prompt corresponding to the **set password** clause, enter the new password again at the second Confirm :? prompt, and enter the old password at the third :? prompt corresponding to the **verify password** clause.
If the password you enter complies with the password security requirements, you see:

```
User 'test_2' is altered.
```

Create a Replication Server Login Name

Use the **create user** command to add new user login names to Replication Server.

You must specify a password for the user when the login name is created. If the user has no password, you must set the password to “null,” which specifies an empty string.

The **create user** command requires **sa** permission. The syntax for **create user** is:

```
create  user user
set password {new_password | null}
[set password_parameter to 'parameter_value']
```

A user’s password can be up to 30 characters long and include letters, digits, and symbols. Case is significant. If the password contains spaces, enclose the password in single quotation marks.

Users can change their own passwords using the **alter user** command.

To create a login name for the user “thomk” with the password “vacUUm”, enter:

```
create user thomk
 set password vacUUm
```

As the administrator, you can set a password expiration interval for a user. For example, to create a user named jsmith having an initial password of 1Buiopr89, with a password expiration interval of 90 days, enter:

```
create user jsmith
set password to 1Buiopr89
set password_expiration to '90'
```

See *Replication Server Reference Manual > Replication Server Commands >* ***create user***.

See also

- *Permission Summary* on page 229

Change a Replication Server Password

The replication system administrator can change the password of any user with the **alter user** command. A user can change his or her own password.

The syntax for **alter user** is:

```
alter user user
set password {new_password | null}
[verify password old_password]
[set password_parameter to 'parameter_value']
```

The same rules that you use for specifying the password using **create user** also apply to **alter user**.

The **verify password** clause, which prevents users from altering each other’s passwords, is required for users without **sa** permission.

For example, if the user with login name “louise” wants to change her own password from “EnnuI” to “somNIfic”, she should enter:

```
alter user louise
 set password somNIfic
 verify password EnnuI
```

As the administrator, you can set the password expiration interval for the user. For example, to change the password and password expiration interval of user jsmith to 60 days, enter:

```
alter user jsmith
set password to newpass
set password_expiration to '60'
```

See *Replication Server Reference Manual > Replication Server Commands >* **alter user**.

Password Configuration Options for All Users

There are several **configure replication server** options you can use to implement and administer Replication Server password security for all users. Replication Server uses password encryption instead of clear text when storing all passwords for new Replication Server installations.

Syntax

```
configure replication server
set password_param to 'parameter_value'
```

Password Configuration Options

password_parameter	**Description**
min_password_len	Minimum number of characters required. • 0 – no minimum length. • Range – 6 to 16 (default 6).
max_password_len	Maximum number of characters. Always set **max_password_len** to a value greater than **min_password_len**. Range – 13 to 30 (default 30).
password_lowercase_required	Whether lowercase characters are required. • True – required. • False – not required (default).
password_uppercase_required	Whether uppercase characters are required. • True – required. • False – not required (default).
password_numeric_required	Whether a numeric character is required. • True – required. • False – not required (default).
password_special_required	Whether a special character is required. • True – required. • False - not required (default).

password_parameter	**Description**

simple_passwords_allowed	If you set this option (or "simple_passwords_allowed") to false, Replication Server does not allow the password to contain the user name or any values from a user password dictionary.
	
	• True – allowed (default).
	• False – not allowed.
	
	You can create the password dictionary in the RSSD in the `rs_dictionary` system table. The table does not store default values. You must create your own scripts to insert values into the table. For example:
	
	`insert into rs_dictionary (words) values (“abcd”);`
	` insert into rs_dictionary (words) values (“1234”);`

disallowed_prev_passwords	Number of previous passwords that cannot be reused when the user changes his or her password. • 0 – previous passwords allowed. • Range – 0 to 32,767 (default 0). The parameter value does not apply to a user password when the administrator is resetting the password.

password_parameter	**Description**
password_expiration	Number of days after which the password expires. • 0 – password never expires (default). • Range – 0 to 32,767. You can use **password_expiration** with **alter user** and **create user**. If the password has expired, Replication Server locks the account and notifies the user that the password has expired. If the user does not reset his password, he or she cannot log in once disconnected until the administrator resets the password. The new password must meet all the password requirements. Passwords do not expire for any user that **rs_init** creates with **connect source** permission or the ID user. These passwords override any setting for **password_expiration** that you set for all users in the Replication Server. Databases, other Replication Servers, and Replication Agents use user IDs with **connect source** permission. Administrators set the password to not expire for any user that is created for Replication Agent or an RSI.
initial_password_expiration	Number of days after which the initial password expires. • 0 – initial password never expires. • Range – 0 to 32,767 (default 0). An initial password for a user is the password set by the administrator when creating the user or when resetting the user password.

password_parameter	**Description**
max_failed_logins	Maximum number of failed login attempts Replication Server allows before locking the account. • 0 – account never locked. • Range – 0 to 32,767 (default 0). Replication Server locks the account according to the time interval set in **password_lock_interval**.
password_lock_interval	Number of minutes that an account remains locked if the user reaches the maximum number of login attempts set in **max_failed_logins**. • 0 – account remains locked until administrator resets password. • Range – 0 to 32,767 (default 0).
unused_login_expiration	Number of days after which an unused user account expires. • 0 – unused account never expires. • Range – 0 to 32,767 (default). Replication Server locks an account that remains unused for longer than **unused_login_expiration**. The administrator can reactivate the acount by resetting the password.

Examples

- Enforce the minimum password length as 8 characters for all users:
  ```
  configure replication server
  set min_password_len to '8'
  ```
- Enforce the password expiration interval as 90 days for all users:
  ```
  configure replication server
  set password_expiration to '90'
  ```

Usage

- **password_expiration** is the only parameter you can use with **alter user** and **create user**. See **alter user** and **create user** in *Replication Server Reference Manual > Replication Server Commands*.
- Password settings that you set for individual users with **create user** or **alter user** override any value that you set with **configure replication server**.
- Use the **rs_helpuser** stored procedure to display the status and settings of current users.

- Minimum password length:
  - When the administrator or the user changes a user password, the new one must comply with any system minimum length that has been set with **configure replication server**.
  - Setting the minimum password length does not impact the current passwords of users until users change the password.
- Password expiration interval:
  - When the administrator or the user changes the password of the user, Replication Server records the date. When the user logs in, Replication Server checks the login date against the password expiration setting. If there is a password expiration value set either for the user or at the system level, and Replication Server determines that the password has expired, Replication Server notifies the user to change the password and locks the account. Replication Server unlocks the account only when the user enters a new password that meets requirements. If the user disconnects before changing the password, the administrator must reset the password.
  - SAP recommends that you set the **password_expiration** to 0 for users that have "connect source" privilege, such as Replication Agent users, to prevent their passwords from expiring and interfering with replicating data.
- When the LDAP user authentication is enabled, the password applies to both Replication Server and LDAP user accounts. Ensure that you enter a valid password that adheres to Replication Server password policy.
- The **password_encryption** parameter is deprecated.

Permissions

You must have sa permission to configure password parameters.

Drop a Replication Server Login Name

Use the **drop user** command to remove an existing login name from the Replication Server.

drop user requires **sa** permission. The syntax for **drop user** is:

```
drop user user
```

For example, the following command removes the “thomk” login name:

```
drop user thomk
```

Resetting a Lost or Forgotten sa User Password

Use the **reset_password=sa** parameter to reset the password for the sa user if you lose or forget the password. You cannot use the parameter to reset passwords of any other account.

1. Add the **reset_password=sa** parameter to the Replication Server configuration file.

   Note: You cannot use **isql** to run **reset_password=sa**.
2. Restart Replication Server.

During start-up, Replication Server generates a random password for one-time use for the sa user. The **reset_password=sa** parameter is then removed from the configuration file to prevent password from being generated during subsequent restarts.

3. Log in as the sa user using the generated one-time password.

   The password expires immediately, and Replication Server locks the sa user account to prevent another user from attempting to log in using the same password. Replication Server notifies the sa user that the password has expired.

4. Enter a new password that meets all the requirements.

Manage Replication Server Permissions

Replication system administrators manage Replication Server permissions with the **grant** and **revoke** commands. Permissions determine which RCL commands users are permitted to execute.

Any user with a Replication Server login name can execute all **admin** commands and the **check subscription** command. Other commands can be executed only by users who have been granted the required permissions.

Replication Server Permissions

Replication Server users can be granted any of four permissions.

Table 16. Replication Server Permissions

Permission	Description
sa	Users with **sa** permission are Replication system administrators. They can execute any Replication Server command and may grant and revoke other permissions, including **sa**, to and from other users.
create object	Users with **create object** permission can create objects such as replication definitions, subscriptions, and function strings. Users with **create object** permission automatically have **primary subscribe** permission.
primary subscribe	Users with **primary subscribe** permission can execute the commands needed to create subscriptions for primary data stored in databases managed by the Replication Server. Users with **primary subscribe** permission at the primary site and **create object** permission at the replicate site can create a subscription for data at the primary site, but cannot create replication definitions or function strings at the primary site.

Permission	Description
connect source	The **connect source** permission is required for: • Login names that RepAgents use to log in to Replication Server, allowing RepAgent to execute the subset of RCL commands known as Log Transfer Language (LTL). • Login names that a source Replication Server uses to connect to a destination Replication Server for the purpose of sending replicated data or replicated functions. You provide this login name using the **create route** command.

Requirements for Creating Subscriptions

Learn what permissions you require before you can create subscriptions.

A subscription creator must have accounts on both the primary and replicate Replication Servers, and the accounts must have the same login name and password. The subscription creator enters a command or a series of commands at the replicate Replication Server, which passes the request to the primary Replication Server.

When the optional clauses **use dump marker** and **subscribe to truncate table** are used, the login name and password for the replicate Replication Server should be the same for the primary Replication Server, as well as for both the primary and replicate databases.

At the replicate Replication Server (the destination of the subscription data), the subscription creator must have, at minimum, **create object** permission in order to materialize the subscription.

At the primary Replication Server (the source of the subscription data), the subscription creator must have, at minimum, **primary subscribe** permission in order to enter at the replicate site all commands involved in creating subscriptions:

- **create subscription** (for atomic and nonatomic materialization)
- **define subscription** (for bulk materialization)
- **activate subscription** (for bulk materialization)
- **validate subscription** (for bulk materialization)
- **drop subscription**

The **primary subscribe** permission, a subset of **create object** permission, is provided at the primary Replication Server. It lets users at replicate sites create subscriptions to data stored at primary sites. From replicate sites, these users cannot create any other objects at primary sites, only subscriptions.

Note: Users with **create object** and **sa** permissions can also create subscriptions from replicate Replication Servers. The minimal permission required at the primary Replication Server for a user at a replicate site to create subscriptions is **primary subscribe**.

A user creating a subscription must have the following Adaptive Server permissions:

- **select** permission on the table in the primary database
- **insert**, **update**, and **delete** permission on the replicate table
- **execute** permission on the **rs_marker** stored procedure in the primary database

If you are a replication system administrator, restrict **primary subscribe** and **create object** permissions at primary sites to users who require them in order to create subscriptions.

It is possible for a user who has **primary subscribe** or **create object** permission to begin creating a subscription without having **select** permission on the table. If this occurs, Replication Server responds in the following manner:

- If the subscription is created with atomic materialization, the **select with holdlock** operation fails at the primary database during materialization. The subscription retry daemon (dSUB) retries the **select with holdlock** until the subscription is dropped or until the **select** permission is granted to the user for the table at the primary database.
- If the subscription is created with nonatomic materialization, the **select** operation fails at the primary database during materialization. The subscription retry daemon (dSUB) retries the **select** until the subscription is dropped or the **select** permission is granted.
- If the subscription is created with bulk materialization, there is no **select** transaction, so no error messages are logged, and the subscription succeeds.

Permission Summary

You must have the minimum permission required to execute each RCL command.

If you have **create object** permission, you automatically have **primary subscribe** permission. If you have **sa** permission, you can execute any command.

Table 17. Minimum Permissions to Execute RCL Commands

To Execute	Minimum Permission Required
abort switch	**sa**
activate subscription	**create object** at replicate, **primary subscribe** at primary
create partition	**sa**
admin commands	Can be executed by any user
allow connections	**sa**
alter connection	**sa**
alter database replication definition	**create object**
alter function	**create object**
alter function replication definition	**create object**
alter applied function replication definition	**create object**

To Execute	Minimum Permission Required
alter request function replication definition	**create object**
alter function string	**create object**
alter function string class	**sa**
alter logical connection	**sa**
alter partition	**sa**
alter queue	**sa**
alter replication definition	**create object**
alter route	**sa**
alter user	**sa** – Users can change their own passwords by including the **verify** clause
assign action	**sa**
check publication	Can be executed by any user
check subscription	Can be executed by any user
configure connection	**sa**
configure logical connection	**sa**
configure replication server	**sa**
configure route	**sa**
create article	**create object**
create connection	**sa**
create database replication definition	**create object**
create error class	**sa**
create function	**create object**
create function replication definition	**create object**
create applied function replication definition	**create object**
create request function replication definition	**create object**
create function string	**create object**

To Execute	Minimum Permission Required
create function string class	**sa**
create logical connection	**sa**
create partition	**sa**
create publication	**create object**
create replication definition	**create object**
create route	**sa**
create subscription	**create object** at replicate, **primary subscribe** at primary
create user	**sa**
define subscription	**create object** at replicate, **primary subscribe** at primary
drop article	**create object**
drop connection	**sa**
drop database replication definition	**create object**
drop error class	**sa**
drop function	**create object**
drop function replication definition	**create object**
drop function string	**create object**
drop function string class	**sa**
drop logical connection	**sa**
drop partition	**sa**
drop publication	**create object**
drop replication definition	**create object**
drop route	**sa**
drop subscription	**create object** at replicate, **primary subscribe** at primary
drop user	**sa**
grant	**sa**
ignore loss	**sa**
move primary	**sa**
rebuild queues	**sa**

To Execute	Minimum Permission Required
resume connection	**sa**
resume distributor	**sa**
resume log transfer	**sa**
resume queue	**sa**
resume route	**sa**
revoke	**sa**
set proxy	**sa**
set autocorrection	**create object**
set log recovery	**sa**
shutdown	**sa**
suspend connection	**sa**
suspend distributor	**sa**
suspend log transfer	**sa**
suspend route	**sa**
switch active	**sa**
sysadmin commands	**sa**
validate subscription	**create object** at replicate, **primary subscribe** at primary
wait for create standby	**sa**
wait for switch	**sa**

Grant Permissions

Use the **grant** command to grant permissions to users.

The ability to grant and revoke permissions is reserved for the replication system administrator. Any user who has been granted **sa** permission can play the role of replication system administrator, and can transfer the **grant** and **revoke** ability to other users by granting them **sa** permission.

The syntax for the **grant** command is:

```
grant
 {sa | create object | primary subscribe | connect source}
 to user
```

The *user* is the login name of the user to receive the permission. You can grant only one permission at a time.

Permissions are assigned to Replication Server users—not to database users. A Replication Server user who has **create object** permission can create Replication Server objects that are associated with any database managed by the Replication Server.

In the following example, the replication system administrator grants **create object** permission to the "thomk" login name:

```
grant create object to thomk
```

Revoke Permissions

Use the **revoke** command to remove permissions previously granted to a user.

The syntax for the **revoke** command is:

```
revoke {sa | create object | primary subscribe |
 connect source}
 from user
```

Note: You cannot revoke the **sa** permission from, or drop, the **sa** login name. This ensures that Replication Server is never without a replication system administrator.

The four permissions are managed independently. They can be granted and revoked in any order and the result is the same.

The following **revoke** command prevents user "louise," who does not have **sa** permission, from creating replication definitions:

```
revoke create object from louise
```

Examine Users, Passwords, and Permissions

You can display the login names, passwords, and permissions for Replication Server users and threads by using the **rs_helpuser** stored procedure or by querying the `rs_maintusers` and `rs_users` system tables in the RSSD.

Use the rs_helpuser Stored Procedure

Use the **rs_helpuser** stored procedure to display information about user login names known to a Replication Server.

The syntax for **rs_helpuser** is:

```
rs_helpuser [user]
```

With no parameters, **rs_helpuser** displays information about all user login names known to the current Replication Server. Permissions are displayed for each primary or maintenance user login name.

If you supply a login name parameter, **rs_helpuser** displays information about that login name only.

Query the rs_maintusers System Table

The `rs_maintusers` system table in the RSSD contains the login name and password information for maintenance users.

`rs_maintusers` includes a column to identify if the password is encrypted or clear text, and a column to hold the encrypted password.

For example, the following query, executed in the RSSD, lists all available information, including login names, for maintenance users:

```
select * from rs_maintusers
```

Query the rs_users System Table

The `rs_users` system table in the RSSD contains the login name and password information for Replication Server users.

`rs_users` also includes a column to identify if the password is encrypted or clear text, and a column to hold the encrypted password.

The `rs_users` system table also includes a `permissions` column, which stores the permissions for each login name. The `permissions` column is a bit-mask of the permissions granted to users.

For example, the following query, executed in the RSSD, lists users who have **sa** permission:

```
select username, uid from rs_users
 where permissions & 0x0001 != 0
```

Permission Bitmask Values in the rs_users System Table

Each type of permission has a bitmask value.

Table 18. Permission Bitmask Values in the `rs_users` System Table

Permission	Mask Value
sa	0x0001
connect source	0x0002
create object	0x0004
primary subscribe	0x0008

Replication Server Gateway

With version 15.2, Replication Server introduces Replication Server gateway, which minimizes explicit login into the different servers, and makes managing a replication system easier.

In managing a replication system, the replication system administrator (RSA) must log in to multiple replication servers, ID servers, and the corresponding Replication Server System Database (RSSD). The RSA must also frequently switch logins between Replication Server and the RSSD.

The Replication Server gateway uses your RSSD primary user name and password to log in to RSSD, your ID server user name and password to log into ID Server, your remote server identification (RSI) to log into a remote Replication Server, and your maintenance user ID to log into the remote Adaptive Server. You do not need to supply this information more than once, when you access Replication Server itself.

Cascading Connection

The Replication Server gateway also supports cascading connections, which allow your Replication Server to communicate with servers that it is not directly connected to.

It also allows you to manage a replication domain using a single client connection. For example, you can connect to an ID Server, and then to the ID Server's RSSD. In this case, both the primary, controlling Replication Server and the ID server are gateways; commands pass through to the ID server's RSSD, and result sets pass back through to you.

Enable the SAP Replication Server Gateway

Use the **connect** command to turn SAP Replication Server into a gateway to its RSSD, ID server, or to a remote SAP Replication Server.

Note: Issuing the **connect** command requires an **sa** role for the first login to SAP Replication Server.

Syntax:

```
connect [to] [rssd | idserver | srv_name | ds_name.db_name]
```

Parameters:

- **rssd** – turns SAP Replication Server into a gateway to its RSSD. Allows the gateway to use *RSSD_primary_user* and *RSSD_primary_pw* entries in its configuration file.
- **idserver** – turns SAP Replication Server into a gateway to its ID server, providing that the SAP Replication Server itself is not the ID server. Allows the gateway to use *ID_user* and *ID_pw* entries in the configuration file.

- *srv_name* – the name of the remote SAP Replication Server you want the gateway to connect to. The SAP Replication Server gateway uses RSI to log into the remote server, and requires a direct route to the remote server.

  Note: SAP Replication Server cannot directly connect to itself. However, you can work around this by using a cascading connection.
- *ds_name.db_name* – the name of the remote data server and database that you want the gateway to connect to. The SAP Replication Server gateway uses the maintenance user to log into the remote data server. This allows you to perform tasks that maintenance users of the designated database are permitted to do. However, you cannot access the other databases defined in the data server you connected to.
  SAP Replication Server gateway can directly connect to SAP ASE and SAP IQ as well as replicate data servers that are supported by Enterprise Connect Data Access (ECDA). You cannot use SAP Replication Server gateway to connect to replicate data servers if you are using one of the ExpressConnect products to communicate with those servers.

Track Connections

Use **show connection** and **show server** to manage your cascaded connection.

Cascaded connections created in the gateway are kept in a connection stack, with the Replication Server that issued the first **connect** command placed at the bottom of the stack.

- **show connection** – lists the contents of the connection stack.
- **show server** – displays the current working server.

Drop Connections

Use **disconnect** command to terminate a connection to a server.

disconnect exits the connection stack one at a time. To exit from all the connections, use **disconnect all**.

```
{disconnect | disc} [all]
```

The **disconnect** command behaves differently in Replication Server 15.1 and earlier.

In Replication Server 15.1 and earlier, a **disconnect** command terminates the gateway mode, and returns the working server status to the Replication Server that issued the first **connect** command. When your connection stack includes Replication Server versions 15.2, and 15.1 or earlier, and you issue a **disconnect** command, the **show connection** and **show server** commands may not display the expected output.

For details about the commands, see *Replication Server Reference Manual*.

Limitations to Replication Server Gateway

When using Replication Server gateway, the client and the server must use the same locale set because Replication Server cannot perform character set conversion. You cannot use Replication Server gateway to connect to non-Adaptive Server data servers when Replication Server is using ExpressConnect to communicate with those servers.

Manage Network-based Security

Learn about Replication Server support for third-party, network-based security mechanisms.

In a client/server environment, it is important to provide secure data pathways so data transmission remains confidential. Replication Server supports third-party, network-based security mechanisms that focus on:

- Authentication and unified login
- Secure message transmission

With network-based security, users are authenticated—the process of verifying that users are who they say they are—by the security system at login. They receive a credential that can be presented to remote servers in lieu of a password. As a result, users have seamless access to the components of the replication system through a single login.

Replication Server version 12 and later supports MIT Kerberos version 5 or later, CyberSafe Kerberos version 5 Security Server, and Transarc DCE version 1.1 Security Server. Depending on which of these security mechanisms you choose, you can select one or more of these features to secure data transmission:

- Unified login – enables the user to log in to components of the replication system with a single credential issued by the security mechanism.
- Confidentiality – enables the sending and receiving of encrypted data.
- Integrity – ensures that data has not been tampered with.
- Replay detection – verifies that data has not been intercepted.
- Origin check – verifies the source of each data packet.
- Out-of-sequence detection – checks that data packets are received in the order sent.

The security mechanism allows Replication Server to establish secure connections with other Replication Servers, with Adaptive Server, and with other data servers that support the Kerberos or DCE security mechanism and certain Replication Server requirements. You choose the method or methods to secure data transmission between them.

How Security Services Work

How security services work depends on whether Replication Server (or Adaptive Server or other data server) is acting as client or server.

Clients use the security mechanism to ensure a secure pathway to a remote server. Replication Server logs in to remote servers (acting as a client) and also accepts incoming logins (acting as a server).

Replication Server, when acting as the client, uses the security mechanism to ensure a secure pathway to a remote Replication Server or Adaptive Server. Once the secure pathway is established, the security mechanism can provide message protection. When Replication Server acts as a server, it accepts or rejects logins based on its default security settings.

Login Authentication

Security services use login authentication.

If a client requests authentication services:

1. The client validates the login with the security mechanism and receives a credential, which contains relevant security information.
2. The client sends the credential to the server and informs the server it wants to establish a secure connection.
3. The server authenticates the client's credential with the security mechanism. If the credential is not valid, the secure connection is rejected.
4. The server checks message protection properties, if the properties are compatible, the connection is established.

Message Protection

Security services use message protection.

If the current Replication Server (the client) requests data protection services:

1. The client uses the security mechanism to prepare the data packet it will send to the server. For example, if the client requests message confidentiality, the security mechanism encrypts the commands that will be sent to the remote server. If the client requests out-of-sequence checking, the security mechanism time-stamps each data packet.
2. The client sends the data to the destination server.
3. When the server receives the data, it uses the security mechanism to perform the appropriate decryption or validation.
4. The server returns the results to the client, using the security mechanism to perform the security action requested. For example, the server returns results in encrypted form or time-stamps each data packet returned to the client.

Requirements and Restrictions

There are several requirements and restrictions for network-based security.

To enable network-based security you need:

- A network-based security mechanism installed on all machines for which network security is to be enabled. The security mechanism must be supported by SAP Replication Server.

  Note: Make sure that you use either the MIT Kerberos, CyberSafe Kerberos or Transarc DCE security mechanism. SAP network-based security does not run on other Kerberos or DCE security mechanisms.
- SAP Replication Server version 11.5 or later for all client and destination SAP Replication Servers.
- SAP ASE version 12 or later and/or compatible heterogeneous data servers for all client and destination data servers.Compatible heterogeneous data servers must support the

security mechanism installed on SAP Replication Server and the set proxy concept. See the *Heterogeneous Replication Guide*.

These restrictions apply:

- Both ends of a secured pathway (client and server) must support the same security mechanism, and the security parameters must have the same feature settings.
- User names must be unique throughout the replication system.

  If your replication system supports multiple security systems, and you cannot guarantee unique user names, you may need to turn off request stored procedures to avoid a potential security breach.

See also

- *Maintain Network Security* on page 268
- *Potential Security Issue* on page 272

Set up Network-based Security

Network-based security requires several steps to set up.

1. Modify configuration parameters and environment variables, as necessary.
2. Identify the Replication Server principal user.
3. Activate the network-based security mechanism.
4. Start server and clients.
5. Configure security services for connections, routes, and other Replication Server pathways.

Modify Configuration Parameters and Environment Variables

Learn what are the configuration files you may need to configure for network security.

Configuration files are created during installation at default locations in the SAP Sybase directory structure. The configuration files you may need to configure for network security are:

- `libtcl.cfg`
- `objectid.dat`
- The `interfaces` file

If you are using Kerberos security services, you may also need to modify the KRB5_KTNAME environment variable.

Configure libtcl.cfg

Drivers are libraries that provide an interface to an external service provider. Use the `libtcl.cfg` configuration file on a 32-bit machine or `libtcl64.cfg` configuration file on a 64-bit machine as a template into which you enter all the configuration information about the security drivers installed on a machine.

The `libtcl.cfg` file is located in the `$SYBASE/$SYBASE_OCS/config/` directory in UNIX, or the `%SYBASE%\%SYBASE_OCS%\ini` directory in Windows. See the *Open Client and Open Server Configuration Guide* for more information about SAP drivers.

The syntax for a security driver entry is:

```
provider=driver init-string
```

where

- *provider* is the local name for the security mechanism, for example, "dce." The mapping of the local name to a global object identifier is defined in `objectid.dat`.
  - The default local name for the DCE security mechanism is "dce."
  - The default local name for the Kerberos security mechanism is "csfkrb5."

  If you use a local mechanism name other than the default, you must change the local name in the `objectid.dat` file.
- *driver* is the name of the security driver, for example, `libsdce.so`.
- *init-string* is the initialization string for the driver.
  - For the DCE driver, use this syntax for *init-string*, where *cell_name* is the name of your DCE cell:
    ```
    secbase=/.:/cell_name
    ```
  - For the Kerberos driver, use this syntax for *init-string*, where *domaine_name* is the name of your Kerberos domaine:
    ```
    secbase=@domaine_name
    ```

Use a text editor to customize `libtcl.cfg` for your site. Make sure that lines you do not want are preceded with the ";" character. Change one parameter at a time and reboot SAP Replication Server to effect the changes you make.

- An example of an entry for a DCE driver is:
  ```
  [SECURITY]
  dce=libsdce.so secbase=/.:/cell_name
  ```
- An example of an entry for a Kerberos driver is:
  ```
  [SECURITY]
  csfkrb5=libsybskrb.so
  secbase=@ASE libgss=/krb5/lib/libgss.so
  ```

Configure objectid.dat

The `objectid.dat` file maps global object identifiers (OIDs) to local names.

It is located in the `$SYBASE/config` directory in UNIX, or the `%SYBASE%\ini` directory in Windows. You may need to edit `objectid.dat` only if you have changed the local name of a security service in the `libtcl.cfg` file.

- A sample entry in the `objectid.dat` file for DCE is:

  ```
  [secmech]
  1.3.6.1.4.1.897.4.6.1 = dce, dcesecmech
  ```
- A sample entry in the `objectid.dat` file for Kerberos is:

  ```
  [secmech]
  1.3.6.1.4.1.897.4.6.6 = csfkrb5
  ```

Configure the interfaces File

The `interfaces` file contains network and security information for servers.

The `interfaces` file is located in `$SYBASE/interfaces` in UNIX, or `%SYBASE%\ini\sql.ini` in Windows. If you use network security, you must include a `secmech` line that gives the global identifiers of supported security services. Supported security mechanisms are listed by their OIDs. Multiple security mechanisms are separated by commas.

This is a sample entry for the `interfaces` file for either DCE or Kerberos where *server_principal_user_name* is the name of the Replication Server principal user:

```

server_principal_user_name
        query tcp ether plum 1050
        master tcp ether plum 1050
        secmech 1.3.6.1.4.1.897.4.6.6
```

See also

- *Identify the Principal User* on page 253

Set Environment Variables (Kerberos)

When Replication Server serves as a client, set the KRB5CCNAME to indicate the location of the credential cache.

The credential is a combination of a ticket-granting ticket and the ticket's session key. Replication Server uses this credential to identify itself when login to remote server.

If you are using the Kerberos network security, you may need to reset the shared-library path and KRB5_KTNAME environment variables.

- Make sure that the shared-library file is in a directory specified in the shared library path so that the client can find the shared-library file at runtime. Shared-library files are:
  - `libgss.so` on Sun Solaris
  - `libgss.sl` on HP-UX
- If the server key table file is in a location other than the Kerberos system default, set the KRB5_KTNAME environment variable to the fully qualified pathname of the key table file.
- If you want to use a principal name which is different from Replication Server name, set the SYBASE_RS_PRINCIPAL environment variable.

- Make sure that the LD_LIBRARY_PATH environment variable includes the path to the CyberSafe/MIT `lib` directory as well as the `lib` directories for Adaptive Server, Open Client/Server, and Replication Server.
- Similarly, make sure that the PATH environment variable includes the path to the CyberSafe/MIT `bin` directory as well as the `bin` directories for Adaptive Server, Open Client/Server, and Replication Server.

Configuring the rs_principal_users.cfg File

If you modify the principal name of a Replication Server when multiple instances of Replication Servers are running, add the new principal name in the `rs_principal_users.cfg` configuration file,.

1. Open the `rs_principal_users.cfg` configuration file found in the `$SYBASE` folder.
2. Enter the principal name of a Replication Server that is modified and used for authentication with other Replication Servers.

   For example, if there are ten Replication Servers with names and principal names as *PRS1*, *PRS1*, *PRS3*, and so on. If you modify the principal name of *PRS1* to *PRS1_principal*, enter the modified name in the `rs_principal_users.cfg` file as:

   ```
   PRS1:PRS1_principal
   ```

   If you modify the principal name of more than one Replication Server, enter one line for each server.

   For example:

   ```
   PRS2:PRS2_principal
   PRS3:PRS3_principal
   PRS4:PRS4_principal
   ```

   Note: You can add the principal names of all Replication Servers in one `rs_principal_users.cfg` configuration file and copy this file to the same folder where the Replication Server configuration file is located; for example, `$SYBASE`.
3. Run **sysadmin principal_users[,reload]** to reload the principal names of all Replication Servers stored in the `rs_principal_users.cfg` configuration file.

   See *Replication Server Reference Manual > Replication Server Commands > sysadmin principal_users[,reload]*.

Adaptive Server-to-Adaptive Server Replication with Kerberos Scenario

Set up Kerberos authentication for an Adaptive Server-to-Adaptive Server replication system.

Prerequisites

- Install Adaptive Server Enterprise15.7 SP100 or later, and start the database. See the *Adaptive Server Installation Guide*.

- Install Replication Server 15.7.1 SP100 or later and start the server. See the *Replication Server Installation Guide*.
- Install the Kerberos key distribution center (KDC). To install the KDC for your Kerberos environment, see the vendor documentation.

Configuring Adaptive Server to Use Kerberos

Configure the Adaptive Server to use Kerberos security for data replication.

Prerequisites

Before you add the principal name in the KDC, ask the system administrator to provide the Kerberos library path.

Task

In this example, the primary Adaptive Server is *Kerberos_PDS* and its principal name is *Kerberos_PDS_principal*. The replicate Adaptive Server is *Kerberos_RDS* and its principal name is *Kerberos_RDS_principal*.

1. To generate the `keytab` file, and its credentials, add the Adaptive Server principal name in the KDC .

   For example, on the MIT Kerberos machine, run:

   ```
   export LD_LIBRARY_PATH=/mitkrb/lib:$LD_LIBRARY_PATH
   ```

   ```
   export KRB5_CONFIG=/mitkrb/krb5.conf
   ```

   ```
   export PATH=/mitkrb/linux/bin:$PATH
   /mitkrb/linux/sbin/kadmin -p kadmin/admin -k -t /mitkrb/linux/
   admin.key
   ```

   ```
   kadmin:addprinc Kerberos_PDS_principal@ASE //password: a1234abcd
   ```

   ```
   kadmin:ktadd -k /usr/Kerberos_PDS_principal.keytab
   Kerberos_PDS_principal@ASE
   ```

   ```
   kadmin:addprinc Kerberos_RDS_principal@ASE //password: a1234abcd
   ```

   ```
   kadmin:ktadd -k /usr/Kerberos_RDS_principal.keytab
   Kerberos_PDS_principal@ASE
   ```

   ```
   kadmin:quit
   ```

   ```
   export KRB5CCNAME=/usr/Kerberos_PDS_principal.cc
   /mitkrb/linux/bin/kinit -f -k -t /usr/
   Kerberos_PDS_principal.keytab Kerberos_PDS_principal@ASE
   ```

   ```
   export KRB5CCNAME=/usr/Kerberos_RDS_principal.cc
   /mitkrb/linux/bin/kinit -f -k -t /usr/
   Kerberos_RDS_principal.keytab Kerberos_RDS_principal@ASE
   ```

   where *Kerberos_PDS_principal* and *Kerberos_RDS_principal* are the principal names for the *Kerberos_PDS*, and the *Kerberos_RDS* respectively.

2. Configure the `interfaces` file found in the `$SYBASE/interfaces` in UNIX, or `%SYBASE%\ini\sql.ini` in Windows.

   Add this line:

   ```
   secmech 1.3.6.1.4.1.897.4.6.6
   ```

   ```
   Kerberos_PDS
           query tcp sun-ether replinuxb15 20001
           master tcp sun-ether replinuxb15 20001
           secmech 1.3.6.1.4.1.897.4.6.6
   Kerberos_PDS_principal
           query tcp sun-ether replinuxb15 20001
           master tcp sun-ether replinuxb15 20001
           secmech 1.3.6.1.4.1.897.4.6.6
   Kerberos_RDS
           query tcp sun-ether replinuxb15 20002
           master tcp sun-ether replinuxb15 20002
           secmech 1.3.6.1.4.1.897.4.6.6
   Kerberos_RDS_principal
           query tcp sun-ether replinuxb15 20002
           master tcp sun-ether replinuxb15 20002
           secmech 1.3.6.1.4.1.897.4.6.6
   ```
3. Configure the `libtcl.cfg` configuration file on a 32-bit machine or `libtcl64.cfg` configuration file on a 64-bit machine found in the `$SYBASE/$SYBASE_OCS/config/` directory in UNIX, or the `%SYBASE%/$SYBASE_OCS/ini` directory in Windows, by adding:

   ```
   [SECURITY]
   csfkrb5=libsybskrb64.so libgss=/krb5/lib/libgssapi_krb5.so
   secbase=@ASE
   ```

   or:

   ```
   [SECURITY]
   csfkrb5=libsybskrb.so libgss=/krb5/lib/libgssapi_krb5.so
   secbase=@ASE
   ```

   where:
   - *csfkrbr* – is the default name for the Kerberos security mechanism.
   - *driver* – is the name of the security driver, for example, `libgssapi_krb5.so`.
   - *init-string* – is the initialization string for the driver, for example, `secbase=@ASE`.

   Note: Ask the system administrator to provide the Kerberos library version and path.
4. If you use a local mechanism name other than the default name, configure the `objectid.dat` file.

   The `objectid.dat` file is in the `$SYBASE/config` directory in UNIX, or the `%SYBASE%/ini` directory in Windows.

   Add the local name in the `objectid.dat` file and ensure it includes this line:

   ```
   "1.3.6.1.4.1.897.4.6.6 = csfkrb5"
   ```

5. To configure **use security services**, enter:

```
isql -U sa -P -S Kerberos_PDS
use master
go
sp_configure 'use security services', 1
go
```

```
isql -U sa -P -S Kerberos_RDS
use master
go
sp_configure 'use security services', 1
go
```

6. Restart Adaptive Servers with Kerberos security mechanism.

   To restart the *Kerberos_PDS*:

```
export LD_LIBRARY_PATH=/lib:$LD_LIBRARY_PATH
```

```
export KRB5_KTNAME=/usr/Kerberos_PDS_principal.keytab
```

```
export KRB5CCNAME=/usr/Kerberos_PDS_principal.cc
```

```
export KRB5_CONFIG=/mitkrb/krb5.conf
```

```
export SYBASE_PRINCIPAL=Kerberos_PDS_principal@ASE //
use SYBASE_PRINCIPAL or "-k" option
dataserver -d data_Kerberos_PDS.dat -k Kerberos_PDS_principal@ASE
-s Kerberos_PDS -c Kerberos_PDS.cfg
//add "-k Kerberos_PDS_principal@ASE"
```

   To restart the *Kerberos_RDS*:

```
export LD_LIBRARY_PATH=/lib:$LD_LIBRARY_PATH
```

```
export KRB5_KTNAME=/usr/Kerberos_RDS_principal.keytab
```

```
export KRB5CCNAME=/usr/Kerberos_RDS_principal.cc
```

```
export KRB5_CONFIG=/mitkrb/krb5.conf
```

```

export SYBASE_PRINCIPAL=Kerberos_RDS_principal@ASE //
use SYBASE_PRINCIPAL or "-k" option
dataserver -d data_Kerberos_RDS.dat -k Kerberos_RDS_principal@ASE
-s Kerberos_RDS -c Kerberos_PDS.cfg
//add "-k Kerberos_PDS_principal@ASE"
```

7. Using sa user credentials, access Adaptive Servers when Kerberos is on:

```
cd $SYBASE
. SYBASE.sh
export KRB5_CONFIG=/mitkrb/krb5.conf
export LD_LIBRARY_PATH=/lib:$LD_LIBRARY_PATH
export PATH=/bin:$PATH
/bin/kinit sa
Password for sa@ASE: password
isql -V -I interfaces -J -U sa -S Kerberos_PDS_principal -w 700
isql -V -I interfaces -J -U sa -S Kerberos_RDS_principal -w 700
```

where:

- **isql –** is the Interactive SQL parser to Replication Server.
- **-V –** specifies the network-based security options for user authentication.
- **-S –** specifies the server's network name.
- **-U –** specifies the user name.
- **-P –** specifies the password for the user name.

Configuring Replication Server to Use Kerberos

Configure the Replication Server to use a user-defined Kerberos principal name to replicate data from an Adaptive Server database.

In this example, you configure the primary Replication Server (*PRS*) principal name as *PRS_principal* and the replicate Replication Server (*RRS*) principal name as *RRS_principal*.

1. Follow step 1 to step 4 in the '*Configuring Adaptive Server to Use Kerberos*' to add *PRS_principal* and *RRS_principal* in the KDC, `interfaces`, and `libtcl64.cfg` configuration files.

   Enter Replication Server principal names in the `interfaces` file as:

```
.../$ vi interfaces
PRS
        query tcp ether replinuxb15 30002
        master tcp ether replinuxb15 30002
        secmech 1.3.6.1.4.1.897.4.6.6
PRS_principal
        query tcp ether replinuxb15 30002
        master tcp ether replinuxb15 30002
        secmech 1.3.6.1.4.1.897.4.6.6
RRS
        query tcp ether replinuxb15 30003
        master tcp ether replinuxb15 30003
        secmech 1.3.6.1.4.1.897.4.6.6
RRS_principal
        query tcp ether replinuxb15 30003
        master tcp ether replinuxb15 30003
        secmech 1.3.6.1.4.1.897.4.6.6
Kerberos_PDS
        query tcp sun-ether replinuxb15 20001
        master tcp sun-ether replinuxb15 20001
        secmech 1.3.6.1.4.1.897.4.6.6
Kerberos_PDS_principal
        query tcp sun-ether replinuxb15 20001
        master tcp sun-ether replinuxb15 20001
        secmech 1.3.6.1.4.1.897.4.6.6
Kerberos_RDS
        query tcp sun-ether replinuxb15 20002
        master tcp sun-ether replinuxb15 20002
        secmech 1.3.6.1.4.1.897.4.6.6
Kerberos_RDS_principal
        query tcp sun-ether replinuxb15 20002
        master tcp sun-ether replinuxb15 20002
        secmech 1.3.6.1.4.1.897.4.6.6
```

Note: Make sure both *Kerberos_PDS*, and *Kerberos_RDS* and their principal names are also included in the `interfaces` file. Adaptive Server `interfaces` file should contain the same information as Replication Server `interfaces` file.

2. In Adaptive Server, add Replication Server principal names:

```
isql -U sa -P -S Kerberos_PDS
use master
go
sp_addlogin PRS_principal,a1234abcd
go
sp_adduser  PRS_principal
go
grant set session authorization to PRS_principal
// or: grant set proxy to PRS_principal
go
```

```
isql -U sa -P -S Kerberos_RDS
use master
go
sp_addlogin RRS_principal,a1234abcd
go
sp_adduser  RRS_principal
go
grant set session authorization to RRS_principal
// or: grant set proxy to RRS_principal
go
```

3. Add Replication Server users and their principal names:

```
isql -U sa -P a1234abcd -S PRS -I interfaces -J -w 700
create user RRS_principal set password a1234abcd
go
grant sa to RRS_principal
go
grant connect source to RRS_principal
go
```

```
isql -U sa -P a1234abcd -S RRS -I interfaces -J -w 700
create user PRS_principal set password a1234abcd
go
grant sa to PRS_principal
go
grant connect source to PRS_principal
go
```

To access Replication Server with the Replication Agent thread, enter:

```
isql -U sa -P a1234abcd -S PRS -I interfaces -J -w 700
create user Kerberos_PDS_principal set password a1234abcd
go
grant sa to Kerberos_PDS_principal
go
```

```
grant connect source to Kerberos_PDS_principal
go
```

4. If you use a local mechanism name other than the default name, configure the `objectid.dat`.

   Add the local name in the `objectid.dat` file and ensure it includes this line:

   ```
   "1.3.6.1.4.1.897.4.6.6 = csfkrb5"
   ```

5. To configure **use security services**, enter.

   ```
   isql -U sa -P a1234abcd -S PRS -I interfaces -J -w 700
   configure replication server set 'use_security_services' to 'on'
   go
   shutdown
   ```

   ```
   isql -U sa -P a1234abcd -S RRS -I interfaces -J -w 700
   configure replication server set 'use_security_services' to 'on'
   go
   shutdown
   ```

   See *Replication Server Reference Manual> Replication Server Commands > configure replication server*.

6. Restart the Replication Servers.

   To restart *PRS*:

   ```
   cd $SYBASE
   . SYBASE.sh
   export LD_LIBRARY_PATH=/lib:$LD_LIBRARY_PATH
   ```

   ```
   export KRB5_KTNAME=/usr/PRS_principal.keytab
   ```

   ```
   export KRB5CCNAME=/usr/PRS_principal.cc
   ```

   ```
   export SYBASE_RS_PRINCIPAL=PRS_principal
   ```

   ```
   export KRB5_CONFIG=/mitkrb/krb5.conf/
   REP-15_5/install/RUN_PRS
   ```

   To restart *RRS*:

   ```
   cd $SYBASE
   . SYBASE.sh
   export LD_LIBRARY_PATH=/lib:$LD_LIBRARY_PATH
   ```

   ```
   export KRB5_KTNAME=/usr/RRS_principal.keytab
   ```

   ```
   export KRB5CCNAME=/usr/RRS_principal.cc
   ```

   ```
   export SYBASE_RS_PRINCIPAL=RRS_principal
   ```

   ```
   export KRB5_CONFIG=/mitkrb/krb5.conf/
   REP-15_5/install/RUN_RRS
   ```

7. Configure the **security_mechanism** and **ID_security_mechanism** to use Kerberos.

   For *PRS*:

   ```
   isql -U sa -P a1234abcd -S PRS -I interfaces -J -w 700
   configure replication server set 'security_mechanism' to 'csfkrb5'
   ```

```
go
configure replication server set 'id_security_mechanism' to
'csfkrb5'
go
shutdown
```

For *RRS*:

```
isql -U sa -P a1234abcd -S RRS -I interfaces -J -w 700
configure replication server set 'security_mechanism' to 'csfkrb5'
go
configure replication server set 'id_security_mechanism' to
'csfkrb5'
go
shutdown
```

8. Restart *PRS* and *RRS*:

To restart *PRS*:

```
cd $SYBASE
. SYBASE.sh
export LD_LIBRARY_PATH=/lib:$LD_LIBRARY_PATH
```

```
export KRB5_KTNAME=/usr/PRS_principal.keytab
```

```
export KRB5CCNAME=/usr/PRS_principal.cc
```

```
export SYBASE_RS_PRINCIPAL=PRS_principal
```

```
export KRB5_CONFIG=/mitkrb/krb5.conf/
REP-15_5/install/RUN_PRS
```

To restart *RRS*:

```
cd $SYBASE
. SYBASE.sh
export LD_LIBRARY_PATH=/lib:$LD_LIBRARY_PATH
```

```
export KRB5_KTNAME=/usr/RRS_principal.keytab
```

```
export KRB5CCNAME=/usr/RRS_principal.cc
```

```
export SYBASE_RS_PRINCIPAL=RRS_principal
```

```
export KRB5_CONFIG=/mitkrb/krb5.conf/
REP-15_5/install/RUN_RRS
```

9. Configure the **unified_login**, and **id_unified_login** settings.

For *PRS*:

```
isql -U sa -P a1234abcd -S PRS -I interfaces -J -w 700
configure replication server set unified_login to 'required'
go
configure replication server set id_unified_login to 'required'
go
shutdown
```

For *RRS*:

```
isql -U sa -P a1234abcd -S RRS -I interfaces -J -w 700
configure replication server set unified_login to 'required'
go
configure replication server set id_unified_login to 'required'
go
shutdown
```

See *Replication Server Reference Manual> Replication Server Commands > configure replication server*.

10. Add the RSSD details in the Replication Server configuration file.

    For *PRS*:

```
RSSD_unified_login=required
#RSSD_mutual_auth=not_required
#RSSD_msg_confidentiality=not_required
#RSSD_msg_integrity=not_required
#RSSD_msg_origin_check=not_supported
#RSSD_msg_replay_detection=not_required
#RSSD_msg_sequence_check=not_required
RSSD_sec_mechanism=csfkrb5
RSSD_server_principal=Kerberos_PDS_principal  // this is for PRS
ID_server_principal=PRS_principal  // if this RS is not ID server.
```

    For *RRS*:

```
RSSD_unified_login=required
#RSSD_mutual_auth=not_required
#RSSD_msg_confidentiality=not_required
#RSSD_msg_integrity=not_required
#RSSD_msg_origin_check=not_supported
#RSSD_msg_replay_detection=not_required
#RSSD_msg_sequence_check=not_required
RSSD_sec_mechanism=csfkrb5
RSSD_server_principal=Kerberos_RDS_principal  // this is for RRS
ID_server_principal=PRS_principal  // if this RS is not ID server.
```

    Add principal user names in the `rs_principal_users.cfg` configuration file, if needed.

11. Configure the **unified_login** settings in Adaptive Server.

    For *Kerberos_PDS*:

```
isql -U sa -P -S Kerberos_PDS
sp_configure "unified login required", 1
```

    For *Kerberos_RDS*:

```
isql -U sa -P -S Kerberos_RDS
sp_configure "unified login required", 1
```

12. Restart *PRS* and *RRS* with Kerberos security mechanism:

    To restart *PRS*:

```
cd $SYBASE
. SYBASE.sh
export LD_LIBRARY_PATH=/lib:$LD_LIBRARY_PATH
export KRB5_KTNAME=/usr/PRS_principal.keytab
```

```
export KRB5CCNAME=/usr/PRS_principal.cc
```

```
export SYBASE_RS_PRINCIPAL=PRS_principal
```

```
export KRB5_CONFIG=/mitkrb/krb5.conf/
REP-15_5/install/RUN_PRS
```

To restart *RRS*:

```
cd $SYBASE
. SYBASE.sh
export LD_LIBRARY_PATH=/lib:$LD_LIBRARY_PATH
```

```
export KRB5_KTNAME=/usr/RRS_principal.keytab
```

```
export KRB5CCNAME=/usr/RRS_principal.cc
```

```
export SYBASE_RS_PRINCIPAL=RRS_principal
```

```
export KRB5_CONFIG=/mitkrb/krb5.conf/
REP-15_5/install/RUN_RRS
```

13. If the Replication Server and Adaptive Server principal names are different from their server names, add principal user names in the `rs_principal_users.cfg` configuration file.

Add one line for each Replication Server and Adaptive Server:

- PRS:PRS_principal
- RRS:RRS_principal
- Kerberos_PDS:Kerberos_PDS_principa
- Kerberos_RDS:Kerberos_RDS_principal

14. If you do not want to restart Replication Server, reload the principal user names from the `rs_principal_users.cfg`:

```
sysadmin principal_users, reload
```

You can also use this command to display all principal names.

15. To access *PRS* with the Replication Agent thread, enter:

```
isql -V -I interfaces -J -U sa -S Kerberos_PDS_principal
use PRS_RSSD
go
sp_config_rep_agent PRS_RSSD, 'security mechanism', 'csfkrb5'
go
sp_config_rep_agent PRS_RSSD, 'unified login', 'true'
go
sp_config_rep_agent PRS_RSSD, 'rs_password', 'NULL'
go
sp_config_rep_agent PRS_RSSD, 'rs servername', 'PRS_principal'
go
sp_stop_rep_agent PRS_RSSD
go
sp_start_rep_agent PRS_RSSD
go
```

```
use prspdb
go
sp_config_rep_agent prspdb, 'security mechanism', 'csfkrb5'
go
sp_config_rep_agent prspdb, 'unified login', 'true'
go
sp_config_rep_agent prspdb, 'rs_password', 'NULL'
go
sp_config_rep_agent prspdb, 'rs servername', 'PRS_principal'
go
sp_stop_rep_agent prspdb
go
sp_start_rep_agent prspdb
go
```

16. Access Replication Server when Kerberos security is on.

To access *PRS*, using sa user credentials:

```
isql -U sa -P a1234abcd -S PRS -I interfaces -J -w 700
isql -U sa -P a1234abcd -S PRS_principal -I interfaces -J -w 700
```

To access *RRS*, using sa user credentials:

```
isql -U sa -P a1234abcd -S RRS -I interfaces -J -w 700
isql -U sa -P a1234abcd -S RRS_principal -I interfaces -J -w 700
```

Or, access Replication Server with the principal user credential:

```
cd $SYBASE
. SYBASE.sh
export LD_LIBRARY_PATH=/mitkrb/linux/lib:$LD_LIBRARY_PATH
export KRB5_CONFIG=/mitkrb/krb5.conf
/mitkrb/linux/bin/kinit sa
Password for sa@ASE: password

isql -V -I interfaces -J -w 700 -U sa -S PRS_principal
isql -V -I interfaces -J -w 700 -U sa -S RRS_principal
```

17. Use non-sa user credentials to access Replication Server when Kerberos security is on.

a) To access Replication Server with the user name 'scott', add user scott in KDC:

```
export LD_LIBRARY_PATH=/lib:$LD_LIBRARY_PATH
export KRB5_CONFIG=/mitkrb/krb5.conf
export PATH=/mitkrb/linux/bin:$PATH
/sbin/kadmin -p kadmin/admin -k -t mitkrb/linux/admin.key
addprinc scott@ASE   // 1234abcd
ktadd -k /usr/u/scott/scott.keytab scott@ASE
quit

export KRB5CCNAME=/usr/u/scott/scott.cc
/mitkrb/linux/bin/kinit -f -k -t /usr/u/scott/scott.keytab
scott@ASE
```

b) Add user 'scott' in Replication Server:

```
isql -U sa -P a1234abcd -S PRS -I interfaces -J
create user scott@ASE set password a1234abcd
```

c) Access Replication Server, either with the user name and password:

```
isql -U scott -P a1234abcd -S PRS -I interfaces -J
```

Or, with the principal user credentials:

```
cd $SYBASE
. SYBASE.sh
export LD_LIBRARY_PATH=/mitkrb/linux/lib:$LD_LIBRARY_PATH
export KRB5_CONFIG=/mitkrb/krb5.conf
export KRB5CCNAME=/usr/u/scott/scott.cc
isql -V -S PRS_principal -I interfaces
//if your login is "scott"
isql -V -U scott -S PRS_principal -I interfaces
```

Follow these same steps to configure a single Adaptive Server which acts both the primary and the replicate database in an Adaptive Server-to-Adaptive Server replication system.

Establish the Principal User

When network-based security is enabled with unified login, Replication Server must log in to remote servers as the principal user.

When network security is not enabled, Replication Server logs in to remote servers as one of several possible users, depending on the task to be performed. The principal user credential is the only credential Replication Server has to log in to other processes when network security is active.

When Replication Server logs in to another Replication Server or a data server, the principal user name contained in the credential is mapped to the server name space and a secure connection is established.

Note: Make sure that principal user names are unique. Replication Server cannot log in to another server of the same name.

Replication Server executes the **set proxy** command in the remote server (as the principal user) and switches to the appropriate user for the current task.

Identify the Principal User

You can specify the principal user name with the **-S** flag when you log in to or start Replication Server.

It is the responsibility of the replication system administrator to establish a principal user for each Replication Server. SAP recommends that you use the name of the Replication Server as the principal user name.

If you do not specify a principal user name using the **-S** flag, Replication Server uses the Replication Server name.

Identify the Principal User to the Security Mechanism

The security administrator for the security mechanism must define the Replication Server principal name to the security mechanism.

For DCE:

- Use the DCE **dcecp** tool's **user create** command to create the principal user.

  When you are defining a server to DCE, use options that specify that the new principal user can act as a server.
- Use the **keytab create** command of the **dcecp** utility to create a DCE key table file, which contains a principal user's password in encrypted form.

Note: DCE is not supported on UNIX

For CyberSafe Kerberos:

- Use the Kerberos **csfadml** tool to create the principal user.
- Use **csfadml** to extract the key table file.

For MIT Kerberos:

- Use administrative command **addprinc** to create principal user.
- Use administrative command **ktadd** to extract key table file.

Refer to documentation from the security mechanism provider for detailed information about identifying servers and users to the security mechanism.

Identify Principal Users to Replication Server

The principal user for other processes—including RepAgents, data servers, and other Replication Servers—using system security and unified login to connect to Replication Server must be identified in the `rs_users` table for the current Replication Server. You can use the **create user** command to add principal user names to `rs_users`.

Identify the Replication Server Principal User to the Replication System

You must add the Replication Server principal user name to destination processes—Replication Servers and data servers—including the ID Server and the RSSD to which Replication Server is connecting using unified login.

Refer to the *Adaptive Server Enterprise System Administration Guide* for information about adding login names to Adaptive Server.

Activating Network-based Security

Before configuring security services, you must activate network-based security for the Replication Server using the **configure replication server** command.

1. Log in to Replication Server and enter:

```
configure replication server
  set use_security_services to 'on'
```

2. Shut down Replication Server.
3. Restart Replication Server by executing the **repserver** command or the Replication Server run file.
   - If you are using the DCE security mechanism, make sure you include the **-K** flag to specify the key table file location.
   - If you are using the Kerberos security mechanism, the key table location must be specified by the KRB5_KTNAME environment variable (UNIX) or the key table registry key entry (Windows 2000 or 2003).

   Refer to the *Replication Server Reference Manual* for syntax and other information about the **repserver** command.

See also

- *Disabling Network-based Security* on page 269

Start Server and Clients

For the network security environment to work properly, both servers and clients should be started only after they have a valid credential.

For Kerberos systems:

- On UNIX systems, servers and clients should be started after a **kinit**
- On Windows NT systems, server and clients can be started automatically using the single sign-on feature or manually using the Kerberos credentials manager.

Refer to your Kerberos documentation for more information.

Transarc DCE systems behave in similar manner, refer to your Transarc documentation for information about setting up the proper environment.

Configure Security Services for Replication Server

Learn what network-based security features Replication Server parameters provide.

Configuration parameters enable:

- Unified login
- Mutual authentication
- Choice of supported security mechanism
- Message confidentiality through encryption
- Other secure message transmission features: message integrity, origin check, replay detection, and out-of-sequence detection

Note: Depending on the security mechanism you choose, one or more of these security features may not be available at your site.

You set default parameters in the **rs_init** program during system configuration. Refer to the *Replication Server Configuration Guide* for your platform for information about **rs_init**. This section describes how you set these parameters at the command line.

Identify Replication Server Pathways

Replication Server coordinates data replication activities for local data servers and exchanges data with Replication Servers and data servers at other sites. Learn the Replication Server pathways for which you can configure network-based security.

- When Replication Server is acting as a client, you can configure security for:
  - All pathways established when Replication Server logs in to another server. These are default global settings.
  - The connection to the RSSD.
  - Individual connections.
  - Individual routes.
  - Replication Server to ID Server pathway.
  - Pathways used to create a route, create a subscription, or drop a subscription.
- When Replication Server is acting as a server, you can configure security for:
  - All incoming logins. These are default global settings.
  - User connection to Replication Server (set when logging on).

Secure Different Types of Network Pathway

Configure security for the different types of pathway for outgoing logins.

Table 19. Network Pathways

Pathway	How to Secure It	Special Parameters and Exceptions
All pathways initiated by the current Replication Server (acting as a client)	Set global security parameters using **configure replication server**. This is the default setting for all outgoing logins unless overridden for individual pathways.	Use **use_security_services** to turn off all network security with a single command.
Connection to the RSSD	Use a text editor to configure the `rs_config` file.	Security parameters have an "RSSD_" prefix. For example: **RSSD_unified_login**.

Pathway	How to Secure It	Special Parameters and Exceptions
Individual connections	Set security parameters for a connection to a remote database with: • **create connection**, or • **alter connection** See the *Replication Server Reference Manual* for more information about these commands.	Use **dsi_exec_request_sproc** to suspend request stored procedures.
Individual routes defined using the **create route** command	Set security parameters using: • **create route**, or • **alter route** See the *Replication Server Reference Manual* for more information about these commands.	
Replication Server to ID Server	Set security parameters with **configure replication server**. See the *Replication Server Reference Manual* for more information about this command.	Security parameters have an “id-” prefix. For example: **id_msg_confidentiality**.
Replication Server to primary Replication Server and primary database to: • create a route • create or drop a subscription	Replication Server duplicates the security settings used when the user creating the route or creating or dropping the subscription logs in to Replication Server.	
All incoming logins (Replication Server acting as server)	Set parameters for incoming logins with **configure replication server**. Default parameters for outgoing and incoming parameters are set at the same time and are identical.	
Pathway established when user logs in to Replication Server.	Set security parameters with the **isql** utilities.	Security parameters set for this pathway must be compatible with those set at the Replication Server for all incoming logins. Security for this pathway cannot be configured using the **rs_init** utility.

See also

- *Configure Security for Database Connections* on page 262
- *Replication Server Borrows Security Settings to Secure Other Pathways* on page 268
- *Disabling Network-based Security* on page 269

Security Configuration Parameters

Replicaton Server provides security configuration parameters generally available for all pathways.

Table 20. Security Parameters Affecting Replication Server

configuration_parameter	Description
msg_confidentiality	Indicates whether Replication Server sends and receives encrypted data. If set to “required,” outgoing and incoming data must be encrypted. If set to “not_required,” Replication Server accepts incoming data that is encrypted or not encrypted. Values are “required” or “not_required.” Default: not_required
msg_integrity	Indicates whether data is checked for tampering. Values are “required” or “not_required.” Default: not_required
msg_origin_check	Indicates whether the source of data must be verified.Values are “required” or “not_required.” Default: not_required
msg_replay_detection	Indicates whether data should be checked to make sure it has not been intercepted and re-sent.Values are “required” or “not_required.” Default: not_required
msg_sequence_check	Indicates whether data packages should be checked to ensure that they have been received in the order sent. Values are “required” or “not_required.” Default: not_required
mutual_auth	Requires remote server to provide proof of identify before a connection can be established. Values are “required” or “not_required.” Default: not_required
security_mechanism	Specifies the name of the network-based security mechanism. Default: First security mechanism listed in `libtcl.cfg`.

configuration_parameter	**Description**
unified_login	Indicates how Replication Server seeks outgoing connections and accepts incoming connections. The values are: • "required" – always seeks to log in to remote server with a credential; only accepts incoming logins with a credential. • "not_required" – always seeks to log in to remote server with a password; accepts incoming logins with a credential or a password. **Note:** **unified_login** must be "required" before other security parameters can take effect. Default: not_required

Plan for Compatible Settings

When you set up network-based security, you must plan for the interaction between security settings at each end of the secured pathway. Security settings at both ends of each pathway must be compatible.

Replication Server accepts incoming logins and initiates logins to other servers. Security parameters for all incoming logins (when Replication Server is acting as a server) are set with the **configure replication server** command. There are also security parameters you set for outgoing logins (when Replication Server is acting as a client) that you set for network pathways.

Note: It is the responsibility of the replication system administrator to choose and set security features for each server. Replication Server does not query the security features of remote servers before attempting to establish a pathway. An attempted login fails if security features at both ends of the pathway are not compatible.

Use **configure replication server** with the **use_security_services** parameter to activate or deactivate all compatible security settings for client/server interaction. If the security services parameters are not compatible, for example, if a parameter is set to "not_required" at the client and "required" at the server, the server does not allow the client to log in.

See also

- *Secure Different Types of Network Pathway* on page 256

Compatible Client/Server Settings

Use the server settings that are compatible with the client settings.

Table 21. Compatible Client/Server Settings

Client	Server
use_security_services "off": no security services	Compatible settings: • **use_security_services** "off", or • **use_security_services** "on" and security feature "not required"
use_security_services "on" and security feature "not required"	Compatible settings: • **use_security_services** "on" and security feature "not required," or • **use_security_services** "off"
use_security_services "on" and security feature "required"	Compatible settings: • **use_security_services** "on" and security feature "required"

Configure Default Values

Use **configure replication server** to establish default security settings for all outgoing logins (when Replication Server acts as a client) and incoming logins (when Replication Server acts as a server).

You can override default security settings for these outgoing pathways:

- Individual connections
- Individual routes
- The pathway from Replication Server to ID Server

Note: You cannot override any default security settings that control security for incoming logins.

When Replication Server seeks to open a pathway to another server, it checks to see if security parameters have been set specifically for that pathway. If not, Replication Server uses the default security settings determined using **configure replication server**.

To set global security parameters, log in to Replication Server and execute **configure replication server** at the **isql** prompt. Here is the syntax:

```
configure replication server {
  set security_mechanism to 'mechanism_name' |
  set security_parameter to { 'required' |
    'not_required' }}
```

You can set all of the security configuration parameters affecting Replication Server. They are stored in the `rs_config` table in the RSSD. You must have **sa** permission to execute them.

Require Unified Login

To require all servers and users that connect to Replication Server to be authenticated by the security mechanism, set **unified_login** to 'required'.

Log in to Replication Server and execute this command at the **isql** prompt:

```
configure replication server
  set unified_login to 'required'
```

If **unified_login** is 'not_required', Replication Server allows servers and users to connect with either a credential or a password.

Note: unified_login must be 'required' for other security services to take effect.

Require Data Encryption

To require all data sent or received by Replication Server to be encrypted, set **msg_encryption** to 'required'.

Log in to the Replication Server and execute this command at the **isql** prompt:

```
configure replication server
  set msg_encryption to 'required'
```

See also

- *Configure Security for Database Connections* on page 262
- *Configure Security for Routes* on page 264
- *Configure Security to the ID Server* on page 265

Configure Security for the Connection to the RSSD

At startup, Replication Server contacts the RSSD for configuration information. Secure the pathway from Replication Server to RSSD using network-based security.

When you set up Replication Server, **rs_init** creates the RSSD connection and places default security information in the Replication Server configuration file, `Rep_Server_name.cfg`. By default, **rs_init** sets all network security parameters to “not required.” If you want to secure the pathway, you must use a text editor to change desired default values to “required.”

Configuration values for the RSSD are preceded by an “RSSD_” prefix. For example:

- **RSSD_mutual_auth**
- **RSSD_msg_origin_check**
- **RSSD_server_principal_name**

For example, to set RSSD server principal name to *Kerberos_PDS_princ*, add this line in the `Rep_Server_name.cfg` configuration file:

```
RSSD_server_principal=Kerberos_PDS_princ
```

Note: If you do not enter **RSSD_server_principal_name** in the *Rep_Server_name*.cfg configuration file, Replication Server considers that RSSD server principal name is same as RSSD server name.

See also

- *Security Configuration Parameters* on page 258

Configure Security for Database Connections

Use **create connection** or **alter connection** to configure security for individual connections.

Security parameters configured with these commands affect security for the outgoing connection to the data server. They override parameters set with **configure replication server**.

Create a Secure Connection

You can set security parameters when you create a connection with **create connection**.

Normally, you use **create connection** to add connections to non-SAP databases.

Here is the syntax for including security features with the **create connection** command. See ***create connection*** in the *Reference Manual* for detailed information about using **create connection**.

```
create connection to data_server.database...
  set username [to] user
  [set password [to] passwd]
  [set security_mechanism [to] 'mechanism_name' |
  set dsi_exec_request_sproc [to] { 'on' | 'off' } |
  set security_mechanism [to] 'mechanism_name' |
  set security_parameter [to] { 'required' |
    'not_required' } ]
```

In addition to security configuration parameters you can set with **create connection**, you can set the **dsi_exec_request_sproc** special security parameters.

Connections parameters are stored in the `rs_config` table in the RSSD, and you must have **sa** permission to execute them.

Security parameters set at both ends of a connection must be compatible.

See also

- *Security Configuration Parameters* on page 258

Special Security Parameters for Connections

You can use special parameters to secure connections.

Table 22. Special Security Parameters for Connections

security_parameter	**Description**
dsi_exec_request_sproc	Indicates whether request stored procedures at the primary Replication Server are "off" or "on." Use in multiple security-system environments. Default: off

See also

- *Plan for Compatible Settings* on page 259
- *Use More than One Security Mechanism* on page 271

Modifying Security for a Connection

Use **alter connection** to change the security settings for a database connection.

Syntax:

```
alter connection to data_server.database {
...
set password to passwd |
set security_mechanism to 'mechanism_name' |
set dsi_exec_request_sproc to { 'on' | 'off' } |
set security_parameter to { 'required' |
    'not_required' }}
```

To change the security parameters of a database connection, perform these steps at the Replication Server:

1. Execute **suspend connection** to suspend activity on the connection.
2. Execute **alter connection** to change a security parameter.

   Note: Set one parameter at a time.
3. Execute **resume connection** to resume activity on the connection.

Examples of Using alter connection to Configure Security

- To require Replication Server to connect to the target database (`TOKYO_DS.pubs2`) with a credential, execute:

  ```
  alter connection to TOKYO_DS.pubs2
     set unified_login to 'required'
  ```

  Note: unified_login must be "required" for other security services to take effect.
- To turn "off" request stored procedures at the TOKYO data server in a multiple security-system environment, execute:

```
alter connection to TOKYO_DS.pubs2
   set dsi_exec_request_sproc to 'off'
```

See also

- *Security Configuration Parameters* on page 258
- *Special Security Parameters for Connections* on page 263

Configure Security for Routes

Use **create route** or **alter route** to configure security for individual routes.

Security parameters configured with these commands affect security for the outgoing login to the destination Replication Server. They override default parameters set with **configure replication server**.

Create a Secure Route

You can set security parameters when you create a route with **create route**.

Here is the syntax for including security features using the **create route** command:

```
create route to dest_replication_server {
...
[set username to 'user' ]
[set password to 'passwd' ]
[set security_mechanism to 'mechanism_name' |
set security_parameter to { 'required' |
    'not_required' } ]
```

The parameters are stored in the `rs_config` table in the RSSD. You must have **sa** permission to execute them.

Security parameters set at both ends of a route must be compatible.

See also

- *Plan for Compatible Settings* on page 259
- *Security Configuration Parameters* on page 258

Modifying Security for a Route

Use **alter route** to change the security settings for a route.

Here is the syntax for altering security:

```
alter route to dest_replication_server {
...
set password to 'passwd' |
set security_mechanism to 'mechanism_name' |
set security_parameter to { 'required' |
        'not_required' }}
```

To change the security parameters of a route, log in to Replication Server and perform these steps at the Replication Server:

1. Execute **suspend route** to suspend activity on the route.
2. Execute **alter route** to change a security parameter.

   Note: Set one parameter at a time.
3. Execute **resume route** to resume activity on the route.

Examples of Using alter route to Configure Security

- To require Replication Server to connect to the target Replication Server (TOKYO_RS) with a password, execute these commands:

  ```
  alter route to TOKYO_RS
     set username 'TOKYO_rsi_user'
  ```

  ```
  alter route to TOKYO_RS
     set password 'TOKYO_rsi_pw'
  ```

  ```
  alter route to TOKYO_RS
     set unified_login to 'not_required'
  ```

  Note: If **unified_login** is “not_required,” you must specify an RSI user and password.
- To specify that all messages exchanged with the target Replication Server (TOKYO_RS) are checked for tampering, execute:

  ```
  alter route to TOKYO_RS
    set msg_integrity to 'required'
  ```

See also

- *Security Configuration Parameters* on page 258

Configure Security to the ID Server

Use **configure replication server** to configure network-based security for the network connection from Replication Server to ID Server.

The syntax is:

```
configure replication server
  set id_security_param to { 'required' |
    'not_required' }
```

See the *Replication Server Reference Manual > Replication Server Commands >* ***configure replication server***. The security parameters are stored in the `rs_config` table in the RSSD. You must have **sa** permission to configure them. To distinguish settings for this pathway, all ID Server parameters begin with the “id_” prefix. For example:

- **id_msg_confidentiality**
- **id_security_mechanism**

ID Server security parameters configured with **configure replication server** are dynamic. They take effect immediately and do not require that you restart Replication Server.

Examples of Using configure replication server to Configure Security to the ID Server

- To require that the source of all messages be verified, log in to the source Replication Server and enter:

```
configure replication server
   set id_msg_origin_check 'required'
```

- To require that Replication Server logs in to ID Server with a credential, enter:

```
configure replication server
  set id_unified_login to 'required'
```

See also

- *Security Configuration Parameters* on page 258

Log in to Replication Server

Connect to Replication Server using a client application such as **isql** or a custom application program you create with Open Client Client-Library.

isql Command Line Options for Security

There are several command line options that you can use with **isql** to enable network-based security services for the connection to Replication Server.

Table 23. isql Command Line Options for Security

Option name	Meaning
-K *keytab_file*	Use only with DCE security. It specifies a DCE keytab file that contains the security key for the user logging into the server. Keytab files can be created with the DCE **dcecp** utility—see your DCE documentation for more information. Replication Server must have read permission on this file. **Note:** For Kerberos users: Specify the location of the key table file using the key table registry key entry (Windows 2000 or 2003).
-S *server_name*	Specifies the server's network name. If unified login is enabled, this option also specifies the principal user.

Option name	Meaning
-V *security_options*	Specifies unified login. With this option, the user must log in to the network's security system before running the **isql** utility. If a user specifies the **-U** option, the user must supply the network user name known to the security mechanism; any password supplied with the **-P** option is ignored. **-V** can be followed by a string of options that enable additional security services. Here is a list of options and the services they enable. • **c** – data confidentiality • **i** – data integrity • **m** – mutual authentication • **o** – data origin stamping service • **r** – data replay detection • **q** – out-of-sequence detection
-X	Specifies that connections are made with encrypted passwords.
-Z *security_mechanism*	Specifies the name of a security mechanism to use on the connection to Replication Server. Supported security mechanism names are listed in the `libtcl.cfg` file. If no security mechanism is supplied, the default is used, which is the first security mechanism listed under SECURITY in `libtcl.cfg`.

Examples of Connecting to Replication Server

You can connect to Replication Server by logging in to the security mechanism and then logging in to Replication Server, or you can log directly in to Replication Server.

You must include the **-S** flag to identify the principal user.

Connecting to Replication Server from the Security Mechanism

Example that shows how to log in first to the DCE security mechanism and then to Replication Server.

Note: When using DCE, if you want to log in as another user, you must include the **-U** and **-K** options.

1. Log in to the DCE/Kerberos security mechanism and receive a credential:
   - For DCE, enter
     ```
     dce_login user_name password
     ```
   - For Kerberos, enter
     ```
     kinit user_name password
     ```
2. Log in to Replication Server with **isql**:
   - For DCE, enter

```
isql -Srs_server_name -Vsecurity_option
```

- For Kerberos, enter

```
 isql -Srs_server_principal_name -Vsecurity_option
```

Connecting to Replication Server from Outside Security

Example that shows how to connect to Replication Server from outside the security mechanism.

Enter:

- For DCE:

```
isql -Srs_server_name -Uuser_name
     -Kkeytab_file
```

- For Kerberos:

```
isql -Srs-server_name -Yuser_name
```

Replication Server Borrows Security Settings to Secure Other Pathways

The security services you use when logging in to Replication Server from the command line not only secure the pathway between the client and the server, they may also be duplicated later on in the session when Replication Server opens other pathways.

Replication Server logs in to the primary Replication Server and the primary database over informal pathways when executing these commands:

- **create subscription**
- **drop subscription**
- **create route**

To secure these pathways, Replication Server borrows the security settings entered by the user executing **create subscription**, **drop subscription**, or **create route** when that user logged in to Replication Server.

Maintain Network Security

Learn to manage and maintain network security.

Use set proxy To Switch Logins

Use **set proxy** to allow Replication Server commands to be executed on the target data server by the correct user.

When **unified_login** is enabled, Replication Server always logs in to remote processes as the principal user. Nonetheless, Replication Server commands must be executed on the target data server by the correct user for a particular operation. For example, Replication Server must use the maintenance user login name when applying changes to replicate databases. Replication Server uses the Adaptive Server **set proxy** command to switch automatically from the login user to the required user.

You can customize the **set proxy** command with the **rs_setproxy** function string. **rs_setproxy** changes the login name in a data server. **rs_setproxy** has function-string-class scope.

See *Replication Server Reference Manual > Replication Server System Functions >* ***rs_setproxy*** and *Replication Server Reference Manual > Replication Server Commands >* ***set proxy***.

Disabling Network-based Security

Use the **use_security_services to 'off'** parameter to disable all security services.

When you disable network security, Replication Server does not accept incoming logins with security credentials and does not attempt to log in to other processes with a security credential. No security services are active.

1. Log in to the Replication Server, and at the **isql** prompt enter this command:

   ```
   configure replication server
       set use_security_services to 'off'
   ```
2. Restart Replication Server by executing the **repserver** command or the Replication Server run file.

See also

- *Replication Server Executable Program* on page 64
- *Set up Network-based Security* on page 239

Change the Security Mechanism

Use the **set security_mechanism** parameter to change to another security mechanism.

Log in to Replication Server and execute this command at the **isql** prompt:

```
configure replication server
   set security_mechanism to 'mechanism_name'
```

The security mechanism you change to must be installed and listed in the SECURITY section of the `libtcl.cfg` file.

Reset Per-target Values to Default Values

You can change all of your per-target security values for connections or routes using the **set security_services to 'default'** option.

Resetting Per-target Values for Connections

Use **alter connection** to change per-target security settings to global values set with **configure replication server**.

Changes take effect after you resume the connection. This procedure does not affect the configuration of **use_security_services**.

1. Log in to the Replication Server and execute **suspend connection** at the **isql** prompt. Enter:

   ```
   suspend connection to dataserver.database
   ```

2. Change security settings with **alter connection**. Enter:

   ```
   alter connection to dataserver.database
       set security_services to ‘default’
   ```

3. Resume the route or connection with **resume connection** for the changes to take effect. Enter:

   ```
   resume connection to dataserver.database
   ```

Resetting Per-target Values for Routes

Use the **set security_services to 'default'** parameter with **alter route** to change per-target security settings to global values set with **configure replication server.**

Changes take effect after you resume the route. This procedure does not affect the configuration of **use_security_services**.

1. Suspend the route. Enter:

   ```
   suspend route to dest_replication_server
   ```

2. Alter the route. Enter:

   ```
   alter route to dest_replication_server
     set security_services to 'default'
   ```

3. Resume the route. Enter:

   ```
   resume route to dest_replication_server
   ```

View Information About Security Services

You can display information about the Replication Server network-based security using the **admin security_property** and **admin security_setting** commands.

What Security Mechanisms and Services Are Available?

Use **admin security_property** to find out which security mechanisms and services are supported at the Replication Server:

```
admin security_property[, security_mechanism]
```

Replication Server displays the name of supported security mechanisms, the security services available for that mechanism, and whether or not those services are supported at your site.

What Are the Current Security Settings?

Use **admin security_setting** to determine the status of supported security services.

You can view status information for security parameters that have been set for routes and/or the ID Server. You can use the following syntax, where *rs_idserver* is the name of the ID Server and *rep_server* is the name of the destination Replication Server:

```
admin security_setting[, rs_idserver |, rep_server ]
```

How Replication Server Maps a Security System Login to a Replication Server Login

Learn how Replication Server maps a security system login to a Replication Server login and how Replication Server translates invalid characters.

Your network-based security mechanism may use login names that are not valid on Replication Server. For example, login names on Replication Server must not exceed 30 characters or include certain special characters such as *, (, and %. Login names on Replication Server must be valid identifiers, which are described in *Replication Server Reference Manual > Topics > Identifiers*.

If the security login name is not a valid identifier, Replication Server automatically maps invalid characters to valid characters and truncates login names at 30 characters.

How Replication Server Converts Invalid Characters

Learn the mapping of invalid characters to valid characters when Replication Server translates invalid characters.

Table 24. Conversion of Invalid Characters to Valid Characters

Invalid characters	Convert to
\ % & , : = > ‘ ' ~	an underscore: _
! ^ ( ) . < ? { }	a dollar sign: $
“ - ; * + / [ ] |	a pound sign: #

Use More than One Security Mechanism

Learn how to set up more than one security mechanism.

If your replication system supports multiple security mechanisms, you may need to install more than one security mechanism on your Replication Server to ensure that both ends of each pathway can support the same mechanism. In this scenario, you can:

1. Configure the Replication Server, for all routes, connections, and other pathways, using **configure replication server**. Make sure that the default security mechanism name is the first one listed under SECURITY in the `libtcl.cfg` file.
2. Configure security for the individual pathways that use a different security mechanism. Make sure that the security mechanism is listed in `libtcl.cfg`.

To find out the security mechanisms and supported security parameters of the Replication Server, use the **admin security_property** command. To find out the security mechanisms and current settings of a particular pathway, use the **admin security_settings** command.

See also

- *View Information About Security Services* on page 270

- *Secure Different Types of Network Pathway* on page 256

Potential Security Issue

If different security mechanisms are used at the primary and replicate databases and Adaptive Server user names cannot be guaranteed unique at these sites, a potential security breach exists for request stored procedures.

If this scenario exists on your system, you can make sure that security is maintained by turning "off" the **dsi_exec_proc** parameter for the connection with the primary database. Executing **alter connection** and turning **dsi_exec_proc** "off" disables the Replication Server request-stored-procedures feature.

Here is the syntax:

```
alter connection to  data_server.database
  set dsi_exec_request_sproc 'off'
```

Manage SSL Security

The Replication Server secure sockets layer (SSL) Advanced Security option provides session-based security. SSL is the standard for securing the transmission of sensitive information, such as credit card numbers and stock trades, over the Internet.

SSL Overview

SSL, also called Transport Layer Security (TLS), provides a lightweight, easy-to-administer security mechanism with several encryption algorithms. It is intended for use over those database connections and routes where increased security is required.

SSL uses certificates issued by certificate authorities (CAs) to establish and verify identities. A certificate is like an electronic passport; it contains all the information necessary to identify an entity, including the public key of the certified entity and the signature of the issuing CA.

See documentation from your third-party SSL security mechanism for instructions for using that software. See also the Internet Engineering Task Force (IETF) Web site for additional information.

An SSL installation requires these items:

- Certificate authority – a valid entity that verifies and signs certificates. Each CA has its own verification policies for issuing digital signatures.
- Certificate – an electronic document that identifies a server, a user, an organization, or other entity. A certificate contains the public key of the certified entity and a signature of the issuing CA.
- Filter – a special network driver that filters information delivered to and from a port.
- Identity file – concatenates a certificate and the certificate's private key.

- Trusted roots file – contains a list of certificates. Open Client/Server accepts only those CAs listed in the trusted roots file.
- CipherSuites – a set of cryptographic algorithms for authenticating a client and server, transmitting certificates, encrypting data, and establishing security session keys.

The SSL protocol runs above TCP/IP and below application protocols such as HTTP or TDS. Before the SSL connection is established, the server and client exchange a series of I/O round trips to negotiate and agree upon a secure encrypted session. This process is called the SSL handshake.

The SSL Handshake

The standard SSL handshake consists of three steps.

The standard SSL handshake steps are:

1. The client sends a connection request, which includes the SSL options the client supports, to the server.
2. The server returns its certificate and a list of supported encryption algorithms called CipherSuites, key-exchange algorithms, and digital signatures.
3. Both client and server agree on a CipherSuite, and a secure, encrypted session is established.

SSL on SAP Replication Server

SAP Replication Server SSL support is based on functionality provided by SAP Open Client/ Server.

SAP Replication Server does not directly invoke SSL APIs. See the *Open Server Server-Library/C Reference Manual* for a complete description of Open Client/Server support for SSL.

SAP Replication Server Advanced Security option supports server authentication and data encryption; it does not support client authentication. For incoming connections, SAP Replication Server supports both SSL and non-SSL ports. For outgoing connections, SAP Replication Server supports both SSL and non-SSL ports on the target server. Clients must log in to the server using a user name and password. SAP Replication Server verifies the user name and password. Once this connection is made, a secure encrypted session can be established.

Use of SSL-secured links can impact SAP Replication Server performance. SAP recommends SSL only for those connections or routes that transmit sensitive data.

SSL Requirements

There are several requirements for SSL.

- Replication Server 15.0 or later supports TLS version 1.0 or 2.0; it does not support SSL version 3.0.

- SSL requires Replication Server version 12.5 and later. Earlier versions of Replication Server do not support SSL.
- The Replication Server Administrator must generate and secure the server certificates and trusted root CA certificates as files outside Replication Server.

Setting Up SSL Security on Replication Server

Learn how to set up SSL services on Replication Server.

Prerequisites

Before setting up SSL services on Replication Server, review the SSL Plus user documentation and documentation for any third-party SSL security software you are using.

Task

1. Edit `$SYBASE/$SYBASE_OCS/config/libtcl.cfg` to include SSL driver location.
2. Edit `$SYBASE/config/trusted.txt` to include trusted CA certificates.
3. Obtain a certificate from a trusted CA for each Replication Server accepting SSL connections.
4. Create the identity file that concatenates a certificate and its private key.
5. Use **rs_init** to enable SSL on Replication Server and to add an encrypted SSL password to the Replication Server configuration file.

   Note: You can also enable and disable SSL on Replication Server using **configure replication server** and the **use_ssl** option.
6. Create an SSL entry in the Replication Server interfaces file or directory service.
7. Restart Replication Server.

See *Replication Server Configuration Guide > Secure Sockets Layer* for detailed instructions for each of these steps.

Enable SSL Security on Replication Server

You can enable or disable the SSL security feature using **rs_init**, or you can use **configure replication server** with the **use_ssl** option.

To enable SSL with **use_ssl**, enter:

```
configure replication server
    set use_ssl to 'on'
```

Set **use_ssl** to “off” to disable SSL. By default, SSL is not enabled on Replication Server. When **use_ssl** is “off,” Replication Server does not accept SSL connections.

use_ssl is a static option. You must restart Replication Server after you change its value.

Command Auditing

Enable command auditing for Replication Server to record information about user actions and commands.

Types of Actions Recorded by Command Auditing

When you enable command auditing, Replication Server records information on each user action that results in an entry to the audit log:

- Execution of any command belonging to the classes of commands that are recorded.
- Failure to execute a command because the user lacks the required permissions. For example, **create user** requires sa permission.
- Failure to execute a command for other reasons, such as syntax errors.
- User who started Replication Server.
- Number of failed login attempts.

Note: Command auditing records passwords in the log file as asterisks: *****.

Command auditing records entire batches of commands, even if there is only one command that includes the type of information recorded, or that belongs to a command class that is recorded. Command auditing inserts the error description in the log, before the batch.

Classes of Commands Recorded by Command Auditing

Replication Server records all Replication Command Language data definition language (DDL) commands when you enable command auditing, except system information commands, such as the **admin** commands you use only to display information, and that you do not use to configure Replication Server.

For example, Replication Server records **alter route**, **configure replication server**, **connect**, **create connection**, **create partition**, **create user**, **grant**, **ignore loss**, **sysadmin sqm_purge_queue**, and **wait for create standby**, but does not record **admin config** and **admin sqm_readers**.

Command Auditing Configuration

You can configure command auditing to record the commands in the Replication Server log, which is the default destination, or in any other destination file you provide. Use **configure replication server** with **audit_enable** to set auditing on or off:

```
configure replication server
set audit_enable to {on|off}
```

Set **audit_enable** to on to enable command auditing. The default is off.

Optionally set **audit_dest** to specify the destination file for the command log:

```
configure replication server
set audit_dest to ['log'|'filename']
```

You can set **audit_dest** if **audit_enable** is on. The default value for **audit_dest** is **log**, which is the Replication Server log. Specify a file name and path for any other destination. Ensure that the owner has read and write permissions for any file you specify in **audit_dest**. In UNIX, Replication Server creates the log file with 0600 permissions if the file does not already exist. If you create your own log file in UNIX with different permissions such as 0666, Replication Server retains your permissions. For example, to log commands to `/tmp/RSaudit.log`:

```
configure replication server
set audit_dest to '/tmp/RSaudit.log'
```

Example Messages in the Command Auditing Log

In the log file, "AUDIT" precedes the corresponding command or user action.

- Command that executes successfully:

  ```
  I. 2012/03/29 02:30:23. AUDIT: incoming command (issued by sa):
  sysadmin site_version
  ```
- Command that fails to execute because the user lacks the required permissions:

  ```
  I. 2012/03/29 02:31:46. AUDIT Command failed: SA permission
  required for:
  I. 2012/03/29 02:31:46. AUDIT: incoming command (issued by user1):
  shutdown
  ```
- Command that fails to execute for other reasons:

  ```
  I. 2012/03/29 03:18:15. AUDIT The following command batch has one
  or more failures:
  I. 2012/03/29 03:18:15. AUDIT: incoming command (issued by sa):
  sysadmin badcommand
  ```
- User who started Replication Server on a UNIX platform –

  ```
  I. 2012/03/29 03:18:03. AUDIT: incoming command (issued by none):
  Repserver started by username: ny_admin1
  ```
- Failed login attempt to Replication Server –

  ```
  I. 2012/03/22 02:12:52. AUDIT: Failed login attempt for user sa
  ```
- A batch of commands that executes successfully:

  ```
  I. 2012/03/29 03:22:19. AUDIT: incoming command (issued by sa):
  create user user3 set password *********
  I. 2012/03/29 03:22:19. AUDIT: incoming command (issued by sa):
  sysadmin site_version
  ```
- A batch of commands with one command that fails to execute because the user lacks the required permissions:

  ```
  I. 2012/03/29 03:23:14. AUDIT Command failed: SA permission
  required for:
  I. 2012/03/29 03:23:14. AUDIT: incoming command (issued by user1):
  admin who
  I. 2012/03/29 03:23:14. AUDIT: incoming command (issued by user1):
  shutdown
  ```
- A batch of commands with at least one command that fails to execute for other reasons:

  ```
  I. 2012/03/29 03:24:08. AUDIT The following command batch has one
  or more failures:
  ```

```
I. 2012/03/29 03:24:08. AUDIT: incoming command (issued by sa):
sysadmin site_version
I. 2012/03/29 03:24:08. AUDIT: incoming command (issued by sa):
sysadmin badcommand
```

Security Recommendations

Recommendations for Replication Server security issues such as for performimg administrative tasks, SSL, encryption, permissions and roles, and the configuration file..

- As a best practice, perform administration tasks only on the local Replication Server host.
  By default, Replication Server does not prevent an administrator who knows the Replication Server host name and port number, from accessing and administering the Replication Server remotely.
- Wait for a master database transaction such as creating a new user or changing a password, to replicate successfully to all replicate Adaptive Servers before executing a user database transaction such as creating a table, that depends on the master database transaction.
  Replication Server maintains the transaction commit order for transactions executed within a single Adaptive Server database. However, Replication Server does not maintain such an order for transactions executed across multiple Adaptive Server databases. For example, at the primary Adaptive Server:
  - To create a master database transaction such as creating the mylogin user , use the sa user to enter:
    ```
    sp_addlogin 'mylogin', 'password'
    go
    use mydb
    go
    sp_adduser
    'mylogin'
    go
    ```
  - To create a user database transaction such as creating the `mytab` table with the mylogin user ID, enter:
    ```
    use mydb
    go
    create table mytab (mycol int)
    go
    ```

  It is possible for Replication Server to replicate the **create table** command before **sp_addlogin** procedure which causes the **create table** to fail on the replicate Adaptive Server because the mylogin user does not yet exist at the replicate database.
- Replication Server can use Secure Sockets Layer (SSL) to provide session-based security. SSL uses certificates issued by certificate authorities (CAs) to establish and verify identities.
  If a SSL certificate is compromised, you must request for a new certificate from the CA with a new Replication Server name and certificate number.
- The administrator should control permissions on the Replication Server log to provide monitor-only access to auditors. By default, any user that you create in Replication Server,

who has not been granted any roles, has monitor-only access to RSSD tables sufficient for a support role.

- Consider disk-level encryption for sensitive data in stable queues.

  Even with connectivity based on SSL between the primary and replicate databases and Replication Server, Replication Server must persist data temporarily in the stable queues, and this persisted data is not encrypted.
- SAP recommends that you use SSL for connections or routes that transmit sensitive data. The Replication Server Secure Sockets Layer (SSL) Advanced Security option provides session-based security.
- Replication Server stores initial configuration properties such as host name, port, user name, and password, in a file with the `.res` suffix that the **rs_init** utility uses. Set the appropriate umask permissions in UNIX or directory permission in Windows for the `.res` file, or delete the file if you do not require it.

  Although **rs_init** does not require the `.res` file after the initial configuration, Replication Server stores the file in the operating system file system protected only by the operating system permissions.

See also

- *Manage SSL Security* on page 272

Manage Replicated Tables

Learn the preparations, the procedures, and the specific commands used to set up manage replicate tables, table replication definitions, and publications.

You can copy data from one database to another in different ways depending on which method best suits the needs at your site:

- Using a single database replication definition that lets you choose whether or not to replicate individual tables, transactions, functions, system stored procedures, and data definition language (DDL). You can use multisite availability (MSA) for database replication.
- Using function replication definitions, where each one identifies a specific system stored procedure for replication.
- Using table replication definitions, where each one identifies a specific table for replication and, optionally, specifies a subset of columns to be replicated.

See also

- *Manage Replicated Objects Using Multisite Availability* on page 425
- *Manage Replicated Functions* on page 355

Introduction to Managing Replicated Tables

SAP Replication Server allows you to copy and update data from a table in one database—the primary—to a table in another database—the replicate.

Note: The primary database is also referred to as the “source.” The replicate database is also referred to as the “destination.”

To establish a table as the source, you create a replication definition that specifies the location of the data you want to copy and describes the structure of the table in which the data resides.

Before you copy data from the source table, you must also create a duplicate of the table in the destination data server. Then, in the SAP Replication Server that manages the destination table, you create a subscription to the replication definition. A subscription resembles a SQL **select** statement.

If you do not want to duplicate all of a table’s data, SAP Replication Server lets you specify a subset of columns to copy in the replication definition or use a **where** clause in the subscription to specify a subset of rows to receive.

You can include replication definitions for related tables and stored procedures in a publication and then create subscriptions against all of them as a group. When you use publications you can organize your subscriptions and monitor status information for all subscriptions in the group with a single command.

You can change the datatype of replicated values using the heterogeneous datatype support (HDS) feature. HDS allows you to translate the datatype of a replicated column value to a datatype acceptable to the replicate data server. You can use HDS in SAP environments, in non-SAP environments, and in mixed SAP and non-SAP data server environments.

See also

- *Manage Subscriptions* on page 373
- *Subscription Example* on page 405

Plan a Replication System

Planning a replication system includes considering the design, being aware of the restrictions on data replication, and preparing the replication system.

Design Considerations

There are several design considerations when you set a replication system.

When you set up a replication system, consider the following:

- Security, including user login names and passwords, permissions required for executing commands, and third-party security systems.
- Concurrency control; specifically, protecting your replication system from conflicts that may result from data being modified by one client when it is also being used by another. See *Replication Server Design Guide > Introduction > Transaction Management*.
- CPU, memory, disk, and network resources. See *Replication Server Design Guide > Capacity Planning*.
- Your replicated data model and routing scheme.
- Requirements for using heterogeneous data servers as data sources or data destinations. See *Replication Server Design Guide > Non-ASE Data Server Support*.
- Compatibility between Adaptive Servers and Replication Servers of different versions and restrictions on data replication.

For information about compatibility issues, see the release bulletin for your platform.

See also

- *Manage Replication Server Security* on page 207
- *Replication Server and Distributed Database Systems* on page 7
- *Routing Schemes* on page 143
- *Mixed-Version Replication Systems* on page 17

Restrictions on Data Replication

There are several restrictions when you design a replication system.

When you design your replication system, you should also consider these restrictions:

- Adaptive Server and Replication Server system tables cannot be copied during normal replication. However, the execution of supported commands and system procedures on certain system tables can be copied in warm standby applications. See *Replicated Information for Warm Standby* in the *Replication Server Administration Guide Volume 2*. In addition, some data is automatically copied between RSSDs in the replication system.
- Generally tables that you want to copy must have unique primary keys. With certain limitations, Replication Server supports the replication of a table to Adaptive Server even if the table does not have a unique key.
- Client applications should not update unique index or primary key columns in a way that a key could duplicate the key of another row. Because of the way Replication Server copies transactions, this type of update could result in duplicate rows or errors at replicate databases.

  For example, if `pk_col` is the primary key column for `table1`, the following command could cause errors or incorrect data at the replicate database:

  ```
  update table1
  set pk_col = pk_col + 1
  ```

  If there is a primary key or unique index constraint on the replicate table, the updates fail and the DSI thread for the replicate database is suspended.
- If a trigger is associated with a replicate table, do not put a commit statement inside the trigger. Triggers that contain commit statements at replicate sites may cause a duplicate key and make Replication Server recovery fail.
- Replication Servers of different versions can work together in the same replication system, but certain features may be restricted.
- Virtual computed columns cannot be replicated since Replication Agent cannot forward virtual columns to Replication Server, and Replication Server cannot insert or update virtual columns.
- When replicating encrypted columns which have:
  - Domain rules or check constraints defined on the columns, Replication Server bypasses the domain rules or check constraints for insert and update statements.
  - Access rules defined on the columns, Replication Server returns the 2929 error—“The access rule cannot be attached”—when processing **update**, **delete**, or **select** statements.

See also

- *Mixed-Version Replication Systems* on page 17
- *Replication of Tables Without Unique Keys* on page 287

Preparing a Replication System

There are several tasks to complete before you can replicate data.

1. Set up the replication system
   a) Install SAP Replication Servers. See the SAP Replication Server installation and configuration guides for your platform.
   b) Create the databases that will be the primary and replicate. See the *Adaptive Server Enterprise Reference Manual* or the documentation for your non-SAP database software.
   c) Establish connections from SAP Replication Servers to the primary and replicate databases. See the configuration guide for your platform.
   d) Establish all necessary routes between SAP Replication Servers.
   e) Configure and start up Replication Agents for source databases.
2. Verify that all replication system components are working. See *Verify and Monitor Replication Server* in the *Administration Guide Volume 2*.

See also

- *Create Database Connections* on page 170
- *Manage Routes* on page 141
- *Manage a Replication System* on page 59

Summary of Procedures for Replicating Tables

The replication procedure consists of several steps required to replicate data between tables using table replication definitions and subscriptions.

1. Plan your replication system and verify that you have prepared the replication system correctly.
2. Create the table as the Database Owner in the primary database, if it does not already exist, or, if there is a different table owner, specify the table owner name when you create the replication definition.
   - In Adaptive Server, use **create table** to create the table, or use **sp_help** to verify that the table exists.
   - If you are replicating data from a source other than Adaptive Server, create the table according to the instructions for your database software. Other data server steps in this procedure may vary for heterogeneous replication.
3. If your database supports stored procedures, you can execute **rs_send_repserver_cmd** in the primary database to create one or more replication definitions for the table from which you want to copy data. Otherwise, in the primary Replication Server, create one or more replication definitions. Each replication definition can be subscribed to by a different site that uses a different table view.

When you create replication definitions, anticipate the requirements for the subscribing table, as described in step 8. The replication definition may contain all or a subset of the columns in the source table. It may specify the same or different table names, owner names, column names, or datatypes for the source and destination tables. It may change the datatype of the replicated value.

4. If you are using publications, execute the following steps at the primary Replication Server.

   a) Create one or more publications for the tables you want to replicate using **create publication**.

   b) Create one or more *articles*, replication definition extensions, for each replication definition you want to include in the publication using **create article**. You can include a **where** clause to specify a subset of rows to send to the destination database.

   c) Validate the publications, using **validate publication**, so that you can create subscriptions against them.

5. Mark the primary table for replication.

In the primary Adaptive Server, use **sp_setreptable** to enable table replication. This step allows the RepAgent thread to forward transactions for the table to the primary Replication Server.

Note: For non-Adaptive Server primaries, see your Replication Agent documentation for instructions on marking tables and columns.

6. If the primary table contains `text`, `unitext`, `image`, or `rawobject` columns, you may need to use **sp_setrepcol** in the primary Adaptive Server to adjust the replication status for these columns.

Note: For non-Adaptive Server primaries, see your Replication Agent documentation for instructions.

7. Prepare a login name for the user creating the subscription. Login names that create subscriptions at replicate Replication Servers must also exist at the primary Replication Server.

8. In the replicate database, create a table that matches the schema published by the replication definition. Create the replicate table as the Database Owner or as the same table owner specified in the replication definition.

In Adaptive Server, use **create table** to create the table, or use **sp_help** to verify that the table exists.

The replicate table may have the same or different name and/or the same or different owner name as the primary table. It may contain all or a subset of the columns in the primary table, with the same or different column names or datatypes. The replication definition must specify any such differences between the primary and replicate tables.

Note: The replicate table may include a column that is not in the replication definition if the column accepts null values, has a defined default value, or you use a custom function string to apply a value to that column.

9. Grant the replicate database maintenance user login name **select**, **insert**, **delete**, and **update** permissions on the replicate table. The maintenance user executes commands for replicated transactions.

10. If necessary, customize your database operations using functions, function strings, and function-string classes. Replication Server function strings execute data server operations.

    See *Replication Server Administration Guide Volume 2 > Customizing Database Operations* for details.

11. Create a subscription in the replicate Replication Server. If you are using publications, proceed to step 12.

    Log in to a replicate Replication Server and create one or more subscriptions to the table replication definition for the data you want to copy. You can subscribe to all the rows in the replication definition's columns, or use a **where** clause to copy only certain rows.

    A replicate database can subscribe to multiple replication definitions of a primary table, but a replicate table can subscribe to only one replication definition of a primary table.

    When you create a subscription, the replicate table is filled in with the initial table data in a process called materialization. In most cases, Replication Server copies data into the replicate table automatically. You can also manually materialize the data.

12. If you are using publications, create a publication subscription against the publications created in step 4. Execute **create subscription** at the replicate Replication Server.

    When you create a publication subscription, Replication Server creates subscriptions against each article in the publication. Article subscriptions do not contain **where** clauses.

13. Check the subscription status.

    Verify that the subscription data has fully materialized in the replicate database and that transactions are replicating successfully.

See also

- *Specify Data for Replication* on page 30
- *Plan a Replication System* on page 280
- *Use the create replication definition Command* on page 293
- *Create Multiple Replication Definitions Per Table* on page 305
- *Use Publications* on page 341
- *Mark Tables for Replication* on page 307
- *Replicate text, unitext, image, and rawobject Columns* on page 314
- *Manage Subscriptions* on page 373
- *Manage Replication Server Security* on page 207

- *Publication Subscriptions* on page 416
- *Commands for Managing Function Replication Definitions* on page 358
- *Subscription Commands* on page 393
- *Subscription Example* on page 405
- *Preparing a Replication System* on page 282

Commands for Managing Table Replication Definitions

Replication Server provides commands and stored procedures to manage table replication definitions.

Table 25. Commands for Managing Table Replication Definitions

Command	Task
create replication definition	Creates a replication definition for a primary table, which describes the columns you want to copy, the location of the table, and other information.
alter replication definition	Modifies an existing replication definition in a variety of ways, including: • Adding or dropping columns • Add or drop primary keys • Add or drop searchable columns from the replication definition • Specifying different replicate table, table owner, column name, or datatype • Changing minimal column replication • Add or alter column-level datatype translations • Change `text`, `unitext`, `image`, or `rawobject` column replication status • Change how the replication definition is used in replicating to a standby database
drop replication definition	Removes a replication definition from the replication system. You must drop all subscriptions for a replication definition before you can drop the replication definition.
rs_send_repserver_cmd	Executes replication definition change requests directly at the primary database. You can use the **rs_send_repserver_cmd** stored procedure to execute the **create replication definition**, **alter replication definition**, and **drop replication definition** commands at the primary database.
admin verify_repserver_cmd	Verifies that Replication Server can successfully execute a replication definition change request.

See also

- *Create Replication Definitions* on page 286
- *Alter Replication Definitions* on page 326
- *Drop Replication Definitions* on page 338
- *Execute Replication Definition Changes Directly at the Primary Database* on page 328
- *Verify Replication Definition RCL Commands* on page 330
- *Using the Replication Definition Change Request Process* on page 331

Create Replication Definitions

A replication definition describes the primary table to Replication Server, specifying the columns you want to copy.

It may also describe attributes of the replicate table. Replicate tables that match the specified characteristics can subscribe to the replication definition. You can create multiple replication definitions for the same primary table, each customized for a particular use.

To create a replication definition, you can execute one of the following:

- **create replication definition** at the Replication Server managing the source table.
- **rs_send_repserver_cmd** with the **create replication definition** clause at the primary database when execute replication definition change requests directly at the primary database.

Information about each replication definition is sent to each qualifying Replication Server with a route from the primary Replication Server. There are restrictions in mixed-version systems.

Replication definitions are stored in the `rs_objects` and `rs_columns` system tables in the RSSD. The primary version of a replication definition resides at the primary Replication Server.

See also

- *Create Multiple Replication Definitions Per Table* on page 305
- *Use the create replication definition Command* on page 293
- *Execute Replication Definition Changes Directly at the Primary Database* on page 328
- *Replication Definition Restrictions in Mixed-Version Systems* on page 307

Replication Definition Settings

There are several pieces of information you require to create a replication definition.

Each replication definition must include the following information:

- The name of the replication definition.

- The names of the primary and replicate tables.

  Replication Server assumes that the replication definition name is the name of both the source and destination tables, unless you specify differently.

  To use table names containing spaces or special characters, enable quoted identifiers support.
- The name of the data server and database where the primary table is located.
- The column names and datatypes that you want to copy. You can copy all or a subset of the primary table's columns. The replicate column names and datatypes are the same as the primary column names and datatypes, unless you specify differently.

  To use column names containing spaces or special characters, enable quoted identifiers support.
- The primary key—one or more columns that uniquely identify each row in the source table.

  A primary key cannot include encrypted columns, or columns with `text`, `unitext`, `image`, `rawobject`, or `rawobject` in-row datatypes. See *Datatypes* in the *Replication Server Reference Manual* for datatypes that Replication Server supports.

Optionally, a replication definition may also include:

- The names of the owners of the primary and replicate tables. The default table owner is the Database Owner (dbo).
- The names of searchable columns—columns that can be specified in the **where** clause of a subscription to indicate the rows from the primary table to copy into the replicate table.
- For a warm standby application, whether to use the replication definition to copy data into a standby database and whether to copy all of the table's columns or just the columns in the definition's column list.
- Whether to copy only the minimal number of columns required for update and delete operations. This option may enhance overall system performance.
- Replication options for `text`, `unitext`, `image`, and `rawobject` columns.
- Column-level datatype translations.

Replication of Tables Without Unique Keys

With certain limitations, Replication Server supports the replication of a table to Adaptive Server even if the table does not have a unique key.

If a table does not have a unique key, it is possible that there are two or more rows with the same values. However, DSI shuts down if it cannot find a unique row to apply an operation. The **dsi_top1_enable** parameter instructs DSI to select and update only the first instance of multiple similar rows by setting *unsigned_integer* to 1 in the **top *unsigned_integer*** clause of the Adaptive Server **select** statement.

Set the **dsi_top1_enable** parameter to on to support replication of tables without unique keys. To set the parameter for:

- A specific connection to a replicate Adaptive Server database, enter:

```
alter connection to data_server.database set dsi_top1_enable to
{on | off}
```

- All replicate database connections to the Replication Server, enter:

  ```
  configure replication server set dsi_top1_enable to {on | off}
  ```

The default is off.

Do not use **configure replication server** to set **dsi_top1_enable** to on if there are connections to non-Adaptive Server replicate databases. Instead, use **alter connection** to set the parameter individually for each Adaptive Server replicate database connection.

During replication from supported databases into SAP HANA database, Replication Server supports the replication of LOB columns in a table without unique a key. See Replication of LOB Columns in a Table Without a Unique Key in the *Heterogeneous Replication Guide*.

Limitations

Replication Server does not support replication of a table without unique keys if:

- There is a Java object datatype in the table. See *Java Datatypes* in the*Replication Server Reference Manual*.
- There is a customized function string for the table.
- There is a table replication definition for the table.
- Transactions use updates and deletes with the **like** option in the **where** clause at the primary database.
- The replicate database is not Adaptive Server.

Quoted Identifiers

You can enable quoted identifier support for object names that need to be enclosed in double quote characters to be parsed correctly.

Quoted identifiers are object names that contain special characters such as spaces and nonalphanumeric characters, start with a character other than an alphabetic character, or that correspond to a reserved word, and need to be enclosed in double quote characters to be parsed correctly.

Enable quoted identifier support for the DSI for table and column names because the object names:

- contain special characters such as spaces and nonalphanumeric characters
- start with a character other than an alphabet
- correspond to a reserved word

To ensure that replication proceeds correctly for objects with quoted identifiers created in versions of Adaptive Server earlier than 15.7, update the Adaptive Server system catalog after you upgrade Adaptive Server, but before you restore replication. See *Updating the Adaptive Server System Catalog to Support Quoted Identifiers* in the *Replication Server Configuration Guide*.

Enable Quoted Identifiers Support

Use **create connection** or **alter connection** with **dsi_quoted_identifier** to enable quoted identifier support.

See the *Parameters Affecting Database Connections* table in **alter connection** in the *Replication Server Reference Manual* for the full command description.

Warning! If you set **dsi_quoted_identifier** to **on** for an Adaptive Server database connection , you must not include double quotes in any stored procedure you want to replicate. Otherwise, the DSI thread shuts down.

Data servers receive quoted identifiers differently. Adaptive Server and Microsoft SQL Server need a special connection set-up for quoted identifiers because they do not expect quoted identifiers. Oracle and UDB do not need a special connection to accept quoted identifiers.

Use **admin config** to check the value of **dsi_quoted_identifier**.

See also

- *Configuration Parameters Affecting Physical Database Connections* on page 177

System Function to Support Quoted Identifiers

The **rs_set_quoted_identifier** function string is added to set the DSI connection to Adaptive Server and Microsoft SQL Server.

When **dsi_quoted_identifier** is set to **on**, Replication Server sends the **rs_set_quoted_identifier** function string to the replicate database as part of the connection configuration when the connection is established. Replication Server uses this function string to allow quoted identifiers to be sent through the connection.

See *Replication Server Reference Manual > Replication Server System Functions >* ***rs_set_quoted_identifier*** and *Replication Server Administration Guide Volume 2 > Customize Database Operations > Working with Functions, Function Strings, and Classes > Summary of System Functions*.

Mark Identifiers as Quoted

Use the **create replication definition** or **alter replication definition** commands with the **quoted** parameter to mark identifiers as quoted identifiers.

When **dsi_quoted_identifier** is on for a replicate server connection and when **dsi_quoted_identifier** is subscribed to a replication definition that has identifiers marked as quoted identifiers, the marked identifiers are enclosed in double quotes.

When you set **dsi_quoted_identifier** to on and mark an identifier, the replicate database that subscribes to the replication definition receives the marked identifier as a quoted identifier. If **dsi_quoted_identifier** is off, the markings are ignored and the identifier sent to the replicate database is not enclosed in double quotes.

Note: When replicating to a warm standby database and to replication definition subscribers, and the primary table name is marked as quoted but the replicate table name is not, or vice-versa, Replication Server sends both the primary table name and the replicate table name as quoted.

Example 1

To create the **authors_repdef** table replication definition for the `authors` table with the `authors_col_1` column as a quoted identifier:

```
create replication definition authors_repdef
   with primary at primaryDS.primaryDB
   with all tables named "authors"
   ("authors_col_1" int quoted, "authors_col_2" int)
   primary key ("authors_col1")
```

Example 2

To mark as quoted the `authors` table:

```
alter replication definition authors_repdef
with replicate table named "authors" quoted
```

Example 3

To unmark the column `authors_col_1`:

```
alter replication definition repdef
with replicate table named "authors"
alter columns with "authors_col_1" not quoted
```

See **create replication definition** and **alter replication definition** in the *Replication Server Reference Manual* .

Quoted Identifiers Without Replication Definition Support

Replication Server can add quotes to all identifiers without checking whether the identifier is quoted in a replication definition or in the primary Adaptive Server database.

Setting the connection-level **dsi_quoted_identifier** to **on** enables quoted identifier support for primary tables only created in Adaptive Server 15.7.1 and later.

Setting the connection-level **dsi_quoted_identifier** to **always** automatically adds quotes to object names and ensures that replication continues for all primary data servers supported by Replication Server. Otherwise, the DSI connection to the replicate database can shut down and stop replication if Replication Server processes table names that are not quoted and not specified in a table replication definition with the **quoted** clause. See the *Replication Server Release Bulletin* for supported Adaptive Server versions and the *Replication Server Options Release Bulletin* for supported non-Adaptive Server data servers and versions.

We recommend that you to set connection-level **dsi_quoted_identifier** to **always** if you are using database replication definition. If there is any object that cannot work the with **always** value, set **table-level dsi_quoted_identifier** to an appropriate value for the object.

Example 1

To ensure that replication proceeds even if some table names are not quoted in the corresponding table replication definitions, set the **always** option for all tables for a new connection to the `rdb` replicate database in the NY_DS data server. At the replicate Replication Server, enter:

```
create connection to NY_DS.rdb
...
set dsi_quoted_identifier to always
...
go
```

Example 2

Ensure that replication proceeds for the `authors` table owned by Alice, for an existing connection to the `rdb` replicate database in the LON_DS data where the replication definition for `authors` might not have set the table name as quoted. At the replicate Replication Server, enter:

```
alter connection to LON_DS.rdb
for replicate table named alice.authors
set dsi_quoted_identifier to always
go
```

Quoted Identifier Replication at the Table Level

You can configure table-level **dsi_quoted_identifier** for an object to instruct Replication Server to replicate quoted objects correctly.

Suppose you perform table replication on a connection, where the connection-level **dsi_quoted_identifier** is **on** and subsequently you set up database replication on the same connection to replicate tables with quoted identifiers. This requires the connection-level **dsi_quoted_identifier** to be set to **always**. The existing table replication may fail because the table name and column names are all quoted. To make sure that the existing table replication is successful, set table-level **dsi_quoted_identifier** to **on** for the table.

The table-level **dsi_quoted_identifier** setting takes precedence over any existing connection-level **dsi_quoted_identifier** setting and the connection-level setting takes precedence over the server-level **dsi_quoted_identifier** setting.

If there are quoted identifiers in a primary table, to ensure replication proceeds correctly, you must create a table replication definition with the **quoted** clause and also set the connection-level **dsi_quoted_identifier** to **on**.

For example, to ensure replication proceeds even if the primary table "test quote" has quoted identifiers, create a table replication definition *repdef1* with the **quoted** clause and set the connection-level **dsi_quoted_identifier** to **on**.

```
create table "test quote" ("col1%##@" int, col2 char(10), primary
key("col1%##@"))
go
```

```
create replication definition repdef1
...
with all tables named "test quote" quoted
("col1%##@" int quoted, col2 char(10))
primary key("col1%##@")

alter connection to LON_DS.rdb
set dsi_quoted_identifier to 'on'
```

If there are quoted identifiers in a primary table and if you use **create subscription** with the **init replicate table** option for a table replication definition, you must set **dsi_quoted_identifer** to **always** and make sure that:

- The primary table name that you specify in the table replication definition must be the same as the table name in the primary database.
- The column name that you specify in the table replication definition is the same as the column name in the primary database.
- The owner name that you specify in the schema mapping is the same as the owner name in the primary database.
- All the identifiers (including the table name and column names) are quoted in the table replication definition if you plan to drop the table replication definition after you create a database replication.

For example, to ensure replication proceeds even if the primary table “test quote” has quoted identifiers, create a table replication definition *repdef1* with the **quoted** clause for all objects (tables and columns) and set **dsi_quoted_identifier** to **always**.

```
create table "test quote" ("col1%##@" int, col2 char(10), primary
key("col1%##@"))
go

create replication definition repdef1
...
with all tables named "test quote" quoted
("col1%##@" int quoted, col2 char(10) quoted)
primary key('col1%##@")

alter connection to LON_DS.rdb
set dsi_quoted_identifier to 'always'
```

Mixed-Version Restrictions

The quoted identifier feature is not supported in mixed version environments. For replication of a quoted identifier to succeed, the primary Replication Server and the Replication Server that connects to the replicate data server version must be version15.2 and later. However, intermediate Replication Servers in a route can be of lower versions.

Use the create replication definition Command

Use **create replication definition** to describe to Replication Server the characteristics of a table you want to replicate.

Execute **create replication definition** at the Replication Server that manages the source table database, or you can use the **rs_send_repserver_cmd** stored procedure with the **create replication definition** clause to execute replication definition change requests directly at the primary database.

A replication definition must include the name of the source data server and database.

This example shows how to create a basic replication definition named **publishers** for source and destination tables with the same name. The primary database is `pubs2` managed by the TOKYO_DS data server. All of the table columns are included and the `pub_id` column is specified as the primary key.

```
create replication definition publishers
with primary at TOKYO_DS.pubs2
(pub_id char(4), pub_name varchar(40),
city varchar(20), state char(2))
primary key (pub_id)
```

See *Replication Server Reference Manual > Replication Server Commands >* ***create replication definition*** for complete command syntax and usage guidelines.

See also

- *Execute Replication Definition Changes Directly at the Primary Database* on page 328

Specify the Replication Definition Name and Table Names

A replication definition has a global name space—that is, at every Replication Server with routes from the primary Replication Server, the name refers to the same replication definition.

Replication Server cannot always enforce the unique-name requirement when you enter **create replication definition**. You must ensure that there is no existing replication definition (table or function) with the same name when you create a new replication definition.

By default, the replication definition name is the name of *both* the source and destination tables.

In some instances, you may need to use different names for your source and destination tables, or different names for your tables and replication definitions. Include one of the optional clauses **with all tables named**, **with primary table named**, or **with replicate table named** to specify table names where they differ from the replication definition name.

When Source and Destination Tables Share the Same Name

When the source table and all destination tables share the same name but you want to give the replication definition a different name, use **with all tables named** to specify the table names.

For example, to create a replication definition named **publishers_rep** for source and destination tables named `publishers`, enter this command:

```
create replication definition publishers_rep
with primary at TOKYO_DS.pubs2
with all tables named publishers
...
```

When Source and Destination Tables Have Different Names

When the source table and any destination tables have different names, use **with primary table named** to specify the name of the source table, or use **with replicate table named** to specify the destination table name.

You can use one of these clauses or both of them together.

If you do not specify different table names, the replication definition name is assumed by Replication Server to be the name of *both* the source and destination tables.

For example, to create a replication definition named **publishers_rep** for a source table named `publishers1` and destination tables named `publishers2`, enter:

```
create replication definition publishers_rep
with primary at TOKYO_DS.pubs2
with primary table named publishers1
with replicate table named publishers2
...
```

For a replication definition and a source table named `publishers`, and destination tables named `publishers2`, enter:

```
create replication definition publishers
with primary at TOKYO_DS.pubs2
with replicate table named publishers2
...
```

In this example, the **publishers** replication definition also becomes the source table's name.

Specify the Name of the Source or Destination Table Owner

You can specify the table owner's name as an optional qualifier along with the name of the source or destination table. Data server operations may fail if the table owner does not correspond to what is specified in the replication definition.

For example, to create a replication definition for the `publishers` source table and the `publishers2` destination table owned by the user "ravi," enter:

```
create replication definition publishers
with primary at TOKYO_DS.pubs2
with replicate table named ravi.publishers2
...
```

Specify Column Names and Datatypes

When you create a replication definition, list the names and datatypes of the columns from the table that you want to copy.

A column's name and datatype will be the same in the replicate table as in the primary table unless you specify a different replicate (published) column name or datatype.

Enclose the names of all of the columns and their datatypes in parentheses. For multiple columns, separate each column and its datatype from the next column with a comma.

For example, the following command creates a replication definition named **publishers_rep1** for source and destination tables named `publishers`. It includes all the columns and their datatypes.

```
create replication definition publishers_rep1
with primary at TOKYO_DS.pubs2
with all tables named publishers
(pub_id char(4),
pub_name varchar(40),
city varchar(20),
state char(2))
primary key (pub_id)
```

The following command creates a replication definition named **publishers_rep2** that omits the `city` column. Destination sites that do not require this column can subscribe to this replication definition.

```
create replication definition publishers_rep2
with primary at TOKYO_DS.pubs2
with all tables named publishers
(pub_id char(4),
pub_name varchar(40),
state char(2))
primary key (pub_id)
```

Performance is best if columns are listed in the same order in the replication definition as in the tables themselves.

You can use only native and user defined datatypes supported by Replication Server. If a primary table has columns with user-defined datatypes, you must use a compatible supported datatype in the replication definition. You can also employ user-defined datatypes supplied with Replication Server as part of the installation process.

See *Replication Server Reference Manual > Topics > Datatypes* for complete details on the datatypes supported by Replication Server.

When Source and Destination Columns Have Different Names

When you want only one replication definition for a source table, and the source column names differ from their destination counterparts, use the *column_name* **as** *replicate_column_name* clause in the replication definition.

For example, for a source table named `publishers1` and a destination table named `publishers2`, where the source column `pub1_name` corresponds to the destination column `pub2_name`, enter this:

```
create replication definition publishers_rep
with primary at TOKYO_DS.pubs2
with primary table named publishers1
with replicate table named publishers2
(pub_id char(4),
pub1_name as pub2_name varchar(40),
city varchar(20),
state char(2))
primary key (pub_id)
```

Datatypes in Multiple Primary Table Replication Definitions

When you create multiple replication definitions for the same source table, the declared column datatype (the column datatype in the primary table) must be the same, except when the column's datatype is `rawobject` or `rawobject in row`, which correspond respectively to the `image` and `varbinary` datatypes.

Specifically you can:

- Declare a column's datatype as `rawobject` in one replication definition, but declare the same column's datatype as `image` in another replication definition for the same table
- Declare a column's datatype as `rawobject in row` in one replication definition, but declare the same column's datatype as `varbinary` in another replication definition for the same table

The replicate (published) column datatype can be different between replication definitions for the same table, with no restrictions.

When a column is listed in an existing replication definition for a primary table, specifying the column datatype is optional in subsequent replication definitions for the same primary table —the datatype is inherited from the previous replication definition and retained for the subsequent definition, even if the first definition (where you specified the datatype) is dropped.

To change a column datatype, use the **alter replication definition** command.

See also

- *Alter Column Datatypes* on page 337

Additional Columns in the Replicate Table

The replicate table may include a column that is not in the replication definition if the column has a defined default value or you use a custom function string to apply a value to that column.

Columns can be specified to accept null values in **create table**. When source rows are copied to the destination table, extra columns are filled with null values or may be updated separately by the local data server.

Include text , unitext, image, and java Columns

To copy `text`, `unitext`, `image`, or the Java datatypes `rawobject` and `rawobject in row` column data to any destination site, include those columns in the replication definition.

Replicating `text`, `unitext`, `image`, or Java columns involves additional special procedures and considerations.

See also

- *Replicate text, unitext, image, and rawobject Columns* on page 314
- *Java Datatypes in Replication Server* on page 311

Use Special Datatypes

To distribute updates to particular sites, use the `rs_address` special datatype with bitmap subscriptions.

You can use the `identity` special datatype if the table you are copying contains an `identity` column.

You can also use the `timestamp` special datatype if the table you are copying contains a `timestamp` column.

See also

- *Bitmap Subscriptions* on page 410
- *Replicate identity Columns* on page 323
- *Replicate timestamp Columns* on page 324
- *Using the rs_address Datatype* on page 323

Use User-defined Datatypes

To change the datatype of the replicated value at the primary database to a datatype acceptable to the replicate database, use the **map to** clause of the **create replication definition** command.

See also

- *Translate Datatypes Using HDS* on page 349

Specify the Primary key

The primary key is the column or combination of columns that uniquely identifies each row.

Although many data servers, including Adaptive Server, allow tables that contain duplicate rows, Replication Server requires that the source and destination tables have unique values for the primary key columns in each row.

You must include the **primary key** clause in **create replication definition** to identify the primary key columns in the source table. Primary key columns must also be included in the column list.

When Replication Server applies the default **rs_update** or **rs_delete** function string at a destination site, it specifies values for the primary key in the **where** clause of the update or delete statement.

Enclose the names of the primary key columns in parentheses. For example:

```
create replication definition publishers
with primary at TOKYO_DS.pubs2
(pub_id char(4), pub_name varchar(40),
city varchar(20), state char(2))
primary key (pub_id)
```

For multiple primary key columns, separate each column from the next with a comma.

Note: You cannot include columns of `text`, `unitext`, `image`, `rawobject`, `rawobject in row`, or `rs_address` datatypes as part of the primary key.

Specify Searchable Columns

Use **searchable columns** in **create replication definition** to specify which columns to use in the **where** clause of **create subscription** or **define subscription** (or **create article** for publications) to restrict the rows copied to a subscribing site.

If you do not include a **searchable columns** clause in a replication definition, you cannot use a **where** clause in a subscription or article that references that replication definition.

Enclose the names of the searchable columns in parentheses. For multiple searchable columns, separate each column from the next with a comma.

In the following example, three columns, `pub_id`, `pub_name`, and `state`, are specified as searchable columns. You can include any of these columns in a subscription's **where** clause.

```
create replication definition publishers
with primary at TOKYO_DS.pubs2
(pub_id char(4), pub_name varchar(40),
city varchar(20), state char(2))
primary key (pub_id)
searchable columns (pub_id, pub_name, state)
```

See also

- *Use the where Clause* on page 395

Restrictions on Searchable Columns

Searchable columns have several restrictions.

Searchable columns have these restrictions:

- You cannot specify `text`, `unitext`, `image`, or Java `rawobject` or `rawobject in row` columns as searchable columns.
- Columns included in the **searchable columns** clause cannot have null values.
- To perform bitmap comparison using the **where** clause in the subscription, you must include any columns that use the `rs_address` datatype in the replication definition's **searchable columns** clause.
- The more searchable columns in the **searchable columns** list of a replication definition, the slower Replication Server processes subscriptions; that is, the fewer searchable columns, the more efficiently Replication Server evaluates rows against subscriptions for the table.

See also

- *Using the rs_address Datatype* on page 323

Replicate the Minimal Set of Columns

To enhance replication system performance, specify **replicate minimal columns** in **create replication definition**. This clause lets you send only those columns that are required for delete and update operations to replicate databases.

Normally, Replication Server sends all the columns in each row when applying updates and deletes, as well as inserts, in each replicate database. Replication Server normally sends maximum columns to the standby database—if replication definitions are not used for the table or the replication definitions are not used for the standby connection.

Note: You must send all columns when replicating to SQL Remote databases. Do not send minimal columns or replication will fail.

When you set **replicate minimal columns**:

- For a **delete** operation, the source Replication Server sends only the primary key columns to destination Replication Servers or the standby database.
- For an **update** operation, the source Replication Server sends only the columns modified by the update operation and the primary key columns, to destination Replication Servers or the standby database.

Note: replicate minimal columns does not apply to insert operations, for which all columns are copied.

A destination Replication Server uses the primary key columns in constructing the data server commands that it applies to the replicate or the standby database.

The following replication definition includes **replicate minimal columns**:

```
create replication definition publishers
with primary at TOKYO_DS.pubs2
(pub_id char(4), pub_name varchar(40),
city varchar(20), state char(2))
primary key (pub_id)
replicate minimal columns
```

Change Minimal Columns Setting

Use **alter replication definition** to change an existing replication definition to replicate only the minimal set of columns or to replicate all columns.

Minimal Columns and rs_update and rs_delete Function Strings

If you specify **replicate minimal columns** and need to create non-default **rs_update** and **rs_delete** function strings, use the *rs_default_fs* function string variable to represent the default function string behavior.

See *Replication Server Administration Guide Volume 2 > Customize Database Operations > Use the Default System Variable* for details.

Minimal Columns and Autocorrection

If you specify **replicate minimal columns,** you cannot also specify autocorrection, which corrects discrepancies that may occur during materialization by converting each **update** or **insert** operation into a **delete** followed by an **insert**.

If you set autocorrection on before you specify minimal columns (for example, using **alter replication definition**), autocorrection is not performed. Replication Server logs informational messages for any update operations.

You must set autocorrection on when you create a subscription using nonatomic materialization. If minimal column replication is set for the replication definition and you create a new subscription that uses nonatomic materialization or the bulk materialization method that simulates nonatomic materialization, autocorrection cannot resolve inconsistencies.

See also

- *Autocorrection for Nonatomic Materialization* on page 377
- *Subscription Materialization Methods* on page 374

Use Replication Definitions with Warm Standby Applications

You do not need to use replication definitions with warm standby applications. However, you can use them to control the flow of information to the standby database—even though no subscriptions are needed.

You can create replication definitions just for replication to the standby database or use existing replication definitions for this purpose.

Use **send standby** in **create replication definition** as follows:

- Use **send standby** in any form to replicate transaction data into the standby database using this replication definition. Replication Server uses the replication definition's primary key and minimal columns setting.
- Use **send standby** or **send standby all columns** to send all columns in the table to a standby database.
- Use **send standby replication definition columns** to send only the columns specified in the replication definition to a standby database.

If you omit **send standby**, another replication definition may be used in replicating data for this table to the standby database, or no replication definition may be used.

The replication definition in the following example replicates transactions to a standby database. The primary key and minimal set of columns settings will be used in standby replication. Only the columns specified in the replication definition will be replicated into the standby database—the `city` column is omitted from this replication definition.

```
create replication definition publishers_ws
with primary at LDS.pubs2
with all tables named 'publishers'
(pub_id char(4),
pub_name varchar(40),
state char(2))
primary key (pub_id)
send standby replication definition columns
replicate minimal columns
```

If a replication definition already exists for the same primary table and is marked for use by the standby, creating a new replication definition using **send standby** (or altering another replication definition) unmarks the previous replication definition as being used by the standby.

See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications > Use Replication Definitions and Subscriptions* for more information about using replication definitions with warm standby applications.

See also

- *Specify the Primary key* on page 298
- *Replicate the Minimal Set of Columns* on page 299

Specify text, unitext, and image Column Replication

There are several requirements if you want to create a replication definition for a table that contains `text`, `unitext`, or `image` columns datatypes.

You must:

- Include each `text`, `unitext`, or `image` column that you want to replicate in the column list, and
- Include each column in the optional clauses **replicate_if_changed** or **always_replicate**.

In each clause, enclose the names of the `text` and `image` columns in parentheses. For multiple columns, separate each column from the next with a comma.

- Ensure that each `text`, `unitext`, or `image` column has a corresponding status in Adaptive Server.

See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications > What Information is Replicated for ASE Warm Standby Application? > Replicate text, unitext, image, and rawobject Data*.

See also

- *Replicate text, unitext, image, and rawobject Columns* on page 314

Specify Computed Column Replication

To create a replication definition for a computed columns use the base column datatype in the replication definition for materialized columns. Do not include virtual columns in the replication definition.

Specify rawobject and rawobject in row Column Replication

You can include Java columns in a replication definition. Replication Server replicates Java columns as either `rawobject` or `rawobject in row` datatypes.

To create a replication definition for a table that contains Java datatypes:

- Include each `rawobject` or `rawobject in row` column that you want to replicate in the column list, and
- Include each `rawobject` column in the optional clauses: **replicate_if_changed** or **always_replicate**.

  In each clause, enclose the names of the `rawobject` columns in parentheses. For multiple columns, separate each column from the next with a comma.

  Note: `rawobject in row` columns do not have replication status.
- Ensure that each `rawobject` column has a corresponding status in Adaptive Server.

See also

- *Replicate text, unitext, image, and rawobject Columns* on page 314

Specify Column-level Datatype Translations

You can specify column-level datatype translations in the replication definition.

SAP provides a set of datatype definitions that you install using instructions from the *Replication Server Configuration Guide* for your platform.

- The *declared_datatype* defines the datatype of the value delivered to the Replication Server from the Replication Agent.

- The *published_datatype* defines the datatype of the value after a column-level translation. If there is no column level translation defined using the **map to** clause of the replication definition, then the published datatype defaults to the declared datatype.
- The *delivered datatype* is the datatype of the value as delivered to the replicate database. This may be different from the published datatype if there are class level translations defined for the function-string class used for the replicate data server's connection. If there is no class level translation defined, then the delivered datatype defaults to the published datatype.

See also

- *Translate Datatypes Using HDS* on page 349

Create Replication Definitions Using Extended Limits

SAP Replication Server version 12.5 and later can replicate wider columns, wider parameters, and larger numbers of columns than earlier versions. It can also handle wider data rows and wider messages.

SAP Replication Server supports the extended limits capabilities of SAP ASE version 12.5 and later. See the SAP ASE documentation for more information. For information about using SAP Replication Server extended limits with non-SAP data servers, see the documentation for your SAP Replication Agent and the *Heterogeneous Guide*.

Before You Use Extended Limits

To use extended limits, ensure that the site, route, and Adaptive Server version are upgraded to the supported version level.

To use extended limits, make sure that both the primary and replicate Replication Server are upgraded to site version 12.5 or later, which automatically sets the LTL version to 400. In addition, make sure that all routes using extended limits are set to 12.5 or later. If you are using Adaptive Server, make sure that both the primary and replicate databases are set to version 12.5 or later. Both the primary and replicate databases must be configured for the same page size.

See the Replication Server white paper “Using Adaptive Server Enterprise version 12.5 with Replication Server version 12.1 and earlier: Schema-length and compatibility issues.”

See also

- *Replication Definition Restrictions in Mixed-Version Systems* on page 307

Use Extended Limits

You can create replication definitions using extended limits for both replicate and standby databases.

Extended limits are defined as:

- Wide columns – data rows containing more than 255 to a maximum of 32768 bytes.
- More columns – replication definitions containing more than 250 columns in a replication definition.
- Wide data – data rows up to the size of the data page on the data server. Adaptive Server version 12.5 and later supports page sizes of 2K, 4K, 8K, and 16K.
- Wide messages – messages larger than 16K.

Wide Columns

Replication Server can replicate wide columns containing `char`, `varchar`, `binary`, `univarchar`, `unichar`, `unitext` or Java `inrow` data to a maximum of 32768 bytes. Maximum column width on each system may vary; it is a function of the total number of columns and the page size of the data server.

You can use wide columns as primary keys and searchable columns and in replication definition **where** clauses.

Note: The maximum number of bytes in the **where** clause of a subscription or article is 255 bytes. You cannot use wide columns in the **where** clause of subscriptions or articles.

More Columns

There is no explicit limit on the number of columns in a replication definition. Replication Server does not limit the number of primary key or searchable columns.

Replication Server uses primary key columns to build **where** clauses of SQL statements for the data server. Consider data server limitations when determining the actual number of columns available for primary keys in replication definitions.

Similarly, although Replication Server imposes no limits on the number of searchable columns in a replication definition, the number of columns in the **where** clause of a subscription or article may also be constrained by data server limitations.

Wide Data

Data rows can equal the size of the data page on the data server. Adaptive Server version 12.5 and later supports page sizes of 2K, 4K, 8K, and 16K.

Wide Messages

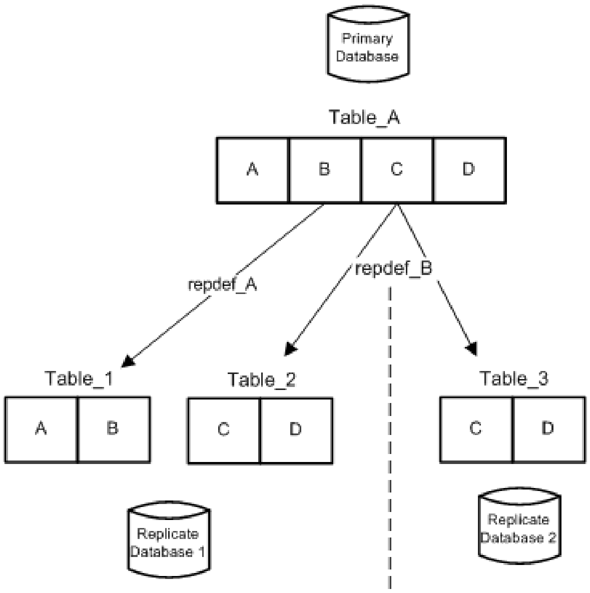
Replication Server copies data rows as messages in stable queues manage by the SQM. These messages contain before and after images of replicated data rows as well as other information. They require significantly more space than the data rows on which they are based. With extended limits, messages can span blocks and are no longer limited to 16K.

Create Multiple Replication Definitions Per Table

You can create multiple replication definitions for the same primary table and customize each one so that it can be subscribed to by a replicate table whose characteristics are different from those of the primary table or from other replicate tables.

For example, you can create two separate replication definitions for the same primary table, one that replicates columns A and B, and another that replicates columns C and D. Each subscribing site receives only the columns that it needs as illustrated in the "Using Multiple Replication Definitions from One Primary Table" figure.

Figure 18: Using Multiple Replication Definitions from One Primary Table



In addition to describing the primary table, each replication definition can specify a smaller number of columns, different column names, different published datatypes, or a different table name for a replicate table. Replicate tables that match the specified characteristics can subscribe to the replication definition.

Different replication definitions created for the same primary table must use the same declared column datatype (unless the datatype is `rawobject` or `rawobject in row`) and the same **null** and **not null** status for `text`, `unitext`, and `image` columns. Use **alter replication definition** to alter a column's datatype or null status.

You can change replication status using **alter replication definition**. For example, you can change the replication status of `text`, `unitext`, and `image` columns from **replicate_if_changed** to **always_replicate**. The replication status for the column will also change for other replication definitions for the same primary table.

See also

- *Alter Column Datatypes* on page 337

Restrictions to Multiple Replication Definitions

There are restrictions that apply when you have multiple replication definitions for the same primary table.

- A replicate database can subscribe to multiple replication definitions. However, a replicate table can subscribe to only one replication definition of a particular primary table.
- A pre-version 12.0 Replication Server may not subscribe to replication definitions that either declare columns with User-Defined Datatypes or employ column-level translations.
- Different replication definitions created for the same primary table must use the same column datatype (unless the datatype is `rawobject` or `rawobject in row`) and, for `text`, `unitext`, `image`, and `rawobject` columns, the same **null** or **not null** status and the same replication status.
- You cannot create multiple replication definitions for a single primary stored procedure.
- Multiple replication definitions for one primary table are only supported in Replication Server version 11.5 and later; however, one replication definition can be marked and propagated to a Replication Server of a previous version, if compatible; that is, has the same primary and replicate table names, same primary and replicate column names, and does not include table owner name.

See also

- *Specify Column Names and Datatypes* on page 295
- *Replication Definition Restrictions in Mixed-Version Systems* on page 307

Replication Definitions and Function Strings

Function strings map Replication Server functions to data server commands for execution in a database.

For each replication definition, the primary Replication Server creates default function strings for the system functions with replication definition scope (**rs_insert**, **rs_update**, **rs_delete**, **rs_select**, and so on). These function strings are distributed with the replication definition to other qualifying Replication Servers with routes from the primary Replication Server.

Some circumstances may require you to create the function strings for system functions (that is, Replication Server does not create them for you).

See *Replication Server Administration Guide Volume 2 > Customize Database Operations* for details on function strings and function-string classes.

See also

- *Specify Database Operations* on page 47

Replication Definition Restrictions in Mixed-Version Systems

There are several restrictions on replication definitions in mixed-version systems.

- If you create or alter a replication definition that includes an identifier longer than 30 characters, only Replication Server 15.0 or later can subscribe to that replication definition.
- After you upgrade a Replication Server to version 15.5 or later, you can only create, alter, or drop replication definitions if the site version is 1550 or later.
- If you execute **alter replication definition** to drop some columns from the replication definition, and there is a subscription to the replication definition from a replicate site with a site version earlier than 1550, the primary Replication Server rejects the **alter replication definition** command.
- Issuing any **alter replication definition** request with the **with DSI_suspended** parameter does not suspend any replicate DSI with site versions earlier than 1550.

See also

- *Mixed-Version Replication Systems* on page 17

Mark Tables for Replication

After you create a replication definition for the table, use **sp_setreptable** to mark the table for replication.

After a table is marked for replication, SAP ASE RepAgent begins forwarding the table's log records to the SAP Replication Server. If you have marked a table for replication, you do not need to mark it again for another replication definition.

Note: Refer to your Replication Agent documentation for instructions on marking tables for replication in non-SAP data servers.

See also

- *Subscription Example* on page 405

Use the sp_setreptable System Procedure

To use **sp_setreptable**, you must be the Database Owner or the System Administrator for the data server.

See *Replication Server Reference Manual > Adaptive Server Commands and System Procedures* for more information about **sp_setreptable** command.

Enable Replication

To designate a primary Adaptive Server table for replication, use **sp_setreptable**.

Log in to the Adaptive Server managing the database for that table and enter:

```
sp_setreptable table_name, 'true'
```

Marking the table in this way specifies that the table name must be unique.

Note: Do not mark a table for replication unless you also create a replication definition for the table in the Replication Server managing that database. The RepAgent will begin forwarding to the Replication Server data for transactions for the affected table. If a replication definition does not exist, Replication Server may report message 32032 and its error log file may fill up. In addition, Replication Server performance may be significantly reduced. Warm standby applications, which do not require replication definitions, are not subject to this problem.

Check Replication Status

You can use **sp_setreptable** to check the replication status for a table or all tables in the database.

To check replication status for the table, enter:

```
sp_setreptable table_name
```

To check replication status for all tables in the database, enter:

```
sp_setreptable
```

Enable SQL Statement Replication

Use **sp_setrepdefmode** to enable and configure SQL statement replication.

sp_setrepdefmode includes options to:

- Enable or disable SQL statement replication for a specific DML operation
- Configure the threshold that must be reached to activate SQL statement replication

The DML operations that apply to SQL statement replication include:

- **U** – update
- **D** – delete
- **I** – insert select

When the table replication mode is set to any combination of **UDI** the RepAgent sends additional information to enable SQL statement replication for the specified DML operation.

For example, to enable SQL statement replication for **update**, **delete** and **insert select** operations on table `t`, enter:

```
sp_setrepdefmode t, 'UDI', 'on'
go
```

See *Replication Server Administration Guide Volume 2 > Performance Tuning > SQL Statement Replication*.

Enable Replication with owner_on Status

User tables may have the same name but different owners. SAP ASE allows you to mark a table for replication and specify that table owner information should be considered when identifying the table.

To mark the table for replication with the “owner on” status, log in to SAP ASE and enter:

```
sp_setreptable table_name, 'true', owner_on
```

At the SAP Replication Server, the replication definition for the table must identify the table owner. For example, if you set owner status for a table to “owner on” with **sp_setreptable**, you must include an owner name when you create the replication definition or SAP Replication Server will be unable to find the correct table at the replicate database.

The owner of the source table and the owner of the destination table can be different.

Note: If you specify “owner off” status for a table, SAP Replication Server does not send table owner information to the replicate site. However, if you are replicating to a standby database, SAP Replication Server sends “dbo” as the table owner.

See the Replication Agent documentation to see if your non-SAP data server allows user tables with the same name but different owners.

Modify the Owner Status of a Table

You can use the **sp_setrepdefmode** system procedure to change the owner status of a table previously marked for replication.

To change the status of a table already marked for replication to “owner on,” log in to Adaptive Server and enter:

```
sp_setrepdefmode table_name, owner_on
```

To change the status of a table already marked for replication to "owner off," log in to Adaptive Server and enter:

```
sp_setrepdefmode table_name, owner_off
```

You must reflect a change in owner status by including owner information in the replication definition. Use **create replication definition** at the Replication Server to create a new replication definition that includes the table owner.

Check the Owner Status of a Table

You can use the **sp_setreptable** system procedure to check the owner status of a table.

Enter:

```
sp_setreptable table_name
```

Disable Replication

Use **sp_setreptable** with the **false** parameter to turn off replication for the table.

```
sp_setreptable table_name, 'false'
```

See the Replication Agent documentation for instructions on disabling replication in non-SAP data servers.

Replicate Java Columns

You can replicate Java columns stored in your primary database to your standby and replicate databases.

Replication Server passes Java objects through the replication system in serialized format without altering the Java objects in any way. See *Java in Adaptive Server Enterprise* for complete information about Java classes in the Adaptive Server database.

Restrictions to Replicating Java Columns

Although you prepare replication definitions and subscriptions for Java columns in the usual manner, be aware of the restrictions that apply.

- Both the primary and replicate databases must be SAP ASE version 12.0 or later.
- SAP Replication Server does not replicate stored procedures that have Java objects as parameters. However, the effect of such a stored procedure can be duplicated through normal table replication.
- You cannot use Java columns as part of the primary key.
- You cannot evaluate Java columns in subscription expressions because Java columns are not searchable.

Upgrade Considerations

After you have upgraded the current Replication Server and set its site version to the current release, use **sysadmin upgrade, "route"** to copy the replication definitions with Java columns from upstream Replication Servers to the current Replication Server.

Although Replication Server does not propagate replication definitions with Java columns to pre-12.0 version Replication Servers, you can replicate Java columns to older Replication Servers by manipulating function strings.

See also

- *Using Function Strings to Replicate Java Columns to Older Replication Servers* on page 312

Java Datatypes in Replication Server

Java columns pass through the replication system as one of two Replication Server datatypes.

- As `rawobject`, in which the information is stored in the database in a separate location in the same way that `image` data is stored. The base datatype of `rawobject` is `image`. This is the default datatype for Java columns in Replication Server. Replication Server handles `rawobject` data in the same way it handles `image` data.
- As `rawobject in row`, in which the information is stored in the database on consecutive data pages allocated to the table in the same way that, for example, `char` data is stored. The base datatype of `rawobject in row` is `varbinary(255)`. Replication Server handles `rawobject in row` data in the same way it handles `varbinary(255)` data.

`rawobject` and `rawobject in row` are compatible only with their base datatypes. They are not compatible with each other; that is, you cannot replicate `rawobject` to `rawobject in row` or vice versa.

The Replication Server reconciliation utility **rs_subcmp** treats Java datatypes as their base datatypes. See *Replication Server Reference Manual > Executable Programs >* ***rs_subcmp*** .

See also

- *Replicate text, unitext, image, and rawobject Columns* on page 314

Create Replication Definitions for Java Columns

You can create replication definitions for Java columns using **create replication definition** and the `rawobject` and `rawobject in row` datatypes.

When creating a replication definition:

- `rawobject` values have replication status. You can choose whether they are always replicated or replicated only if changed. They also have null status.
- `rawobject in row` values do not have replication or null status.

`rawobject` and `rawobject in row` values:

- Cannot be part of the primary key.
- Cannot be evaluated in subscription expressions. Java columns are not searchable, and thus they cannot be used in a subscription or article **where** clause.

This example creates a sample replication definition **p1** for a table `t` that contains Java columns.

```
create replication definition p1
    with primary at ds.db
    with all tables name t
      (c1 int,
      c2 rawobject null,
      c3 rawobject not null,
      c4 rawobject in row)
    primary key (c1)
    replicate_if_changed (c2)
    always_replicate (c3)
```

Columns `c2` and `c3` are `rawobject` columns; they have replication and null status. Column `c4` is a `rawobject in row` column; it does not have replication or null status. Columns `c2`, `c3`, and `c4` are neither part of the primary key nor are they searchable.

See also

- *Replicate text, unitext, image, and rawobject Columns* on page 314

Function Strings for Java Columns

Replication Server uses the **rs_raw_object_serialization** function string to pass Java columns to the replicate database in serialized format, which allows Replication Server to update Java columns directly.

rs_raw_object_serialization is contained in **rs_sqlserver_function_class** and **rs_default_function_class**.

When a replication definition references the `rawobject` datatype, Replication Server creates **rs_get_textptr**, **rs_textptr_init**, **rs_datarow_for_writetext**, and **rs_writetext** function strings for each `rawobject` column just as it does for `image` data.

Using Function Strings to Replicate Java Columns to Older Replication Servers

Replication Server version 12.0 does not propagate replication definitions with Java datatypes to pre-12.0 Replication Servers. However, you can replicate Java columns through older Replication Servers if you use the corresponding base datatype (`image` and `varbinary(255)`) and manipulate the **rs_usedb** and **rs_insert** function strings.

The following example illustrates the method.

1. Create tables containing Java columns in the primary and replicate databases:

   ```
   create table tInfo
       (c1 integer,
       c2 Name rawobject in row,
       c3 Address rawobject null,
       c4 AccountInfo rawobject not null)
   ```

   `Name`, `Address`, and `AccountInfo` are Java classes; `c2`, `c3`, and `c4` are Java columns.
2. Create a replication definition for table `tInfo`.

   If at least one of the Replication Server is pre-12.0, you must create a replication definition using the base datatypes for `rawobject in row` (`varbinary(255)`) and `rawobject` (`image`):

```
create replication definition tInfo1
with primary at DS-1.dbase
with all tables name tInfo
(c1 integer,
c2 varbinary(255),
c3 image null,
c4 image not null,
primary key (c1)
...
```

If the primary and replicate databases are managed by Replication Servers version 12.0 or later, a replication definition could be:

```
create replication definition tInfo
with primary at DS-1.dbase
with all tables named tInfo
    (c1 integer,
    c2 rawobject in row,
    c3 rawobject null,
    c4 rawobject not null)
    primary key (c1)
    ...
```

3. Alter the **rs_usedb** and **rs_insert** function strings for both the primary and replicate database connections. See *Replication Server Administration Guide Volume 2 > Customize Database Operations > Manage Function Strings > Alter Function Strings* .

   - For **rs_usedb**:

     ```
     alter function string rs_usedb
     for function_string_class_name
     output language
     'use ?rs_destination_db!sys_raw? set
     raw_object_serialization on'
     ```

     This change tells Adaptive Server to return Java column data as serialized binary values at subscription materialization. It also allows Replication Server to insert and update Java columns with serialized binary values.
   - For **rs_insert**:

     ```
     alter function string tInfo1.rs_insert
     for function_string_class_name
     output language
     'insert tInfo(c1, c2, c4)
     values (?c1!new?, ?c2!new?, 0xaced000574000130)'
     ```

     This change alters **rs_insert** for **tInfo1** to insert the special binary value 0xaced000574000130 in column `c4`. If you do not alter **rs_insert**, the default value may cause Adaptive Server to return a serialization error.

So, you can create two replication definitions for the same table where the columns between the two replication definitions have different primary (declared) datatypes. If the primary Replication Server is version 12.0 or later, you can create both replication definitions **tInfo** and **tInfo1** for table `tInfo`. In this case, replicate Replication Servers version 12.0 and later can subscribe to **tInfo** and Replication Servers version pre-12.0 can subscribe to **tInfo1**.

Note: You cannot use this method to replicate Java columns to standby databases. The standby connection uses the function-string class **rs_default_function_class**, which cannot be altered.

Replicate text, unitext, image, and rawobject Columns

Replication Server lets you replicate columns that use the Adaptive Server datatypes `text`, `unitext`, `image` and `rawobject`.

- When you replicate `text`, `unitext`, `image`, and `rawobject` columns you must specify a compatible replication status for each `text`, `unitext`, `image`, and `rawobject` column in both the replication definition and in Adaptive Server.
- You cannot include `text`, `unitext`, `image`, or `rawobject` columns as part of the primary key or as searchable columns.
- A unique set of columns must be identified so that `text`, `unitext`, `image`, or `rawobject` columns replication will only affect one row at the target database. This column or set of columns must be included in the primary key if a replication definition is used.
- To replicate `text`, `unitext`, `image`, and `rawobject` columns, follow these steps:
  - Use **create replication definition** to create a replication definition for a table that contains `text`, `unitext`, `image`, or `rawobject` columns.

    See *Replication Server Reference Manual > Replication Server Commands >* ***create replication definition***.
  - Use **sp_setreptable** to mark the table for replication.

    See*Replication Server Reference Manual > Adaptive Server Commands and System Procedures >* ***sp_setreptable***.
- **sp_setreptable** sets the replication status of `text`, `unitext`, `image`, or `rawobject` columns to **always_replicate**.
- If you do not want to replicate some of the `text`, `unitext`, `image`, or `rawobject` columns, use **sp_setrepcol** to change the replications status of those columns.
- Use **create subscription** to make subscriptions for the replication definition and begin replicating the `text`, `unitext`, `image`, or `rawobject` data.

Note: When you execute an update at the primary database, you can update a `text`, `unitext`, `image`, or `rawobject` column and a non-text, non-image, or non-rawobject column—a `char` column, for example—with a single command. When those updates are copied to the replicate database, however, Replicate Server executes two commands, one for `text`, `unitext`, `image`, and `rawobject` updates and one for other datatype updates. If you choose to have DSI ignore certain replication errors, only a portion of the row may be replicated, which creates an inconsistent replicate table.

See the *Replication Server Heterogeneous Replication Guide* and the Replication Server Options documentation for information on non-ASE data servers.

See also

- *Change Column Status for text, unitext, image, or rawobject Columns* on page 317
- *create subscription Command* on page 397

Replicating Large Objects to Non-ASE Servers Using Enterprise Connect Direct Access

Replication Server replicates large objects such as `text` and `image` to non-ASE servers by passing a **writetext** command to Enterprise Connect Direct Access (ECDA), where it is converted to an **update** statement.

The **writetext** command includes large-object pointers that an **update** statement uses to search and propagate the replicate database. Most data servers have their own unique implementation of updating large objects. Therefore, large-object replication to these servers can become slow and inefficient, often requiring a full table scan of the replicate database for a single update.

Replication Server provides an option to include primary keys with **writetext** commands sent to ECDA. With the primary keys, ECDA can create **update** statements that can efficiently search and replicate the replicate database.

Replication Server introduces the Data Server Interface (DSI) configuration parameter **dsi_alt_writetext**. You can use the **dsi_alt_writetext** to instruct the Replication Server to include a text pointer or a set of primary keys with the **writetext** command.

Note: You need a version of ECDA 15.0 ESD #2 to use this feature.

See **dsi_alt_writetext** in the *Replication Server Reference Manual*.

Guidelines for Creating a text, unitext, image, or rawobject Replication Definition

There are several guidelines to follow when you create a table replication definition for `text`, `unitext`, `image`, or `rawobject` columns.

- Include each `text`, `unitext`, `image`, or `rawobject` column that you want to replicate in the column list.
- Specify the datatype for each `text`, `unitext`, `image`, or `rawobject` column.
- Specify whether a **null** is allowed for the column in destination tables. This setting must be consistent with the way the source and destination tables are defined.
- Include each column in the optional clauses **replicate_if_changed** or **always_replicate**.

Specify a Null Value for text, unitext, image, and rawobject columns

To specify whether or not a null value is allowed in the replicate table for each `text`, `unitext`, `image`, or `rawobject` column, use **null** or **not null** after the datatype for the column in the replication definition.

This setting must be consistent with the way the primary and replicate tables are defined. For `text` , `unitext`, `image`, and `rawobject` columns, the default is **not null**, meaning that the replicate table does not accept null values.

If you are using multiple replication definitions, the null value setting should be the same for all replication definitions on a primary table.

Do not specify **null** or **not null** for columns using datatypes other than `text`, `unitext`, `image`, or `rawobject`. Columns with null values cannot be searchable.

The following example replication definition for the table `au_pix` includes a column `pic` of datatype `image`, for which null values are allowed in replicate tables. The `pic` column is included in the **replicate_if_changed** clause.

```
create replication definition au_pix
with primary at TOKYO_DS.pubs2
(au_id char(11),
pic image null)
primary key (au_id)
replicate_if_changed (pic)
```

Mark Tables with text, unitext, image, or rawobject Columns

Use **sp_setreptable** to set the initial replication status for `text`, `unitext`, `image`, and `rawobject` columns in SAP ASE when you mark the table for replication.

sp_setreptable sets the replication status of `text`, `unitext`, `image`, or `rawobject` columns to **always_replicate**.

If you use **sp_setreptable** to mark a table for replication and the table includes `text`, `unitext`, `image`, and `rawobject` columns, an internal operation needs to be completed for every `text`, `unitext`, `image`, or `rawobject` columns in every data row of the table. This internal modification is performed in a single transaction, and for large tables, this operation may be time-consuming and involve a significant amount of data.

Before you use **sp_setreptable** on a large table that has `text`, `unitext`, `image`, or `rawobject` columns, be sure that you have enough log space for this operation. You may also want to choose a time that will be least disruptive for client applications or replication system administration.

You can speed up the process of marking a table with `text`, `unitext`, `image`, or `rawobject`, if you use the option **use_index**. When using this option, SAP ASE creates an internal nonclustered index for each `text`, `unitext`, `image`, or `rawobject`, in the table. For example:

```
sp_setreptable aux_pix, true, null, use_index
```

See ***sp_setreptable*** in the *Reference Manual*.

Note: See the Replication Agent documentation for instructions on marking tables for replication in non-SAP data servers.

Change Column Status for text, unitext, image, or rawobject Columns

Use **sp_setrepcol** to adjust the replication status for `text`, `unitext`, `image`, or `rawobject` columns.

When you mark a table with `text`, `unitext`, `image`, or `rawobject` columns for replication, **sp_setreptable** sets the replication status of `text`, `unitext`, `image`, or `rawobject` columns to **always_replicate**.

The replication status is the same for all replication definitions of a primary table. If you change the replication status for one replication definition with **alter replication definition**, you change the replication status for all replication definitions on the same primary table.

If you do not want to replicate some of the `text`, `unitext`, `image`, or `rawobject` columns in a marked table, use **sp_setrepcol** to adjust the replication status. You can set the replication status for one or all columns to **always_replicate**, **do_not_replicate**, or **replicate_if_changed**.

To use **sp_setrepcol**, you must be the Database Owner or System Administrator for the data server.

Note: If you have marked the database for replication to a standby database using **sp_reptostandby** and marked database tables for replication to a replicate database using **sp_setreptable**, Replication Server copies `text`, `unitext`, `image`, and `rawobject` columns to standby and replicate databases as **always_replicate**. If you want to copy `text`, `unitext`, `image`, and `rawobject` columns as **replicate_if_changed**, use **sp_setrepcol** to adjust the replication status. See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications > What Information is Replicated for ASE Warm Standby Application? > Replicate text, unitext, image, and rawobject Data* for more information about replicating in a warm standby application.

See *Replication Server Reference Manual > Adaptive Server Commands and System Procedures >* ***sp_setrepcol***.

text, unitext, image, or rawobject Column Replication Status

There are three status clauses to set the replication status of the `text`, `unitext`, `image`, or `rawobject` columns.

Table 26. Text , Unitext, Image , or Rawobject Column Replication Status

Status clause	Description
always_replicate	Adaptive Server logs replication information for the `text`, `unitext`, `image`, or `rawobject` column whenever any column in the row changes.
replicate_if_changed	Adaptive Server logs replication information for the `text`, `unitext`, `image`, or `rawobject` column only when the column data changes.
do_not_replicate	Adaptive Server does not log replication information for the `text`, `unitext`, `image`, or `rawobject` column.

Enable Column Replication

Use **sp_setrepcol** to mark a column with an `image` or `rawobject` datatype for replication.

Syntax:

```
sp_setrepcol table, column, status
```

For example, to mark the `pic` column of datatype `image` for replication in the table `au_pix`, enter one of the following:

- `sp_setrepcol au_pix, pic, always_replicate`
- `sp_setrepcol au_pix, pic, replicate_if_changed`
- `sp_setrepcol au_pix, pic, replicate_if_changed, use_index`

Disable Column Replication

Use **sp_setrepcol** with the **do_not_replicate** parameter to turn off replication for an `image` or `rawobject` column.

Syntax:

```
sp_setrepcol table, column, do_not_replicate
```

For example, to disable replication of the `pic` column of datatype `image` for replication in the table `au_pix`, enter:

```
sp_setrepcol au_pix, pic, do_not_replicate
```

Enable or Disable Replication for All Columns

To mark all text, unitext, image, and rawobject columns in the table with the same replication status, enter "null" instead of a column name.

For example, to mark all text, unitext, image, and rawobject columns with the **replicate_if_changed** status:

```
sp_setrepcol table_name, null, replicate_if_changed
```

Execute **sp_setrepcol** with the table name and a text, unitext, image, and rawobject column name to display the replication status of the specified column. For example:

```
sp_setrepcol table_name, column_name
```

Execute **sp_setrepcol** with a table name to display the replication status of all of the text, unitext, image, and rawobject columns in the table. For example:

```
sp_setrepcol table_name
```

Alter Replication Status for text, unitext, image, or rawobject Columns

When you replicate text, unitext, image, and rawobject columns you must specify a compatible replication status for each column in both the replication definition and in Adaptive Server.

If you change the replication status of text, unitext, image, and rawobject columns in one table replication definition, the replication status automatically changes in all other replication definitions for the same table that includes those text, unitext, image, and rawobject columns.

If the primary database supports the **rs_send_repserver_cmd** stored procedure, you can change the replication status of a text, unitext, image, or rawobject column in the primary database by:

1. Using **sp_setrepcol** to change the replication status of the column. For example:
   ```
   sp_setrepcol authors, au_pix, replicate_if_changed
   ```
2. Using **rs_send_repserver_cmd** to execute an alter replication definition request to change the replication status. For example:
   ```
   exec rs_send_repserver_cmd 'alter replication definition authors
   replicate_if_changed au_pix'
   ```

If the primary database does not support **rs_send_repserver_cmd**, or if there are no data rows for the table in the database log:

1. Use **sp_setrepcol** to change the status of the column in the database to the new replication status.
2. Use **alter replication definition** to change the status of the column to the new replication status.

Subscription Issues for replicate_if_changed Status

If you create subscriptions for replication definitions with `text`, `unitext`, `image`, or `rawobject` columns that have the status **replicate_if_changed**, use either bulk materialization or materializing `text`, `unitext`, `image`, or `rawobject` data.

See also

- *Bulk Materialization* on page 381
- *Materialize text, unitext, image, and rawobject Data* on page 408

Function Strings for Replicating text, unitext, and image Data

You must create **rsdatarow_for_writetext**, **rs_get_textptr**, **rs_textptr_init**, and **rs_writetext** function strings for each `text`, `unitext`, or `image` column, if you replicate columns with `text`, `unitext`, or `image` datatypes to a non-SAP ASE database.

The function string name must be the `text`, `unitext`, or `image` column name for the replication definition.

Note: You cannot replicate `rawobject` or `rawobject in row` columns to non-SAP databases unless you replicate these columns as their base datatype. The base datatype of `rawobject` is `image`; the base datatype of `rawobject in row` is `varbinary`.

Note: ExpressConnect for Oracle and ExpressConnect for HANA DB do not use LOB pointers to manage LOB data. Consequently, the SAP Replication Server system functions used to manage LOB pointers are unavailable to ExpressConnect for Oracle and ExpressConnect for HANA DB. These functions–which include **rs_get_textptr**, **rs_textptr_init**, and **rs_writetext**–are visible to ExpressConnect, but their use is ignored by SAP Replication Server.

See *Replication Server System Functions* in the *Reference Manual*.

Replicate Computed Columns

Computed columns allow you to create an expression and place the result of the expression in a table column.

A computed column is:

- Materialized – when its value is computed for each insert or update. A materialized computed column is stored in the same way as regular columns.
- Virtual – when its value is computed only when referenced in a query. A virtual computed column is stored in the table or index page.

A computed column expression can be:

- Deterministic – when its value is the same each time it is evaluated.
- Nondeterministic – when its value may be different each time it is evaluated (for example, a date stamp).

See the *Adaptive Server Enterprise System Administration Guide* for more information about creating and managing computed columns.

Replication Server replicates materialized computed columns in DML statements in the same way it replicates other columns; it does not replicate virtual computed columns.

The replication of computed columns is supported by function strings. With Replication Server version 15.0 and later, the class-level function string **rs_set_dml_on_computed** is applied at the replicate database DSI when a connection is established. It issues **set dml_on_computed "on"** after the **use database** statement. If the replicate Adaptive Server is 12.5.x or earlier, the command is ignored.

When you are creating or altering replication definitions for tables containing:

- Deterministic columns – you can choose whether or not to include those columns in the replication definition. Because deterministic columns always realize the same value, you can create the replication definition without them and allow each replicated insert and update to compute values at the replicate database.
- Nondeterministic columns – you must include nondeterministic computed columns in the replication definition to ensure that the primary and replicate databases remain synchronized.

Replicate Encrypted Columns

With version 15.0, Replication Server supports replication of encrypted columns in Adaptive Server.

Replication Server replicates the encrypted columns from the primary Adaptive Server database, in binary format as ciphertext values, rather than clear text values.

The encryption keys for the primary and the replicate databases must be identical. Use replication to create the encryption key at the replicate database, or use a **dump** and **load** command to ensure that the encryption keys are identical.

Replication Server in a warm standby and in an MSA environment replicates the **create**, **alter**, and **drop** commands of the encryption keys. It also replicates **alter table** to encrypt or decrypt a column. To replicate the **create**, **alter**, and **drop encryption key** DDL commands, the **system_encr_passwd** must be identical for both the primary and the replicate databases.

If the encryption keys are stored in a separate database, ensure that it is synchronized at the same time as the database containing the encrypted columns using those encryption keys.

If data has diverged between the primary and the replicate databases because of earlier encryption keys or because of differences between the initialization vector and the padding, manually sync the data to avoid failures of **update** and **delete** statements.

Restrictions

Replicating encrypted columns has restrictions.

- `Text` and `image` columns cannot be encrypted.
- Encrypted columns cannot be used in a **where** clause of a subscription or article because Replication Server receives the value in ciphertext and cannot compare that value to a clear text value. The encrypted columns cannot be searchable columns.
- If an encrypted column is used in a primary key, the encryption key must be defined with INIT_VECTOR NULL and PAD NULL.

  The purpose of an initialization vector and padding is to randomize the ciphertext so that two like values encrypted by the same key result in two differing ciphertext strings. If the ciphertext for encrypted data at the primary and the replicate sites differ, then any attempt by the Replication Server to match the before-image from the primary site with the data at the replicate site fails.

  If no initialization vector is used, the ciphertext at the source and the target databases exactly match. The matching is required because Replication Server issues a **where** clause on the **update/delete** statements using the ciphertext of the encrypted columns.
- If a table replication definition is not used to replicate the data in a warm standby or MSA environment for a table, all the encrypted columns in that table must be encrypted with keys defined as INIT_VECTOR NULL and PAD NULL.
- All encrypted columns declared in the replication definition must be in `varbinary` format. See *Adaptive Server Enterprise Encrypted Column Users Guide > Encrypting Data > Length of Encrypted Columns* to determine the length of the column.

Note: rs_subcmp supports replication of encrypted columns in Adaptive Server.

Replicate Encrypted Data

Replication Server supports the replication of encrypted data.

If your site replicates schema changes, the following DDL statements are replicated:

- **alter encryption key**
- **create table** and **alter table** with extensions for encryption
- **create encryption ke**y
- **grant** and **revoke create encryption key**
- **grant** and **revoke select** on the key
- **grant** and **revoke decrypt** on the column
- **sp_encryption system_encr_passwd**
- **drop encryption key**

The keys are replicated in encrypted form.

If your system does not replicate DDL, manually synchronize encryption keys at the replicate site. The Adaptive Server **ddlgen** utility supports a special form of **create encryption key** for replicating the key's value. See the Adaptive Server documentation for information on the **ddlgen** utility.

For DML replications, the **insert** and **update** commands replicate encrypted columns in encrypted form, which safeguards replicated data while Replication Server processes it in stable queues on disk.

Work with Special Datatypes

Learn how to use the `rs_address`, `identity`, and `timestamp` special datatype columns in replication definitions.

Using the rs_address Datatype

The `rs_address` special datatype makes a unique subscription resolution technique possible: bitmaps of the `rs_address` datatype (based on the underlying `int` datatype) are compared with a bitmask in a subscription's **where** clause to determine whether a row should be replicated.

Prerequisites

You must include any columns that use the `rs_address` datatype in the **searchable columns** clause of the replication definition in order to perform bitmap comparison using the **where** clause.

Task

1. To use this subscription resolution method, create tables that use columns of the `int` datatype.
2. Create a replication definition that includes these columns in the column list, but declare the datatype as `rs_address` instead of `int`.

See also

- *Bitmap Subscriptions* on page 410

Replicate identity Columns

`identity` columns store sequential numbers (such as invoice numbers, employee numbers, or record numbers) that are generated automatically. The value of the `identity` column uniquely identifies each row in a table.

`identity` columns use the `numeric` underlying datatype with scale 0, between 1 and 10^{38} -1, inclusive.

`identity` columns are never updated by the **update** command. **update** applied to primary data from a replicate site (using a request function) can never update the `identity` column with `identity` data.

Specify an identity Column in a Replication Definition

To create a replication definition for a table that contains an `identity` column, specify `identity` as the declared datatype for the column or use a column-level translation to specify `identity` as the published datatype for the column.

A replication definition, or multiple replication definitions for the same table, may not publish more than one column that has the datatype `identity`.

If one replication definition publishes a column as `identity`, another replication definition may publish the column as `numeric` and avoid having the extra commands sent with an insert for subscribers to the second replication definition.

How Replication Server Replicates identity Columns

Replication Server applies two commands to control replication of `identity` columns.

Replication Server applies the following command to the replicate table before **insert**:

```
set identity_insert table_name on
```

Replication Server applies the following command to the replicate table after **insert**:

```
set identity_insert table_name off
```

If a column you are adding to a replication definition contains an `identity` column, the maintenance user must either be the owner of the table, or must be “dbo” or aliased to “dbo”, or must have sa_role pemission at the replicate database in order to use the Transact-SQL **identity_insert** option to perform operations on the table.Without the proper permissions, you see an error message in the Replication Server log as replication of `identity` columns cannot proceed.

Replicate timestamp Columns

Replication Server supports `timestamp` as a Replication Server datatype.

`timestamp` is defined as `varbinary`(8) with a status bit indicator that differentiates it from `varbinary`. This allows the replication of `timestamp` columns to replicate, standby, and MSA databases.

You can also define `timestamp` as a primary key in a replication definition, and a searchable column in a replication definition and a function replication definition.

The **send_timestamp_to_standby** configuration parameter is also added to support `timestamp` replication. When **send_timestamp_to_standby** is enabled and there are no replication definitions, `timestamp` columns are sent to the replicate database.

For any table containing `timestamp` column, the maintenance user must be the owner of the table or must be the “dbo” user of aliased to the “dbo” login name at the replicate database.

Specify a timestamp Column in a Replication Definition

To create a replication definition for a table that contains a `timestamp` column, specify `timestamp` as the declared datatype for the column or use a column-level translation to specify `timestamp` as the published datatype for the column.

A replication definition, or multiple replication definitions for the same table, may not publish more than one column that has the datatype `timestamp`.

Note: The replicate Adaptive Server must be version 15.0.2 or later to support `timestamp` in replication definition.

See *Replication Server Reference Manual > Topics > Datatypes > Date/time, and Date and Time Datatypes*.

Modify Replication Definitions

Learn how to view, alter, and drop replication definitions and learn how Replication Server supports table changes.

In addition, learn how Replication Server supports table changes resulting from the **alter table** command when the table:

- Has subscriptions from a replicate site, or
- Is replicated to the standby database using a replication definition with a **send standby replication definition columns** clause.

Note: Adaptive Server Enterprise version 12.0 allows users to alter existing tables— add non-nullable columns, drop columns, and modify column datatypes.

See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications > Use Replication Definitions and Subscriptions > Create Replication Definitions for Warm Standby Databases > alter table Support for Warm Standby* for **alter table** changes that affect warm standby tables with no subscriptions.

See also

- *Modify Replicated Data* on page 339
- *Replication Definition Restrictions in Mixed-Version Systems* on page 307

Maintain Table Schema

To coordinate primary schema or store procedure changes with the corresponding replication definition changes, use the **rs_send_repserver_cmd** stored procedure to execute replication definition requests at the primary database, while you are changing the primary schema or stored procedure.

Replication Server stores information about table schema in a table replication definition.

When a replication definition is altered, Replication Server may create a new replication definition version. Replication Server processes old data rows that are already in the replication system using the old replication definition version, while processing new data rows entering the Replication Server system using the new replication definition version.

For databases that do not support **rs_send_repserver_cmd**, verify that the data row using the old replication definition is no longer in the database log before you issue the alter replication definition request at the primary Replication Server.

See also

- *Using the Replication Definition Change Request Process* on page 331

View Replication Definitions and Replication Definition Versions

Use the **rs_helprep** and **rs_helpreptable** stored procedures to display information about existing replication definitions, and the **rs_helprepversion** stored procedure to display information on replication definition versions.

See *Replication Server Reference Manual > RSSD Stored Procedures* to use the stored procedures.

Alter Replication Definitions

You may need to alter a replication definition after a column has been added to a primary table or if a destination database requires a column that was not specified in the original replication definition.

In most instances, you alter replication definitions in conjunction with changing database schema in the source or destination table. Be sure to coordinate schema changes between the source and destination sites.

Replication Server may create a new replication definition version when you alter a replication definition. When that happens, Replication Server changes the name of the old replication definition version to a unique name with a “rs_drp” prefix. Replication Server treats replication definitions with names prefixed with “rs_drp” or “rs_in” as internal replication definitions.

Replication Server deletes an internal replication definition when the data associated with the replication definition is no longer in the replication system.

To exclude internal replication definitions from a query to the *rs_objects* table, add to the **where** clause of the query:

```
and objname not like ‘rs_drp%’ and objname not like
‘rs_in%’
```

For example, this query returns the name of all replication definitions created against the *ling.authors* primary table, and excludes the internal replication definitions:

```
select objname from rs_objects where prsid = 16777317
and dbid = 104 and phys_tablename = 'authors' and
phys_objowner = 'ling' and objname not like 'rs_drp%'
and objname not like 'rs_in%
```

See also

- *Modify Replicated Data* on page 339

Replication Definition Change Request Process

When you request changes to replication definitions, Replication Server coordinates the propagation of replication definition changes and data replication automatically.

You can request replication definition changes directly at the primary database using the **alter replication definition**, **alter applied replication definition**, or **alter request function replication definition** commands, while making changes to the database schema.

In Replication Server:

- You can issue a replication definition command directly from a primary database.
- You can use an **alter replication definition** command to instruct Replication Server to suspend the target DSIs after Replication Server applies all data for the old replication definition version at the target database. This provides a window for you to alter the target schema and alter customized function strings before the data for the new replication definition version arrives.
- You can verify that Replication Server can execute a replication definition request successfully by executing the request without changing any data.
- You can instruct Replication Server to skip a failed replication definition request sent by a Replication Agent. When a replication definition command fails at the primary Replication Server, Replication Agent shuts down. If you restart Replication Agent, the failed command executes again unless Replication Server skips the command.

Note: Besides Adaptive Server, Replication Server extends support for **rs_send_repserver_cmd** to supported versions of these non-ASE databases: Microsoft SQL Server and Oracle. Therefore, you cannot use the replication definition change process for IBM DB2. See the *Release Bulletin* for Replication Agent for the supported database versions.

When you issue a replication definition change request, Replication Server determines if there is a need to create a new replication definition version based on the type of change requested. If Replication Server creates a new replication definition version, primary updates before the replication definition change request automatically use the old replication definition version, while primary updates after the replication definition change request use the new replication definition version.

Note: These procedures in the replication definition change request process do not apply to the **alter function replication definition** command. You must quiesce the Replication Server environment because **alter function replication definition** directly changes the function replication definition.

See also

- *Execute Replication Definition Changes Directly at the Primary Database* on page 328
- *Suspend DSI* on page 329
- *Verify Replication Definition RCL Commands* on page 330
- *Skip Faulty Commands and Error Handling* on page 330
- *Using the Replication Definition Change Request Process* on page 331

Execute Replication Definition Changes Directly at the Primary Database

Use the **rs_send_repserver_cmd** stored procedure to execute replication definition change requests directly at the primary database.

Replication Server supports **rs_send_repserver_cmd** for these replication definition RCL commands:

- **alter replication definition**
- **create replication definition**
- **drop replication definition**
- **alter applied function replication definition**
- **create applied function replication definition**
- **alter request function replication definition**
- **create request function replication definition**

The syntax is:

exec rs_send_repserver_cmd '*rs_api*'

rs_api contains the replication definition you want to change.

For example, to drop the `address`, `city`, `state`, and `zip` columns from the **authors** replication definition at the primary database, enter:

```
exec rs_send_repserver_cmd 'alter replication
definition authors drop address, city, state, zip'
```

When you execute **rs_send_repserver_cmd** at the primary database, the Replication Agent sends the RCL command stored in *rs_api* to the Replication Server, which then executes the RCL command. This ensures that Replication Server replicates the primary data with the proper replication definition version—primary data before the **rs_send_repserver_cmd** is replicated with the old replication definition version, while primary data after the **rs_send_repserver_cmd** is replicated with the new replication definition version.

You do not always need to issue replication definition change requests directly from a primary data server. For example, you can execute the alter replication definition request directly from the primary Replication Server in these situations:

- If there is no subscription to the replication definition
- If there are subscriptions to the replication definition, but there is no data in the primary database log for the table or stored procedure
- If you are adding or dropping a searchable column to or from a table replication definition
- If you are adding or dropping a searchable parameter to or from a function replication definition
- If you are altering a replication definition to turn Dynamic SQL on or off

Warning! As Replication Server accepts all commands that Replication Agent sends to Replication Server, you must control access to **rs_send_repserver_cmd** at the primary database.

Changes to rs_locater Table

When you execute **rs_send_repserver_cmd** at the primary database, the Replication Server `rs_locater` system table stores the OQID of the RCL in `type` according to whether the RCL inside *rs_api* is executed:

- Successfully – `type C`
- Unsuccessfully – `type F`

When you execute **sysadmin skip_bad_repserver_cmd** for the RCL that failed, Replication Server updates the `rs_locater` entry to `type S`. Replication Server skips the failed command the next time Replication Agent sends the command.

See `rs_locater` in the *Replication Server Reference Manual*.

Suspend DSI

Use **alter replication definition**, **alter applied function replication definition**, and **alter request function replication definition** with the **with DSI_suspended** option to suspend the standby DSI, if there is one, and each of the subscribing replicate DSI threads.

Replication Server suspends the DSI thread in the standby or replicate database after Replication Server applies all the data for the old replication definition version to the standby or replicate database.

After Replication Server suspends a DSI thread, you can make changes to the target schema or target stored procedures, and to any customized function strings.

When you resume the DSI thread, Replication Server replicates the primary updates using the altered replication definition.

This example shows how to instruct Replication Server to suspend the target DSI after primary data that exists before you execute **alter replication definition** is replicated to the target database:

```
alter replication definition pubs_rep
alter columns with pub_name as pub_name_set
with DSI_suspended
```

You do not need to use **with DSI_suspended** if:

- There is no subscription to the replication definition.
- You do not need to change customized function strings.
- You do not need to change the replicate or standby database schema.

Note: If there is a subscription from a replicate Replication Server with a site version earlier than 1550, the replicate DSI threads for that Replication Server are not suspended.

Verify Replication Definition RCL Commands

Use **admin verify_repserver_cmd** to verify replication definition RCL commands.

When Replication Agent sends a replication definition RCL to Replication Server to execute, and the replication definition RCL fails to execute, Replication Agent shuts down. To avoid this situation, SAP recommends that you use **admin verify_repserver_cmd** at the primary database to verify that Replication Server can successfully execute a replication definition request before you execute the RCL directly from the primary database. Replication Server returns an error if it cannot successfully execute the request.

Replication Server supports **admin verify_repserver_cmd** for the same replication definition commands as **rs_send_repserver_cmd**:

- **alter replication definition**
- **create replication definition**
- **drop replication definition**
- **alter applied function replication definition**
- **create applied function replication definition**
- **alter request function replication definition**
- **create request function replication definition**

This example shows that **admin verify_repserver_cmd** can detect syntax errors, such as using the “columns” keyword in the command line:

```
admin verify_repserver_cmd, ‘alter replication
definition authors drop columns address, city, state, zip
with DSI_suspended’
```

Replication Server returns with a message, such as:

```
Line 1, character 71: Incorrect syntax with the keyword
'columns'.
```

Skip Faulty Commands and Error Handling

Use **sysadmin skip_bad_repserver_cmd** to instruct Replication Server to skip a failed replication definition request the next time Replication Agent starts.

Warning! Use **sysadmin skip_bad_repserver_cmd** carefully. If you execute the command, and then restart the Replication Agent without executing the corrected replication definition command in the primary Replication Server, primary data may replicate using the wrong replication definition version.

In this example, **sysadmin skip_bad_repserver_cmd** instructs Replication Server and Replication Agent to skip the last failed replication definition command in the `pubs2` database of the SYDNEY_DS data server:

```
sysadmin skip_bad_repserver_cmd, SYDNEY_DS, pubs2
```

If the replication definition request you execute at the primary database through **rs_send_repserver_cmd** fails at the primary Replication Server, Replication Agent shuts down. If you restart Replication Agent, the failed command executes again unless Replication Server skips the command. The replication definition request can fail if:

- A subscription is in progress when you execute the request.
- Replication Server cannot find the replication definition or a column.
- There are syntax errors.

If you can resolve the problem that caused Replication Agent to shut down, for example, by waiting for the subscription to complete or correcting the replication definition, you can then restart Replication Agent and Replication Agent reissues the replication definition request.

If the failed replication definition request is caused by an error that cannot be easily fixed, such as a syntax error:

1. Execute the correct replication definition command directly at the primary Replication Server.
2. Execute **sysadmin skip_bad_repserver_cmd** at the primary Replication Server to ensure that Replication Agent and Replication Server skip the most recent failed request that Replication Agent sent.
3. Restart the Replication Agent.

Using the Replication Definition Change Request Process

Use the replication definition change request process that consolidates all the steps for changing a replication definition.

Prerequisites

You can execute the alter replication definition request directly at the primary Replication Server in any of these situations:

- There are no subscriptions for a replication definition.
- There are subscriptions for a replication definition, but there is no data in the primary database log for the primary table or stored procedure.
- You are adding or dropping a searchable column parameter.
- You are turning Dynamic SQL on or off.

Task

1. Group your changes to the primary schema and stored procedure together.

2. Log in to the primary Replication Server.
3. Wait until all subscriptions and articles for the replication definitions are valid, that is, there is no materialization or dematerialization in progress.
4. For each replication definition affected by the primary schema and stored procedure changes, test the replication definition request using **admin verify_repserver_cmd** in the primary Replication Server:

```
admin verify_repserver_cmd, 'alter replication definition authors
drop address, city, state, zip
with DSI_suspended'
```

5. If you have a lot of replication definitions in the replication system, and you have many replication definition change requests, to enhance performance, you can disable **sts_full_cache** for these system tables:
   - `rs_objects`:

     ```
     configure replication server
     set sts_full_cache_rs_objects to 'off'
     go
     ```
   - `rs_columns`:

     ```
     configure replication server
     set sts_full_cache_rs_columns to 'off'
     go
     ```
   - `rs_objfunctions`:

     ```
     configure replication server
     set sts_full_cache_rs_objfunctions to 'off'
     go
     ```

   Tip: Execute the Adaptive Server **update statistics** command on the RSSD tables periodically if there are many RSSD changes. For replication definition change requests, such as to create, alter, or drop replication definitions, the affected tables are `rs_objects`, `rs_columns`, and `rs_objfunctions`. For function string change requests, such as to create, alter, or drop function strings, the affected tables are `rs_funcstrings` and `rs_systext`.

6. At the primary database:
   a) Suspend any data changes to the primary tables and stored procedures that you want to alter.
   b) Alter the table schema and stored procedures.
   c) For the replication definition request that you verified in step 4, execute the **rs_send_repserver_cmd** stored procedure. For example:

      ```
      exec rs_send_repserver_cmd 'alter replication definition
      authors
      drop address, city, state, zip
      with DSI_suspended'
      ```
   d) Resume data changes to the primary tables and stored procedures.
7. If you issue any of the replication definition requests using **with DSI_suspended**, then at each subscribing replicate site, wait until Replication Server suspends the DSI, then:

   a) Alter the replicate table schema or stored procedures, as required.
   b) Alter any customized function strings as required, and wait for the customized function strings to arrive at the replicate site.
   c) Resume the replicate DSI.

8. If you changed the **sts_full_cache** setting for any of the tables in step 5, you can change the settings back now.

SAP strongly recommends that you follow step 4 and use **admin verify_repserver_cmd** to test your replication definition requests. Using **admin verify_repserver_cmd** provides a higher probability that you can avoid a Replication Agent shutdown if a replication definition request command fails when you execute **rs_send_repserver_cmd** at the primary Replication Server.

If any of the schema changes requires you to perform an action at a replicate site, such as changing the replicate schema or a customized function string, then only the very last of the replication definition requests in step 6c affecting the replication definition needs to be issued with **with DSI_suspended**. In some cases, you may need to resume a replicate DSI more than once.

You can skip step 7 if the replicate schema, stored procedures, or customized function strings do not require any changes.

If the Replication Agent shuts down because of a failed replication definition command, you can skip faulty commands to recover Replication Agent.

If the database does not support **rs_send_repserver_cmd**, you need to wait until the primary database log does not have any data rows for the schema that you are changing, and then execute the alter replication definition request at the primary Replication Server.

See also

- *Skip Faulty Commands and Error Handling* on page 330

Changes You Can Make to the Replication Definition

Learn what you can alter in a replication definition.

You can alter the replication definition in one of the following ways:

- Providing a different replicate table name
- Add columns to the columns list
- Provide different replicate column names
- Change the specifications for replicating `text`, `unitext`, `image`, or `rawobject` columns
- Add columns to the primary keys column list
- Remove columns from the primary keys column list
- Add columns to the searchable columns list
- Drop columns from a replication definition

- Drop columns from the searchable columns list
- Change declared or published column datatypes
- Change the specification for replicating minimal columns
- Change how the replication definition is used in replicating to a standby database

Note: Function strings with replication definition scope are not automatically altered when you add columns to a table or to a replication definition. In certain cases, you must alter the function strings manually. See *Replication Server Administration Guide Volume 2 > Customize Database Operations > Manage Function Strings*.

Use **alter replication definition** at the primary Replication Server where you created the replication definition, or use **rs_send_repserver_cmd** at the primary database to send the alter replication definition request. The information you can alter in a replication definition is similar to what you provide when you create replication definitions.

- To rename primary or replicate tables, drop and re-create the replication definition.
- To drop or rename primary columns or change column datatypes, drop and re-create all the replication definitions that have the primary columns and follow the replication definition change request process .

See *Replication Server Reference Manual > Replication Server Commands >* ***alter replication definition***.

See also

- *Create Replication Definitions* on page 286
- *Renaming Replicated Tables* on page 339
- *Replication Definition Change Request Process* on page 327

Providing a Different Replicate Table Name

You can alter the replication definition to replicate data from a source table into a destination table with a different name.

For example:

```
alter replication definition publishers
with replicate table named publishers2
```

Change the Specified Columns

Learn how to add or change a column for a replication definition such as, adding or dropping columns and primary keys, altering column datatypes, and specifying a replicate column name that is different from the primary column name.

Adding a Column to a Replication Definition

Learn to add a column to a replication definition.

To add a `char` column named `zip` (for zip code information) to the replication definition **publishers**:

Alter the replication definition to add the `char` column:

```
alter replication definition publishers_rep
add zip char(10)
```

If the column you added to the destination table has a different name from the source column such as `rep_zip_char`, enter:

```
alter replication definition publishers_rep
add zip as rep_zip char(10)
```

See *Replication Server Reference Manual > Replication Server Commands >* ***alter replication definition***.

See also

- *Add and Delete Columns in Source and Destination Tables* on page 340

Drop a Column from a Replication Definition

Learn to drop a column from a replication definition.

In this example, **alter replication definition** drops the `address`, `city`, `state`, and `zip` columns from the **authors** replication definition:

```
alter replication definition authors
drop address, city, state, zip
```

- If there is a subscription from a replicate Replication Server with a site version earlier than 1550, the primary Replication Server rejects the alter replication definition request to drop a column.

  Note: If you alter a replication definition to drop a column, you may need to reset autocorrection or dynamic SQL settings at replicate Replication Servers with site versions earlier than 1550.
- If there are multiple replication definitions for a primary table, **alter replication definition** drops only the columns from the replication definition you specify in *repdef_name* in the command line.
- The **drop** parameter drops a column or columns from a table replication definition. If a column is part of the primary key or searchable columns, **drop** drops the column from the primary key list or searchable column list. Replication Server rejects an alter replication definition request to drop a column if the column is:
  - The only column
  - The only primary key column for the replication definition
  - In the **where** clause of a subscription or article
  - Before a searchable column which is specified in the **where** clause of an article or subscription.

Dropping a Searchable Column

Learn how to drop a searchable column from a replication definition.

Prerequisites

You can drop searchable columns from a replication definition only if they are not used in subscription or article **where** clause.

Task

1. Use **drop subscription** to remove any subscriptions in which you want the **where** clause to exclude the searchable columns you are dropping.
2. Use **alter replication definition** to drop the searchable column. For example:

   ```
   alter replication definition publishers_rep
   drop searchable columns zip
   ```

   This example removes the `zip` searchable column from the **publishers_rep** replication definition.

   See *Replication Server Reference Manual > Replication Server Commands >* ***alter replication definition***.
3. Use **create subscription** to re-create subscriptions to the altered replication definition.

See also

- *drop subscription Command* on page 403
- *create subscription Command* on page 397

Add or Drop Primary Keys

Learn how to add or drop primary keys. Replication Server depends on primary keys to find the correct rows at the replicate or standby table.

To add the column `zip` as a primary key to the replication definition, enter:

```
alter replication definition publishers_rep
add primary key zip
```

To drop a primary key, enter:

```
alter replication definition publishers_rep
drop primary key zip
```

To replace all primary key columns, first alter the corresponding replication definition to add the new primary keys, then drop the old primary key columns in the table.

Warning! If all primary key columns are missing from the primary table, the DSI will shut down.

Alter Column Datatypes

There are several rules and restrictions for altering column datatypes.

- You cannot change the declared column datatype (the datatype in the primary table) if it is used in a **where** clause in a subscription or a **where** clause in an article.
- You cannot change the `rs_address` datatype.
- You can change the column datatype to `text`, `unitext`, `image`, `rawobject`, or `rawobject in row` only if it is not a primary key or searchable column.
- To change the published (replicate) datatype, you must include the declared (primary) datatype of a column (whether it is being changed or not) and the **[map to]** clause.
- Altering a column's datatype and nullability affects the same column across all replication definitions for a table. However, changes between a `rawobject` or `rawobject in row` and its base datatype, affects only the current replication definition.
- Use column nullability changes for `text`, `unitext`, `image`, and `rawobject` columns only.

See also

- *Translate Datatypes Using HDS* on page 349

Provide a Different Replicate Column Name

Learn how to specify a replicate column name that is different from the primary column name.

To replicate data for the source column `zip` into a destination column named `rep_zip`, enter:

```
alter replication definition publishers_rep
alter columns with zip as rep_zip
```

Enter such a command when:

- You alter the existing destination table to add column `rep_zip`.
- You drop and re-create the destination table to contain the column `rep_zip` in place of the original column `zip`.

Change text, unitext, image, and rawobject Replication Status

Use **alter replication definition** to change the replication status of `text`, `unitext`, `image`, and `rawobject` columns in a replication definition.

See also

- *Alter Replication Status for text, unitext, image, or rawobject Columns* on page 319

Adding a Searchable Column

A searchable column lets you create subscriptions based on values in the column.

To add and take advantage of a searchable column:

1. Use **drop subscription** to remove any subscriptions in which you want the **where** clause to include the added searchable column.
2. Use **alter replication definition** to add the searchable column. For example:

   ```
   alter replication definition publishers_rep
   add searchable columns zip
   ```

   (This example makes the `zip` column searchable.)

   See *Replication Server Reference Manual > Replication Server Commands >* ***alter replication definition***.
3. Use **create subscription** to re-create subscriptions to the altered replication definition.

See also

- *drop subscription Command* on page 403
- *create subscription Command* on page 397

Change Minimal Column Replication

You can specify that Replication Server uses the minimal number of columns (as opposed to all columns in each row) when it copies update and delete operations.

Enter a command like this:

```
alter replication definition publishers_rep
replicate minimal columns
```

Alter a Replication Definition for Warm Standby Replication

Use **alter replication definition** to specify which replication definition to use to replicate data into a standby database in a warm standby application.

You can also specify whether to replicate all the columns in the table or only the columns in the replication definition.

See *Replication Server Reference Manual > Replication Server Commands >* ***alter replication definition***.

See also

- *Use Replication Definitions with Warm Standby Applications* on page 300

Drop Replication Definitions

Learn how to drop replication definitions.

Before you drop a replication definition, first drop all subscriptions and articles that reference that replication definition.

To access a list of existing subscriptions for a specified replication definition, use **rs_helpsub**. See *Replication Server Reference Manual > RSSD Stored Procedures >* ***rs_helpsub***.

To access a list of existing subscriptions for all replication definitions, use **rs_helprep**. See *Replication Server Reference Manual > RSSD Stored Procedures >* ***rs_helprep***.

Enter **drop replication definition** at the primary Replication Server. For example, to drop the **publishers_rep** replication definition, enter a command like this:

```
drop replication definition publishers_rep
```

See *Replication Server Reference Manual > Replication Server Commands >* ***drop replication definition***.

See also

- *drop subscription Command* on page 403
- *Drop Articles* on page 348

Modify Replicated Data

Learn how to modify replicated data and perform related operations to maintain replication.

Before you modify replicated data, carefully review the issues when you planned the replication system. When attempting to modify replicated data, know the dependencies that may exist and the sequence of tasks required to perform the procedure.

See also

- *Manage Subscriptions* on page 373
- *Plan a Replication System* on page 280
- *Using the Replication Definition Change Request Process* on page 331

Add a New Table

To add a new source table, or add a new destination copy for an existing source table, follow the steps in the summary of procedures for replication.

See also

- *Summary of Procedures for Replicating Tables* on page 282

Renaming Replicated Tables

To rename a replicated table, you need to specify the replication definition name and table names and follow the replication definition change request process.

See also

- *Specify the Replication Definition Name and Table Names* on page 293
- *Using the Replication Definition Change Request Process* on page 331

Add and Delete Columns in Source and Destination Tables

Use the replication definition change request process to add or delete columns in the source and destination tables.

See also

- *Using the Replication Definition Change Request Process* on page 331

Change Searchable Columns

You can add searchable columns to a replication definition.

See also

- *Adding a Searchable Column* on page 337

Dropping a Searchable Column

You can drop searchable columns from a replication definition only if the columns are not used in subscription or article **where** clause.

1. Use **drop subscription** to remove any subscriptions in which you want the **where** clause to exclude the searchable columns you are dropping.
2. Use **alter replication definition** to drop the searchable column. For example:

   ```
   alter replication definition publishers_rep
   drop searchable columns zip
   ```

   This example removes the `zip` searchable column from the **publishers_rep** replication definition.

   See *Replication Server Reference Manual > Replication Server Commands >* ***alter replication definition***.
3. Use **create subscription** to re-create subscriptions to the altered replication definition.

See also

- *drop subscription Command* on page 403
- *create subscription Command* on page 397

Change Column Datatypes in a Source or Destination Table

Use the replication definition change request process to change column datatypes in a primary and replicate table in a warm standby only setup.

See also

- *Using the Replication Definition Change Request Process* on page 331

Use Publications

A publication lets you collect replication definitions for the same or related tables and stored procedures and then subscribe to them as a group.

You collect replication definitions in a publication at the source Replication Server and subscribe to them with a publication subscription at the destination Replication Server.

With publications, you monitor the status of one publication subscription for a set of tables and procedures.

These steps summarize the procedure for replicating data using publications:

1. Create or select the replication definitions to include in the publication.
2. Create the publication.
3. Create articles that reference the replication definitions you have chosen.
4. Validate the publication.
5. Create a subscription for the publication.

Note: A replicate database can subscribe to different replication definitions of the same primary table directly or through publications—as long as each replication definition references a different table in the replicate database.

To use publications, the primary Replication Server must be version 11.5 or later. To use publication subscriptions, the replicate Replication Server and the route from the primary Replication Server and the replicate Replication Server must be version 11.5 or later.

When you use publications, you create and manage the following objects:

- Articles – replication definition extensions for tables or stored procedures that let you put table or function replication definitions in a publication. Articles may or may not contain **where** clauses, which specify a subset of rows that the replicate database receives.
- Publications – groups of articles from the same primary database.
- Publication subscriptions – subscriptions to a publication. When you create a publication subscription, Replication Server creates a subscription for each of the publication's articles. Publication subscriptions do not contain **where** clauses.

In general, you manage publications and publication subscriptions in the same way as you do replication definitions and subscriptions. However, when you create a publication, you can specify the subset of rows that the replicate table receives by including a **where** clause in the article—not in the subscription.

You can create and manage publications using the command line.

See also

- *Manage Replicated Functions* on page 355

- *Manage Subscriptions* on page 373

Use Publications to Replicate Data at the Command Line

Learn how to create a publication to replicate data at the command line and prepare the publication for subscription. In addition, learn how to modify and drop a publication and its associated articles and replication definitions.

Commands for Creating and Managing Publications

There are several commands you can use to manage your publications.

All of the commands for managing publications, except **check publication**, are executed at the source Replication Server, where they require **create object** permission. Anyone can execute **check publication** at the source Replication Server—or at the destination Replication Server if the user has the same login and password at both servers.

Table 27. Commands for Managing Publications

Command	Task
create publication	Creates a publication for a group of tables or stored procedures that is to be replicated to one or more subscribing databases.
create article	Creates an article for a publication, allowing you to add one or more **where** clauses to specify a subset of rows to send to the destination database. The publication and the replication definition on which the article is based must exist before you create an article.
validate publication	Checks that the publication contains at least one article and marks the publication as VALID and ready for subscription.
check publication	Displays the status of the publication and the number of articles it contains.
drop publication	Removes the publication from the *rs_publications* system table. You can drop the replication definitions associated with the publication if they are *not* included in other publications or subscriptions.
drop article	Removes the article from the publication and from the *rs_articles* system table. You can drop the replication definition associated with the article if it is *not* included in other articles or subscriptions.
rs_helppubs	Displays information about publications and articles.

You can also use RCL commands for working with publication subscriptions.

See also

- *Commands for Creating and Managing Publication Subscriptions* on page 417

Creating Publications and Articles at the Command Line

Learn how to use RCL commands to prepare a publication for subscription and create a subscription against it.

1. At the source Replication Server:

a) Create or select replication definitions for the tables or stored procedures from which you want to copy data.

The replication definition specifies the source and destination tables or stored procedure and the columns or parameters that are sent to the subscribing database.

b) Use **create publication** to create the publication that groups the replication definitions.

Publication information is stored in the `rs_publications` system table in the source Replication Server RSSD. It includes the name of the publication, data server, and database. The publication name must be unique for the source Replication Server and database.

The following example creates a publication named **pubs2_pub**. The primary database is `pubs2` managed by the TOKYO_DS data server.

```
create publication pubs2_pub
      with primary at TOKYO_DS.pubs2
```

Publication information is not copied to the destination Replication Server until you create a subscription against the publication at the destination Replication Server.

See *Replication Server Reference Manual > Replication Server Commands* for complete syntax and usage guidelines.

c) Use **create article** to create articles for the publication.

Each article specifies the publication to which it belongs and the table or function replication definition with which it identifies. A publication can contain articles based on the same or different replication definitions. The replication definition and publication must exist when you create the article.

An article includes the names of the publication, the replication definition, and the source data server and database. Article information is stored in the `rs_articles` and `rs_whereclauses` system tables. Each article name must be unique within the publication.

The following example creates an article named **titles_art** based on the replication definition **titles_rep** for the publication **pubs2_pub**.

```
create article titles_art
    for pubs2_pub with primary at TOKYO_DS.pubs2
    with replication definition titles_rep
```

An article can include **where** clauses that specify the rows or parameters to be sent to subscribing databases.

Creating an article invalidates the publication, which makes it ineligible for subscription. After you create an article, you must change the status of the publication to VALID, using **validate publication**, before you can create subscriptions against it.

See *Replication Server Reference Manual > Replication Server Commands* for complete syntax and usage guidelines.

d) Use **validate publication** to change the status of the publication to VALID.

When you validate a publication, Replication Server checks that the publication contains at least one article and marks the publication ready for subscription.

Whenever you add or drop an article from a publication, Replication Server invalidates the publication. To mark the publication VALID—and ready for subscription—you must execute **validate publication**.

After you validate a publication, you can create a publication subscription against it.

The following example validates the **pubs2_pub** publication. The source database is `pubs2` managed by the TOKYO_DS data server.

```
validate publication pubs2_pub
            with primary at TOKYO_DS.pubs2
```

See *Replication Server Reference Manual > Replication Server Commands* for complete syntax and usage guidelines.

2. At the destination Replication Server:

a) Use **create subscription** to create the publication subscription.

When you create a publication subscription, Replication Server creates a subscription for each article in the publication.

See also

- *Create Replication Definitions* on page 286
- *Specifying a where Clause with the create article Command* on page 344
- *Publication Subscriptions* on page 416

Specifying a where Clause with the create article Command

You can include one or more **where** clauses in an article. A **where** clause sets criteria for the column or parameter values that are to be replicated.

If you omit the **where** clause, Replication Server copies all rows for columns specified in the table replication definition or all parameters specified in the function replication definition.

The **where** clause syntax for articles is:

```
[where (column_name | @param_name)
      {< | > >= | <= | = | &} value
    [and {column_name | @param_name}
```

```
      {< | > >= | <= | = | &} value]...]
    [or where (column_name | @param_name)
      {< | > >= | <= | = | &} value
    [and {column_name | @param_name}
      {< | > >= | <= | = | &} value]...]
...
```

Each column name in a **where** clause must be listed in the searchable columns list of the table replication definition. The value for each column must have the same datatype as the column to which it is compared.

Note: Each **where** clause in an article is joined by the **or** operator. However, the **!=**, **!<**, **!>**, and **or** operators are not supported inside a **where** clause. The **&** operator is supported only on `rs_address` columns.

The following example creates an article named **titles_art** for the publication named **pubs2_pub**, using a **where** clause that limits replication to rows where the value in the `type` column is ‘popular_comp.’

```
create article titles_art
    for pubs2_pub with primary at TOKYO_DS.pubs2
    with replication definition titles_rep
    where type = 'popular_comp'
```

See *Replication Server Reference Manual > Replication Server Commands* for complete syntax and usage guidelines.

See also

- *Bitmap Subscriptions* on page 410
- *Using the rs_address Datatype* on page 323

View Publication Information

Use the **check publication** command and the **rs_helppub** stored procedure to view information about publications and articles.

Display Publication Status and Number of Articles

Use **check publication** to display the number of articles in a publication and its current status.

Any user can execute **check publication** at either the primary or replicate Replication Server. If you execute **check publication** at the replicate Replication Server, you must have the same login and password at the primary and replicate servers.

The following example displays the status and number of articles in the **pubs2_pub** publication.

```
check publication pubs2_pub
    with primary at TOKYO_DS.pubs2
```

See *Replication Server Reference Manual > Replication Server Commands >* ***check publication***.

Display Publication and Article Information

Use the **rs_helppub** stored procedure at either the primary or replicate Replication Server RSSD to display information about a publication and its articles.

Note: Although you can execute **rs_helppub** at the primary or replicate site, **rs_helppub** only displays publication information stored at the site at which it is executed. For example, if you execute **rs_helppub** at the primary site, **rs_helppub** displays information about all publications created at that site. If, however, you execute **rs_helppub** at the replicate site, **rs_helppub** only displays information about publications for which subscriptions have been created at that site.

Here are some examples of using **rs_helppub**:

- To list all publications at a site, enter:

  ```
  rs_helppub
  ```

  The display output includes publication name, status, the primary Replication Server and database names, the number of articles, and the date of the latest change to the publication.
- To display detailed information about a particular publication, enter:

  ```
  rs_helppub publication_name, primary_dataserver,
      primary_db
  ```

  The display output includes the above information and the names of associated articles, replication definitions, and primary and replicate tables. If subscriptions have been created for the publication, the display includes names of the subscriptions, replicate databases, owners, and the date of the latest change to the subscription.
- To display information about a particular article, enter:

  ```
  rs_helppub publication_name, primary_dataserver,
      primary_db, article_name
  ```

  The output display includes the name of the publication to which the article belongs, associated replication definitions, status information, and **where** clauses and subscriptions, if any.

See *Replication Server Reference Manual > Replication Server Commands >* ***rs_helppub***.

Alter Publication Information

If you want to alter an article or publication, you must drop the article or publication and re-create it. You can also make the **where** clauses in an article more selective.

To make the **where** clauses in an article more selective, you can:

- Drop the article and re-create it with altered **where** clauses, or
- Create another article (for the same replication definition), tailoring the **where** clauses to the new row or parameter selection.

See also

- *Drop Publications* on page 347
- *Drop Articles* on page 348

Adding Articles to a Publication

Learn how to add articles to an existing publication.

1. At the source Replication Server:
   a) Create or select the replication definitions on which the articles are to be based.
   b) Use **create article** to create new articles.
   c) Use **validate publication** to validate the publication so that subscriptions can be created for the new articles.
2. At the destination Replication Server:
   a) To create subscriptions for the new articles, enter **create subscription** or **define subscription** and include the **for new articles** clause.

See also

- *Publication Subscriptions* on page 416

Drop Publications

Use **drop publication** to remove a publication and all of its articles from the system tables.

Before you drop a publication, you must, at the replicate Replication Server, drop all subscriptions created against the publication.

Execute **drop publication** at the Replication Server that manages the source database. You must have **create object** permission.

The following example drops the **pubs2_pub** publication and the articles it contains.

```
drop publication pubs2_pub
        with primary at TOKYO_DS.pubs2
```

Publication information is dropped immediately from the primary Replication Server; it is not dropped from the replicate Replication Server until:

- You attempt to create a subscription against the dropped publication, or
- You enter **check publication** at the replicate Replication Server.

See *Replication Server Reference Manual > Replication Server Commands >* ***drop publication*** .

See also

- *Drop Subscriptions for Publications and Articles* on page 422

Drop Associated Replication Definitions

To drop replication definitions associated with the publication, include the **drop_repdef** clause when you execute **drop publication**.

Replication Server drops all replication definitions associated with the publication that are not referenced by other publications or subscriptions.

For example, to drop all replication definitions associated with **pubs2_pub**, enter:

```
drop publication pubs2_pub
    with primary at TOKYO_DS.pubs2
    drop_repdef
```

Drop Articles

Use **drop article** to remove an article from a publication.

Before you drop an article, you must drop subscriptions created against it at the replicate Replication Server.

Execute **drop article** at the Replication Server that manages the source database. You must have **create object** permission.

The following example drops the **titles_art** article for the **pubs2_pub** publication.

```
drop article titles_art
    for pubs2_pub with primary at TOKYO_DS.pubs2
```

See *Replication Server Reference Manual > Replication Server Commands >* ***drop article***.

See also

- *Drop Subscriptions for Publications and Articles* on page 422

Drop the Associated Replication Definition

To drop a replication definition associated with an article, include the **drop_repdef** clause when you execute **drop article**.

Replication Server drops the replication definition if it is not referenced in other publications or subscriptions.

For example, to drop the **pubs2_pub** article and the replication definition it references, enter:

```
drop article titles_art
    for pubs2_pub with primary at TOKYO_DS.pubs2
    drop_repdef
```

Translate Datatypes Using HDS

In a heterogeneous replication system, when information is replicated from one data server to another, values stored at the primary data server must often be altered so that they can be copied successfully to a different datatype at the replicate data server.

User-created function strings can produce these datatype translations, but require significant user input and are limited by the capabilities of the replicate data server.

To make datatype translations more readily available for different data servers, Replication Server provides heterogeneous datatype support (HDS), an easy-to-apply methodology for translating datatypes at the Replication Server. HDS supports selected datatype translations between these data servers:

- Adaptive Server Enterprise
- DB2
- HANA DB
- Oracle
- Microsoft SQL Server
- UDB

When you use HDS, you can choose which columns and datatypes in the primary database are to be translated, and which replicate data servers will receive the translations.

Sources of information:

- See the *Replication Server Heterogeneous Replication Guide*.
- See the *Replication Server Configuration Guide* for your platform for instructions for installing and setting up the objects that enables HDS.
- See the *Replication Server Reference Manual* for descriptions of the function strings.

Overview of Heterogeneous Datatype Support

If you are replicating information between SAP ASEs, datatype translations are normally unnecessary. However, you can use HDS to perform datatype translations when datatypes differ in the primary and replicate databases.

You can use HDS capabilities when replicating between:

- SAP ASE databases – one SAP ASE datatype to another SAP ASE datatype
- Like non-SAP databases – for example, DB2 `TIMESTAMP` to DB2 `DATE`
- Heterogeneous non-SAP databases – Oracle to DB2, for example
- SAP ASE and non-SAP databases – SAP ASE to Oracle, for example

HDS handles incompatibilities between the datatypes of the primary data server and the replicate data server. In general, these incompatibilities are of four types:

- Incompatible ranges – for example, the range of acceptable dates for SAP `datetime` is January 1, 1753 through December 31, 9999. Another data server, however, may only allow dates from January 1, 0001 through December 31, 9999.
- Incompatible formatting – for example, the primary data server date format is “CCYY-MM-DD,” but the replicate data server requires a date format of “MM/DD/CCYY.”
- Incompatible length – for example, the primary table may have a column with a character length of 10, but the column in the replicate table has a length of 15.
- Incompatible delimiters – for example, SAP delimits binary data with an “0x” prefix, whereas another data server may surround binary data with single quotation marks.

The Replication Agent for each data server delivers replicate values to SAP Replication Server in a datatype format that SAP Replication Server understands, which includes the literal value, delimiter information, and other datatype attributes. SAP Replication Server handles the value as its base datatype—one of the native SAP Replication Server datatypes described in the *Reference Manual*.

You can implement datatype translations in two ways:

- Class-level translations – translate all instances of a datatype for a particular connection.

  Create a connection specifying a connection profile for your non-SAP ASE database. The connection profile includes the class-level translation. See ***create connection using profile*** in the *Reference Manual*.
- Column-level translations – translate all instances of a column described by a table replication definition.

  Use the **map to** clause for column-level translations.

Getting Started with Translating Datatypes

Learn how to set up datatype translations in a heterogeneous replication system.

1. Review the datatype translations available for your primary and replicate data servers. Determine the translations you want and the methods for delivering them:
   - Class-level translations

     For lists of supported class-level datatype translations, see the *Heterogeneous Replication Guide*.
   - Column-level translations
2. Set up column-level translations by creating or altering the replication definition.

See also

- *Manage Subscriptions* on page 373
- *Manage Replicated Functions* on page 355

Create Class-Level Translations

Class-level translations for non-ASE data servers are defined in connection profiles and connection profiles install the class-level translations.

See the *Replication Server Heterogeneous Replication Guide* to find a description of the connection profiles for each supported non-ASE database.

System-Defined Variables

Class-level translations change the datatype of system-defined variables as well as column values.

For example, if a class-level translation changes `datetime` to `rs_db2_timestamp`, the *rs_origin_begin_time* system-defined variable, which is `datetime`, is translated to *rs_db2_timestamp* for that connection.

See also

- *Connection Profiles* on page 167

Create Column-Level Translations

Column-level translations affect each replicated instance of a particular column (datatype) and table. They are defined using the **create replication definition** or **alter replication definition** command.

To set up column-level translations, you simply create or alter the replication definition, identifying the column to be translated and its initial and final datatypes using the **map to** option.

- If you are creating a new replication definition, use **create replication definition**.
  For lists of supported datatype translations, see the *Heterogeneous Replication Guide*.
- If you are adding or altering a column in an existing table, use **alter replication definition**.

SAP provides a set of datatype definitions and datatype classes that you can use to modify the datatype of the replicated columns. Each datatype class contains datatype definitions for a particular data server:

- SAP ASE – **rs_sqlserver_dt_class**
- SAP HANA – **rs_hanadb_dt_class**
- IBM DB2 – **rs_db2_dt_class**
- Microsoft SQL Server – **rs_msss_dt_class**
- Oracle – **rs_oracle_dt_class**
- SAP IQ – **rs_iq_dt_class**
- UDB – **rs_udb_dt_class**

Datatype classes are not replicated and cannot be modified. Column-level translations are implemented after subscription resolution and before class-level translations.

You can activate a column-level translation for a particular column when you create or alter a table replication definition. The syntax for **create replication definition** with column and datatype variables specified for HDS is:

```
create replication definition replication_definition
with primary at data_server.database
...
(column_name [as replicate_column_name] declared_datatype [null |
not null]
[map to published_datatype])
...
```

where:

- The declared datatype depends on the datatype of the value delivered to the SAP Replication Server from the Replication Agent:
  - If the Replication Agent delivers a native SAP Replication Server datatype, such as `datetime`, to the SAP Replication Server, the declared datatype is the native datatype.
  - Otherwise, the declared datatype must be the datatype definition for the original datatype at the primary database.

    For example, the Replication Agent delivers a value in the DB2 `TIMESTAMP` datatype, as a character string with delimiters, to SAP Replication Server. In this case, the declared datatype is the datatype definition `rs_db2_timestamp`.
- The published datatype is the datatype of the column after the column-level translation (and before a class-level translation, if any). The published datatype is normally either an SAP Replication Server native datatype or a datatype definition for the datatype in the replicate database. If the published datatype is omitted from the replication definition, it defaults to the declared datatype.

Both declared and published datatypes have a base datatype. For example, the datatype `rs_db2_timestamp` has a base datatype of `char(26)`; the native datatype `char(26)` also has a base datatype of `char(26)`. A datatype definition describes a non-SAP datatype in terms of an SAP Replication Server native datatype. The base datatype fixes the maximum and minimum length to be associated with the datatype definition and provides defaults for other datatype attributes. The base datatype defines the delimitation of values for the datatype definition when a value of that type is delivered to SAP Replication Server either in Log Transfer Language (LTL) or in a command executed by an SAP Replication Server administrator such as **create subscription**.

Note: Native datatypes include all datatypes supported by SAP Replication Server. However, you cannot use `text`, `unitext`, `image`, `rawobject`, and `rawobject in row` datatypes for defining a datatype definition; neither can you use these datatypes as the source or target of a translation.

For example, to create a table replication definition **ase_employee_repdef_for_db2** that translates values in the `birthdate` column from `datetime` (`birthdate` primary table datatype) to DB2 `DATE` datatype for the replicate database, log in to the primary SAP Replication Server and enter:

```
create replication definition
  ase_employee_repdef_for_db2
    with primary at ase_server.ase_database
    with all tables named 'employee'
      (empid int,
      first_name char(20),
      last_name char(20),
      ...
      birthdate datetime map to rs_db2_date,
      salary money,
      ...
```

In this example, `birthdate` is the column name, `datetime` is the declared datatype, and `rs_db2_date` is the published datatype. Because the declared datatype is a native datatype, the native and base datatype are the same. That is, the base datatype of `datetime` is `datetime`. The published datatype `rs_db2_date` is a datatype definition for DB2, and its base datatype is `char(10)`.

See also

- *Use Class-Level and Column-Level Translations Together* on page 354

How Datatype Definitions Work

Datatype definitions allow you to translate from one datatype to another without losing valuable information.

When used as the declared datatype, a datatype definition provides the mechanism for capturing both the literal value and its datatype attributes—such as delimiters, range information, precision, scale, length, and maximum and minimum values—and translating them into a native datatype format that Replication Server can process.

When used as a published datatype, a datatype definition takes the value in Replication Server native datatype format, including its attribute information, and translates that information into a datatype format acceptable to another database, retaining as much information as the published datatype can accommodate.

When data definitions are used for both the declared and published datatypes, both translations take place.

Note: Microsoft SQL Server does not directly support the new unsigned integer types in 15.0 and requires to use a **map to** clause in their replication definitions.

Column-Level Translations and Multiple Replication Definitions

In general, a column declared in multiple replication definitions must use the same declared datatype in each replication definition—although published datatypes can differ.

`rawobject` and `rawobject in row` (Java) columns declared in multiple replication definitions, however, can use either the `rawobject` (or `rawobject in row`) datatype or its base datatype for the declared datatype. For example, you can use `rawobject` and `image` or `rawobject in row` and `varbinary` in multiple replication definitions for the same Java column. See *Java in Adaptive Server Enterprise* for detailed information about Java columns in Adaptive Server.

Use Class-Level and Column-Level Translations Together

If you activate class- and column-level datatype translations for the same column, both are applied.

Column-level translations are performed after subscription resolution and before class-level translations, just prior to delivery to the replicate database.

This order of execution ensures that column-level translations supersede class-level translations. That is, translations for a particular connection (class-level translations) do not affect translations defined for a particular table and column (column-level translations).

Verify Translations

You can verify how translations alter values before you set up column-level or class-level translations.

Use the **admin translate** command to view the results of a particular translation. **admin translate** accepts a value and a source and target datatype and returns the target value. It is most useful with the diagnostic version of Replication Server, which, if the translation fails, allows you to trace the reason for the failure.

The syntax is:

```
admin translate, value, source_datatype, target_datatype
```

where:

- *value* is the literal representation of the value being translated—including delimiters as required by the base datatype of the source datatype.
- *source_datatype* is the datatype definition or datatype for the value you want to translate.
- *target_datatype* is the datatype definition or datatype for the value after translation.

If the base datatype of either the source or target datatype requires a length specification, such as `char(26)`, enclose the datatype name in quotes.

For example, to verify the translation of a date from `db2_date` to `datetime`, log in to Replication Server and enter:

```
admin translate, ’04/29/1989’, db2_date, datetime
```

In this example, *value* is the character string “04/29/1989,” and you must enclose it in single quotes. See *Replication Server Reference Manual > Replication Server Commands >* ***admin translate*** for a complete description and further examples.

Manage Replicated Functions

Use replicated functions to replicate the execution of a stored procedure from the source database to the destination database.

When you use function replication, Replication Server replicates the execution of a stored procedure from the source database to the destination database. That is, when a stored procedure is executed at the source database, the Replication Server invokes the execution of another stored procedure at the destination database. The two stored procedures need not have the same name nor perform the same tasks.

See the *Replication Server Design Guide* for information about replication system design issues that concern replicated stored procedures.

See *Replication Server Administration Guide Volume 2 > Asynchronous Procedures* for the distribution of stored procedures associated with table replication definitions. See *Replication Server 15.6 Administration Guide Volume 2 > Pre-15.1 Request Function Replication* for the request function distribution without subscription for versions earlier than 15.1.

You identify the stored procedure at the source and the information that is to be passed to the destination by creating a function replication definition, which specifies:

- The names of the stored procedures at the source and destination databases (if they are different)
- The datatypes and parameters that are to be passed to the destination stored procedure

To satisfy the requirements of distributed applications, Replication Server provides two ways to implement replicate functions. Use:

- An applied function to deliver a transaction to a replicate database by the maintenance user.
- A request function to deliver a transaction to a replicate database by the same user who invokes the stored procedure at the primary database.

The **maint_user** runs the transaction at the replicate database if the function is replicated through **applied function replication definition**. The **origin_user** runs the transaction if the function is replicated through **request function replication definition** at the replicate database.

See also

- *Applied Functions* on page 360
- *Request Functions* on page 363

Prerequisites and Restrictions for Replicated Functions

Before you implement applied or request functions in your replication system, be sure that you have met the prerequisites, and that you understand the restrictions on the use of replicated stored procedures.

Replicated Function Prerequisites

There are several prerequisites to meet when you implement applied or request functions.

- Understand how you will use applied or request functions to meet your application needs. Refer to the *Replication Server Design Guide* for more information.
- Set up a RepAgent at the primary Replication Server by following the procedures involved in managing a replication system and the configuration procedures in the *Replication Server Configuration Guide*.
- Set up routes from the primary Replication Server to the replicate Replication Server.
- Replicated functions can be used with applications that involve fragmented primary data. To do this, create a function replication definition and a stored procedure for each primary fragment. Refer to the *Replication Server Design Guide* for more information about working with fragmented primary data.

  In general, the information on replicated functions that is discussed, is based on the Replication Server basic primary copy model, where a single source database distributes data to one or more destination databases.

See also

- *Manage a Replication System* on page 59
- *Manage Routes* on page 141
- *Replication Server Basic Primary Copy Model* on page 8

Replicated Function Restrictions

There are several restrictions when you use replicated stored procedures.

- The names of all replication definitions, including function replication definitions, must be unique in the replication system.
- When you create an applied function replication definition for a primary function in your replication system, make sure that the function does not have an existing function replication definition that satisfies both these conditions:
  - The function replication definition is created using the **create function replication definition** command.
  - The function replication definition is used for the request function replication without subscription in Replication Server 15.0.1 and earlier version.

Otherwise, the existing request function replication will be disabled. See *Replication Server 15.6 Administration Guide Volume 2 > Pre-15.1 Request Function Replication*.

- Replication Server does not support nested transactions—those containing **begin** or **commit** statements—within replicated stored procedures.

  If stored procedures with nested stored procedures are marked for replication:

  - The RepAgent forwards only the outer stored procedure call to the Replication Server.
  - The RepAgent shuts down.
  - An error message appears in the Adaptive Server error log.

  When the **maint_user** or the replicate database replicates a stored procedure, using **sp_setrepproc**, Adaptive Server always executes the stored procedure within a transaction. Even if you have not explicitly executed the replicated stored procedure within a transaction at the primary database, Adaptive Server places an implicit **begin transaction** at the start of the procedure when it is applied by the **maint_user** in the replicate database.

  For more information, see **dsi_max_xacts_in_group** in *Replication Server Administration Guide Volume 2 > Performance Tuning > Configuration Parameters that Affect Performance > Connection Parameters that Affect Performance* . If the replicated stored procedure contains such commands as **begin transaction**, **commit transaction**, or **rollback transaction**, errors may result when you execute the procedure. For example, a **rollback transaction** command might roll back to the start of the transaction group, rather than to the nested **begin transaction** command that was the intended rollback point.
- Replicated functions, like Adaptive Server stored procedures, cannot contain parameters with `text` and `image` datatypes. Refer to the *Adaptive Server Enterprise Reference Manual*.
- Adaptive Server logs a replicated stored procedure invocation in the database in which the enclosing transaction was started:
  - If the user does not begin a transaction explicitly, Adaptive Server begins one in the user's current database before the stored procedure is invoked.
  - If the user begins the transaction in one database and then executes a replicated stored procedure in another database, the execution is still logged in the database where the transaction began.
- If a single transaction invokes one or more request functions and executes applied functions or contains data modification language, or a mixed-mode transaction, Replication Server processes the request functions after all the other operations have completed, together in a separate transaction.
- When you use replicated functions and heterogeneous datatype translations:
  - You cannot alter the datatype of a parameter value using **create applied/request function replication definition** or **alter applied/request function replication definition**. However, you can use datatype definitions to declare parameters for applied function replication definitions, which are then subject to class-level translations.

- Replication Server does not perform translations on parameter values for request functions. However, during function-string mapping, the delimiters defined for the parameter values of their declared datatype are used to generate the SQL.

Warning! Do not put a commit statement inside a replicated function as this may cause a duplicate key and make Replication Server recovery fail.

Commands for Managing Function Replication Definitions

Learn the commands you can use to work with function replication definitions.

Table 28. Commands for Managing Function Replication Definitions

Command	Task
drop function replication definition	Removes a function replication definition from the replication system. You must drop all subscriptions for a function replication definition before you can drop the replication definition.
create applied replication definition	Creates an applied function replication definition that describes the stored procedure and its parameters, for both the primary and replicate databases. It also describes the location of the primary data. The **maint_user** applies the applied function at the replicate site.
create request replication definition	Creates a request function replication definition that describes the stored procedure and its parameters, for both the primary and replicate databases. It also describes the location of the primary data. The same user running the stored procedure at the primary site applies the request function at the replicate site.
alter applied replication definition	Modifies an applied function replication definition, which is created with **create applied function replication definition** command. For example, it: • Specifies a different name for the primary stored procedure invoked at the source database. • Specifies a different name for the stored procedure invoked at the destination database. • Adds parameters or searchable parameters. • Changes how the replication definition is used in replicating to a standby database. If parameters are added, the change applies to all applied function replication definition created for this primary function.

Command	Task
alter request replication definition	Modifies a request function replication definition, which is created with **create request function replication definition** command. For example, it: • Specifies a different name for the primary stored procedure invoked at the source database. • Specifies a different name for the stored procedure invoked at the destination database. • Adds parameters or searchable parameters. • Changes how the replication definition is used in replicating to a standby database. If parameters are added, the change applies to all request function replication definitions created for this primary function.
create function replication definition	Creates a function replication definition that describes the stored procedure, and its parameters, for replication. It also describes the location of the primary data. This command is deprecated and is replaced by **create applied function replication definition** and **create request function replication definition** commands.
alter function replication definition	Modifies a function replication definition. For example, it: • Specifies a different name for the stored procedure invoked at the destination database • Adds parameters or searchable parameters • Changes how the replication definition is used in replicating to a standby database This command can only be used to modify the function replication definition created with **create function replication definition** command.
rs_send_repserver_cmd	Executes replication definition change requests directly at the primary database.
admin verify_repserver_cmd	Verifies that Replication Server can successfully execute a replication definition change request.

See also

- *Modify or Drop Replicated Functions* on page 368
- *Execute Replication Definition Changes Directly at the Primary Database* on page 328
- *Verify Replication Definition RCL Commands* on page 330
- *Commands for Managing Table Replication Definitions* on page 285
- *Subscription Commands* on page 393
- *Implementing an Applied Function* on page 361
- *Implementing a Request Function* on page 364

Use Replicated Functions

A replicated stored procedure is an Adaptive Server stored procedure that you have marked for replication using **sp_setrepproc** with the **function** option . A function replication definition describes the primary and the replicated stored procedure, its parameters, and its location.

You can use these three commands to create a function replication definition:

- **create applied function replication definition**
- **create request function replication definition**
- **create function replication definition** (deprecated)

When you create a function replication definition, Replication Server creates a function, which contains the information in the function replication definition.

When a replicated stored procedure that has its own function replication definition is invoked, its function is transferred from the source to a destination Replication Server. In most cases, the replicated stored procedure is invoked at the primary database and delivered to the replicate database. The only exception is the request function replication with a version earlier than 15.1 without subscription and with such replication definition, where the stored procedure is invoked at the replicate database and delivered to the primary database. In all cases, the primary Replication Server is always the Replication Server where the replication definition is created. This Replication Server controls the primary database. See *Replication Server 15.6 Administration Guide Volume 2 > Pre-15.1 Request Function Replication*.

The function passes parameters to the corresponding stored procedure that is, in turn, invoked in the destination database. A function string translates the function to a syntax that a subscribing database can interpret. When used correctly, function replication can dramatically improve performance because it can encapsulate multiple operations in a single function. Replicated stored procedures do not have to modify any data in order to be replicated.

Applied Functions

Use an applied function to distribute operations performed in a primary database to replicate databases.

Applied functions allow you to realize important performance benefits. For example, if a client application must update a large number of row changes, you can create an applied function that changes many rows, rather than replicating the rows individually.

To use an applied function, you first create a stored procedure in the primary database and a corresponding stored procedure in the replicate database. Use **sp_setrepproc** command to mark the stored procedure to be replicated. At the primary Replication Server, you create an applied function replication definition for the stored procedure. Replicate Replication Servers can subscribe to the function replication definition. When the stored procedure in the primary database is invoked, the replicate Replication Server in turn executes the stored procedure in the subscribing replicate database.

Replication Server does not know in advance what data is needed by the stored procedure at the replicate databases until the execution of the stored procedure is subscribed, thus you must use bulk materialization or the no-materialization method when you subscribe to a function replication definition.

Replication Server executes the stored procedure in the replicate database as the maintenance user, which is consistent with normal data replication.

Implementing an Applied Function

Learn how to create replication objects and execute commands to implement an applied function.

Applied and request functions are very similar. The difference is that the maintenance user executes the applied function at the replicate site, and the same user who executes the stored procedure at the primary database executes the request function at the replicate site.

1. Review the prerequisites and restrictions for applied functions.
2. Set up replicate databases containing replicate tables that the stored procedure will modify.
3. In the primary database, create the stored procedure. The stored procedure may or may not modify primary data. For example, this stored procedure uses the *@pub_name* parameter to update the `pub_name` column of the `publishers` table:

   ```
   create proc update_pubs
   @pub_id char(4), @pub_name varchar(40),
   as
   update publishers
   set pub_name = @pub_name
   where pub_id = @pub_id
   ```
4. In the primary database, mark the stored procedure for replicated function delivery, using the **sp_setrepproc** system procedure. For example:

   ```
   sp_setrepproc update_pubs, 'function'
   ```
5. In the replicate database, create a stored procedure with the same parameters and datatypes as the stored procedure in the primary database. Typically, the two stored procedures perform the same operations. For example:

   ```
   create proc update_pubs
   pub_id char(4), @pub_name varchar(40),
   as
   update publishers
   set pub_name = @pub_name
   where pub_id = @pub_id
   ```

   Note: The stored procedure created in the replicate database does not have to have the same name, but must have the same parameter name and datatype.

   Warning! A stored procedure invoked in a replicate database in applied function delivery is invoked inside a user-defined transaction. See the *Adaptive Server Enterprise Transact-*

SQL Users Guide for information about operations that are not allowed inside user-defined transactions (for example, the **dump transaction** and **dump database** commands).

Do not mark this stored procedure as replicated. In applied function delivery, only the stored procedure in the primary database is marked as replicated.

However, if the replicate database modifies a standby database, mark the stored procedure in the active and standby replicate databases as replicated if you want to use stored procedure replication to the standby.

6. In the replicate database, grant **execute** permission on the stored procedure to the maintenance user. For example:

```
grant execute on update_pubs to maint_user
```

7. In the primary Replication Server, create an applied function replication definition for the stored procedure. For example:

```
create applied function replication definition
update_pubs_rep
with primary at TOKYO_DS.pubs2
with all functions named update_pubs
(@pub_id char(4), @pub_name varchar(40),
 @state char (2))
searchable parameters (@pub_name, @state)
```

The function replication definition must use the same parameter names and datatypes as the stored procedure in the primary database. You have the option to include only the parameters you want to replicate. If the function replication definition has 0 parameters, you must still include the parentheses for this clause.

If you specify searchable parameters, you can subscribe to function invocations based on the value of the function's parameters. In the preceding example, *@pub_name* and *@state* are searchable parameters. Thus, for example, they can subscribe only to "CA" updates.

If you want to replicate the Adaptive Server `timestamp` datatype, declare the datatype `binary(8)` in the function replication definition.

See *Replication Server Reference Manual > Replication Server Commands >* ***create applied function replication definition***.

8. When you create a function replication definition, Replication Server automatically creates a corresponding function in the default function-string class. See *Replication Server Administration Guide Volume 2 > Customize Database Operations > Work with Functions, Function Strings, and Classes > Functions > User-defined Functions*.

If you are not using a default function-string class or a class inherited from the default or if you want to customize the function's invocation, you need to create a function string for the user-defined function.

9. In the replicate Replication Server, create a subscription to the function replication definition, using **create subscription** and the no-materialization method or **define subscription** and the other bulk materialization commands.

Note: You must use the no-materialization method or bulk materialization—instead of atomic or nonatomic materialization—because Replication Server cannot determine in advance what data is needed for the stored procedure at the replicate site.

For example:

```
create subscription pubs_sub
for update_pubs_rep
with replicate at SYDNEY_DS.pubs2
where @state = 'CA'
without materialization
```

If you specified searchable parameters in the function replication definition, you can subscribe to function invocations based on the value of the function's parameters. In this example, the subscription only receives rows if the value of the *@state* parameter is equal to CA.

See *Replication Server Reference Manual > Replication Server Commands >* ***create subscription***.

10. Verify that all Replication Server and database objects in steps 1 through 9 exist at the appropriate locations. You should now be able to execute the applied function.

    See *Replication Server Reference Manual > RSSD Stored Procedures* for information about stored procedures, such as **rs_helpfunc**, that you can use to query the RSSD for information about the replication system.

See also

- *Prerequisites and Restrictions for Replicated Functions* on page 356
- *Mark Stored Procedures for Replication* on page 367
- *Modify or Drop Replicated Functions* on page 368
- *Create or Modify a Function String for a Replicated Function* on page 370
- *Use create subscription command for No Materialization* on page 399

Request Functions

Use a request function to deliver a replicated stored procedure from a primary database to the replicate database through the original user, the same user who invokes the stored procedure at the primary database.

This type of function replication is usually used to enable the remote site to make changes to the central data with the authorized user. For example, a client application at a remote location needs to make changes to the central data. The client application first executes a stored procedure at the remote site—a procedure that may or may not make changes at the remote database. When the stored procedure executes, the replicate Replication Server passes a request function to the central site, where a corresponding stored procedure is invoked that updates the central data. In this example, the remote database is the primary database, while the central database is the replicate database of this request function.

With the primary copy model, a single central database contains all the latest updates. A client application at a remote site can update the central data using request functions. As updates occur at the central table, Replication Server captures the updates and sends them to replicate data servers through applied functions. Execution of stored procedures are stored in the Replication Server stable queues until they can be delivered to the appropriate databases.

To use a request function, create a stored procedure in the remote database and a corresponding stored procedure in the central database. Then, create a request function replication definition at the Replication Server that controls the remote database. The Replication Server that controls the central database can subscribe to this request function replication definition.When the stored procedure in the remote database is invoked, it invokes the stored procedure in the central database.

The Replication Server that manages the central database executes the stored procedure in the central database as the user who executed the stored procedure in the remote database. This guarantees that only authorized users can change central data.

In an application, Replication Server may replicate some or all of the data that is changed in the central database. The changes are distributed to the remote databases managed by Replication Servers that have subscriptions to table replication definitions or as separate applied functions. Either way, the effect of a transaction arrives at the central and then remote databases.

When you use request functions, all updates are made at the central database. This preserves Replication Server primary copy data model and protects the replication system from network failure and excess traffic.

Implementing a Request Function

Learn how to create replication objects and execute commands to implement a request function.

Applied and request functions are very similar. The difference is that the maintenance user executes the applied function at the replicate site, and the same user who executes the stored procedure at the primary database executes the request function at the replicate site.

1. Review the prerequisites and restrictions for request functions.
2. In the replicate Adaptive Server, to manage security, create a login name and password for the user who will execute the stored procedure at the replicate Adaptive Server.
3. In the replicate database, create a replicate stored procedure that updates the real data. For example:

```
create proc update_pubs
@pub_id char(4), @pub_name varchar(40)
as
update publishers
set pub_name = @pub_name
where pub_id = @pub_id
```

Warning! A stored procedure invoked in request function delivery is invoked inside a user-defined transaction. See the *Adaptive Server Enterprise Transact-SQL Users Guide* for information about operations that are not allowed inside user-defined transactions (for example, the **dump transaction** and **dump database** commands).

Do not mark this stored procedure as replicated; however, if this database is also part of a warm standby application, then mark the stored procedure in the active database as replicated if you want to replicate stored procedures to the standby database.

4. In the replicate database, grant **execute** permission on the stored procedure to the same user for whom you created a login name and password in step 2. When the request function is replicated in the replicate database, this user executes it. For example:

```
grant execute on update_pubs to pubs_user
```

5. In the primary database, create a request primary stored procedure with the different name, but the same parameters and datatypes as the stored procedure in the replicate database. The new stored procedure should either do nothing or should display a message to indicate a pending update. Typically, the purpose of this stored procedure is to send a request to other databases, instead of performing any data changes on its own database. For example:

```
create proc update_pubs_request
@pub_id char(4), @pub_name varchar(40)
as
print "Transaction accepted."
```

Note: Use a different name for the stored procedure you create in the replicate and primary databases. In the typical applications, the function will replicate back to the primary database later as an applied function. When you create the request function replication definition in step 8, you must specify the name of the stored procedure in the primary and replicate databases.

6. In the primary database, mark the stored procedure for replicated function delivery using the **sp_setrepproc** system procedure. For example:

```
sp_setrepproc update_pubs_request, 'function'
```

7. In the primary database, grant **execute** permission on the stored procedure to the primary Replication Server user who will invoke it. For example:

```
grant execute on update_pubs_request to pubs_user
```

8. In the primary Replication Server, which manages the request primary stored procedure, create a request function replication definition for this stored procedure. For example:

```
create request function replication definition
    update_pubs_request_rep
with primary at TOKYO_DS.pubs2
with primary function named update_pubs_request
with replicate function named update_pubs
(@pub_id char(4), @pub_name varchar(40)),
 @state char (2))
searchable parameters ( @state)
```

The request function replication definition must use the same parameter names and datatypes as the stored procedure in the replicate database. You have the option to include only the parameters you want to replicate.

See *Replication Server Reference Manual > Replication Server Commands >* ***create request function replication definition***.

9. When you create a function replication definition, Replication Server automatically creates a corresponding user-defined function.

   If you are not using a default function string or wish to customize the function's invocation, you need to create a function string for the user-defined function.

10. In the replicate Replication Server, create a subscription to the request function replication definition, using **create subscription** and the no materialization method or **define subscription** and the other bulk materialization commands. For example:

    ```
    create subscription pubs_sub
    for update_pubs_request_rep
    with replicate at SYDNEY_DS.pubs2
    where @state = 'CA'
    without materialization
    ```

    If you specified searchable parameters in the function replication definition, you can subscribe to function invocations based on the value of the function's parameters. In this example, the subscription only receives rows if the value of the @state parameter is equal to "CA".

    See *Replication Server Reference Manual > Replication Server Commands >* ***create subscription***.

    Note: You must use the no-materialization method or bulk materialization, instead of atomic or nonatomic materialization because the Replication Server cannot determine in advance what data is needed for the stored procedure at the replicate site.

11. Verify that all Replication Server and database objects in steps 1 through 10 exist at the appropriate locations. You should now be able to execute the request function at the primary database.

    See *Replication Server Reference Manual > RSSD Stored Procedures* for information about stored procedures, such as **rs_helpfunc**, that you can use to query the RSSD for information about the replication system.

See also

- *Prerequisites and Restrictions for Replicated Functions* on page 356
- *Manage Replication Server Security* on page 207
- *Mark Stored Procedures for Replication* on page 367
- *Create or Modify a Function String for a Replicated Function* on page 370
- *Use create subscription command for No Materialization* on page 399

Mark Stored Procedures for Replication

Use the **sp_setrepproc** system procedure to mark stored procedures for replication.

The syntax is:

```
sp_setrepproc [proc_name [, {'false' | 'table' | {'function' [,
{‘log_current’ | ‘log_sproc’} ] } } ] ]
```

Parameters:

proc_name – the name of a stored procedure in the current database.

'function' – enables replication for a stored procedure associated with a function replication definition.

'table' – enables replication for a stored procedure associated with a table replication definition. For information on replicating stored procedures associated with table replication definitions, see *Replication Server Administration Guide Volume 2 > Asynchronous Procedures* .

'false' – disables replication for the stored procedure.

‘log_current’ – logs the execution of the stored procedure you are replicating in the current database, not in the database where the stored procedure resides.

‘log_sproc’ – logs the execution of the stored procedure you are replicating in the database where the stored procedure resides, not in the current database. **‘log_sproc’** is the default parameter.

Use **sp_setrepproc** according to these guidelines:

- To list all replicated objects in the database, enter **sp_setrepproc** with no parameters.
- To determine the replication status of the stored procedure, enter **sp_setrepproc** with the stored procedure name only.
- Enter **sp_setrepproc** with the stored procedure name and **'function'**, **'table'**, or **'false'** to enable each type of replication or to disable replication for the stored procedure. You must be the System Administrator or the Database Owner to use **sp_setrepproc** to change the replication status of a stored procedure.
- To log the execution of a replicated stored procedure in the database you choose, enter **sp_setrepproc** with **‘log_current’**, to log execution in the current database, or **‘log_sproc’**, to log execution in the database where the stored procedure resides.

For either applied or request function replication, specify **'function'** to indicate the type of replication definition associated with the stored procedure.

See *Replication Server Reference Manual > Adaptive Server Commands and System Procedures >* **sp_setrepproc**.

Subscribe to Replicated Functions

You must create subscriptions to function replication definitions for either applied or request functions using **create subscription** and the no-materialization method or **define subscription** and the other commands for bulk materialization: **activate subscription**, **validate subscription**, and **check subscription**.

The only exception is the function replication definitions with versions earlier than 15.1 used for request functions without subscription. See *Replication Server 15.6 Administration Guide Volume 2 > Pre-15.1 Request Function Replication*.

If you specified searchable parameters in the function replication definition, you can subscribe to a function based on the value of its parameters.

You drop subscriptions to function replication definitions using **drop subscription**. They are dropped without purging the replicate data associated with the function. You do not need to specify the **without purge** option.

See *Replication Server Reference Manual > Replication Server Commands*, and related commands, for the full syntax for bulk materialization commands.

See also

- *Bulk Materialization* on page 381

Modify or Drop Replicated Functions

Learn how to modify or drop replicated functions.

Alter a Function Replication Definition

Similar to table replication definitions, when you alter a function replication definition, Replication Server may create a new function replication definition version.

Replication Server processes old data rows that are already in the replication system using the old replication function definition version, while processing new data rows entering the Replication Server system using the new function replication definition version.

See also

- *Replication Definition Change Request Process* on page 327

Modify a Function Replication Definition

Use **alter applied function replication definition** and **alter request function replication definition** to alter the function replication definition to add new parameters, add new searchable parameters, or change the name of the destination stored procedure.

The syntax for the commands:

- **alter applied function replication definition**

```
alter applied function replication definition
function_applied_rep_def
    {with replicate function named 'proc_name' |
    add @param_name datatype[, @param_name datatype]... |
    add searchable parameters @param_name[, @param_name]... |
    send standby {all | replication definition} parameters ...|
    }[with DSI_suspended]
```

- **alter request function replication definition**

```
alter request function replication definition
function_request_rep_def
    {with replicate function named 'proc_name' |
    add @param_name datatype[, @param_name datatype]... |
    add searchable parameters @param_name[, @param_name]... |
    send standby {all | replication definition} parameters ...|
    }[with DSI_suspended]
```

These two commands are used to change the function replication definitions created by **create applied function replication definition** and **create request function replication definition** command respectively. See *Replication Server Reference Manual > Replication Server Commands* for more information about **alter applied function replication definition** and **alter request function replication definition**.

See *Replication Server 15.6 Administration Guide Volume 2 > Pre-15.1 Request Function Replication* to modify function replication definitions from versions of Replication Server earlier than 15.1.

To add new searchable parameters to the **where** clause of a **define subscription** command, drop and re-create the subscription for the function replication definition for applied and request functions.

See also

- *Create or Modify a Function String for a Replicated Function* on page 370
- *Implementing an Applied Function* on page 361
- *Implementing a Request Function* on page 364

Drop a Function Replication Definition

Use **drop function replication definition** to drop a function replication definition before you recreate it, in order to change or remove parameters, or to rename a function replication definition.

The syntax for this command is:

```
drop function replication definition function_rep_def
```

Re-create the function replication definition after you drop it. When you drop a function replication definition, the associated user-defined function and function string are also dropped. Subscriptions to a function replication definition must be dropped first. You can re-create the subscriptions after you re-create the function replication definition.

Create or Modify a Function String for a Replicated Function

When you create or alter a function replication definition, Replication Server automatically creates or alters the corresponding user-defined function. You must, however, create a function string for the user-defined function if you are not using a class that inherits function strings from **rs_default_function_class**, either directly or indirectly.

See *Replication Server Administration Guide Volume 2 > Customize Database Operations > Work with Functions, Function Strings, and Classes > Functions > User-defined Functions*.

Create a function string for a user-defined function in the function-string class assigned to the destination database for the replicated function. Use **create function string** at the primary Replication Server to create a function string for a user-defined function.

See *Replication Server Administration Guide Volume 2 > Customize Database Operations > Manage Function Strings > Function Strings and Function-string Classes*.

When you drop a function replication definition, Replication Server always drops the user-defined function and function strings.

You can customize function strings in function-string classes that allow it. In a typical application, the replicated user-defined function passes stored procedure parameter values to the destination Replication Server, and the function string executes the stored procedure with these values in the destination database.

To change the default function string to perform some other action, such as inserting data into an audit log, use the **alter function string** command at the primary Replication Server for the replicated function. The function-string class assigned to the destination database for the replicated function must allow you to customize function strings.

See *Replication Server Administration Guide Volume 2 > Customize Database Operations >* for information on creating and altering function strings. See *Replication Server Reference Manual > Replication Server Commands >* **create function string**.

Use Publications for Stored Procedures

You can use publications to select stored procedures and/or tables, along with their replication definitions, and subscribe to all of them as a group. Publications let you organize your replication definitions and subscriptions and then monitor their status with a single command.

See also

- *Use Publications* on page 341
- *Publication Subscriptions* on page 416

Manage Subscriptions

Subscriptions resemble SQL **select** statements. They identify the replication definition or publication to which you are subscribing, the source and destination databases and data servers, and the materialization method by which the initial information is to be copied.

You can use a **where** clause to specify a subset of rows or parameters that the destination database receives from the source database.

Materialization is the process of copying data specified by a subscription from a primary database to a replicate database, thereby initializing the replicate table. Replicate data can be transferred over a network, or, for subscriptions involving large amounts of data, loaded initially from media. Initialization from media is called bulk materialization. You use one of four materialization methods, depending on how you want materialization to affect the replication system.

Subscriptions for database replication definitions instruct Replication Server to replicate database objects from the primary to the replicate database. You can choose to replicate or not replicate individual tables, transactions, functions, system stored procedures, and data definition language (DDL). This method, called multisite availability (MSA), requires only a single database replication definition for each primary database and a single subscription for each subscribing database.

Subscriptions for table replication definitions instruct Replication Server to replicate data from primary tables into specified replicate tables. After you have created a replication definition for a primary table, replicate sites must subscribe to the replication definition at the primary database to receive updates.

Subscriptions for function replication definitions require you to use the no-materialization or the bulk materialization methods.

You can subscribe to a group of replication definition articles by subscribing to a publication. Publication subscriptions cannot contain **where** clauses. To subscribe to a subset of rows in an article, you must include a **where** clause when you create the article.

You create subscriptions at the Replication Server managing the database where the replicate data is to be maintained. Your previously created replication definition provides the location of the primary data and defines the structure of the primary table and optionally, of the replicate table, where they differ.

Subscriptions are added to the `rs_subscriptions` system table for both the primary and the replicate Replication Server. The materialization method you select determines how you create subscriptions.

Because a subscription can replicate a large set of rows, materialization can burden the network or impede applications that use the primary or replicate data.

See also

- *Manage Replicated Objects Using Multisite Availability* on page 425
- *Manage Replicated Functions* on page 355

Subscription Materialization Methods

Replication Server offers four methods for creating subscriptions, so you can regulate the effects of materialization on the replication system.

Table 29. Subscription Materialization Methods

Method	Description
Atomic materialization (default)	This method, invoked using the default form of the **create subscription** command, copies subscription data through the network in a single atomic operation. Replication Server executes the **rs_select_with_lock** function to retrieve the primary data. This method provides complete consistency throughout the materialization process, but may temporarily obstruct transactions using the primary or replicate data. Do not use this method for large subscriptions if a long-running transaction is unacceptable in the primary database.
Nonatomic materialization	This method, invoked using the **create subscription** command with the **without holdlock** clause, is similar to the atomic method, except that consistency constraints during materialization are relaxed to allow clients at the primary database to process transactions during materialization. Replication Server executes the **rs_select** function to retrieve the primary data. Subscription data is copied in a series of transactions. Because users are allowed to update primary data, this method may result in transactional inconsistency and incomplete data during materialization. When materialization is complete, all inconsistencies are fully corrected. Autocorrection for the replicate table must be enabled to resolve inconsistencies.

Method	Description
Direct load materialization	This method, invoked using the **create subscription** command with the **without holdlock direct_load** clause, differs from nonatomic materialization method in that: • Data is loaded directly from a primary table into a replicate table. • During the autocorrection phrase, subscriptions fail if there are primary key updates. • Replication of other tables is not suspended during direct load materialization. • The replicate DSI does not go down if there is an error for a subscription. • Multiple tables can be materialized concurrently. • Multiple threads can be used to load data from one primary table to a replicate table.
No materialization	This method, invoked using the **create subscription** command with the **without materialization** clause, allows you to create a subscription when the subscription data already exists at the replicate database. You can use this method to create subscriptions to table replication definitions, function replication definitions, and database replication definitions.
Bulk materialization	This method is appropriate when there is too much data to copy through the network. This is a "manual" materialization method that allows you to load the subscription data from media such as magnetic tape. Use this method for subscriptions to database replication definitions and to function replication definitions when data must be initialized at the replicate database. The commands used for bulk materialization are **define subscription**, **activate subscription**, and **validate subscription**.

Atomic Materialization

Atomic materialization is the default materialization method. It is the easiest method to execute and maintains complete data consistency throughout the materialization process.

During atomic materialization, Replication Server logs in to the primary data server as the user creating the subscription and with the password defined at the replicate Replication Server. Therefore, the user must be defined at both the replicate Replication Server and primary database with the same password. The user also needs the same login name and password as the primary Replication Server.

Logged in to the primary data server, the Replication Server selects the subscription rows using a **select with holdlock** operation specified by the **rs_select_with_lock** function. The

holdlock performs a repeatable read, preventing other transactions at the primary site from updating the data until the **select** transaction has completed. The rows are transferred to a materialization queue at the replicate site, where they are applied to the replicate database. You must provide the stable queue with adequate partition space to handle the operation.

Atomic materialization is best for smaller subscriptions where the **select with holdlock** operation does not last long enough to disturb client applications using the primary database. If the subscription selects a large number of rows, you may choose to use nonatomic or bulk materialization, so that clients at the primary database are not affected.

When data already exists at the replicate database, you can use the no-materialization method.

Atomic materialization allows changes to the primary table but effectively delays data server changes until the activation phase of materialization has completed.

Incremental Atomic Materialization

You can avoid long-running transactions at the replicate database by using the **incrementally** option.

The incremental option sends materialization data to the replicate database in a series of transactions, rather than in one large transaction. Otherwise, incremental and non-incremental atomic materialization are identical. Subscription data is available but incomplete until materialization has completed and the subscription is validated.

Rows are removed from the stable queue after they have been successfully inserted, so less partition space is required. You can truncate the database transaction log during materialization, if necessary.

Users at the replicate site will see partial subscription data during materialization, which may invalidate some queries. However, they will have access to inserted rows sooner, which may be beneficial.

The **publishers_rep** replication definition presented in the topics on how to manage replicated tables is used in the following example to create a subscription. The **create subscription** command in the example has no **where** clause, so the subscription causes Replication Server to replicate all the rows in the replication definition. The **incrementally** keyword ensures that the replicate database transaction log does not become full. Clients at the replicate site can be suspended or warned that the `publishers` table is materializing and will contain incomplete data until the process has completed.

```
create subscription publishers_sub
for publishers_rep
with replicate at SYDNEY_DS.pubs2
incrementally
```

See also

- *Specify the Replication Definition Name and Table Names* on page 293

Nonatomic Materialization

Nonatomic materialization, using the **without holdlock** option of the **create subscription** command, is the same as atomic materialization, except for some differences.

Nonatomic materialization differs from atomic materialization because:

- The data is selected from the primary database without a holdlock. Clients at the primary site can update the data while the **select** operation is in process.
- Transactions are always applied incrementally at the replicate database.

Note: If the **replicate minimal columns** feature is set for the replication definition, you cannot create new subscriptions using nonatomic materialization.

With version 15.2, in nonatomic materialization, Replication Server inserts rows into the replicate database incrementally in 1000-row transactions. Clients at the replicate site that are using the table will see partial subscription data during materialization. This may invalidate some queries. Since the subscription is activated before the data is copied to the replicate database, primary table changes may be applied twice to the replicate table in some circumstances. You must enable autocorrection when you use nonatomic materialization. Autocorrection ensures that a second application of data does not result in an error.

Autocorrection for Nonatomic Materialization

To enable autocorrection, issue the **set autocorrection** command with the **on** option for each replication definition to which you plan to subscribe using nonatomic materialization. .

When using autocorrection, if Replication Server updates or inserts a row in a primary table, it converts the update or insert into a delete followed by an insert, so that the update or insert operation cannot fail because of an existing row.

During nonatomic subscription materialization, Replication Server selects data without a holdlock. After adding the data to the replicate database, Replication Server applies replicated commands. If you enable autocorrection, Replication Server corrects certain temporary inconsistencies that may be caused by selecting the data using the **without holdlock** option.

However, if you execute replicated stored procedures that change subscription data during materialization, autocorrection does not always correct the replicate database. During function calls, autocorrection does not protect against inconsistencies.

After a subscription that uses nonatomic materialization has materialized, you can disable autocorrection for better performance. If you disable autocorrection, you can also specify minimal column replication.

See *Replication Server Reference Manual > Replication Server Commands >* ***set autocorrection***.

See also

- *Replicate the Minimal Set of Columns* on page 299

Direct Load Materialization

Use direct load materialization to materialize data between different primary and replicate databases. Direct load materialization is also available between two SAP ASE databases.

Direct load materialization differs from other automatic materialization methods:

- This automatic materialization method can be used for SAP ASE, Microsoft SQL Server, Oracle, and DB2 UDB primary databases.
- Materialization queues are not used with direct load materialization. Data is loaded directly from a primary table into a replicate table.
- Replication is suspended selectively:
  - Replication of tables continues for tables that are not being materialized. DML operations on a primary table that is not being materialized are replicated into the replicate table as the DSI receives them.
  - DML operations on a primary table that is being materialized are stored in a catch-up queue and applied to the replicate table after the initial materialization phase.

    Note: When DML operations in a catch-up queue are applied to the replicate table, each **insert** operation is converted into a **delete** followed by an **insert**. Materialization fails when an update changes the primary key.
- Multiple tables can be concurrently materialized with direct load materialization.
- When subscription materialization stops due to an error, regular replication of other tables is not suspended.
- Multiple threads can be used to load data from one primary table to its corresponding replicate table. You can tune this multi-threaded behavior with **max_mat_load_threads**.
- When a subscription is materialized using **direct_load**, you can use the configuration parameter **dsi_check_unique_key** to control the SAP Replication Server behavior on checking the no unique key criteria. This configuration parameter is available at the server-level through **configuration replication server** and at the connection-level through **alter connection**. Its possible values are on and off, and on is its default value.

  If **dsi_check_unique_key** is on, the primary tables with no unique key must not have any activity until the subscription is VALID. If the activity occurs, the subscription may fail during the catch-up phase and the subscription is aborted, and marked with error. When the subscription is aborted, it must be dropped and recreated. Before recreating the subscription, cleaning up the replicate table (like truncate table) is required.

  When you set **dsi_check_unique_key** to off, the subscription may be created successfully, but may potentially have data inconsistency. Turn off this configuration parameter only under these circumstances to ensure data is correct following subscription validation:
  - There cannot be any delete statements at the primary table with no unique key.
  - There cannot be any insert statements of duplicate rows at the primary table with no unique key.

Direct load materialization can be used to materialize data from:

- SAP ASE to SAP ASE
- SAP ASE to SAP HANA database
- Microsoft SQL Server to SAP HANA database
- Oracle to SAP HANA database
- DB2 UDB to SAP HANA database

Direct load materialization is enabled through the **direct_load** option of the **create subscription** command. When using direct load materialization, note these restrictions for **create subscription**:

- When the **direct_load** option is used, no other subscription can be created or defined at the same time for the same replicate table.
- The **direct_load** option is for subscriptions to table replication definitions only and is used with **without holdlock**. It cannot be used with the **without materialization** or **incrementally** options.
- The **user** and **password** options are used only with **direct_load**.
- You cannot use the **direct_load** option against a logical or alternate connection. The primary connection in the replication definition and the replicate connection in the subscription must be physical connections.
- The maintenance user of the primary database cannot be used in the **user** and **password** options to create subscriptions.
- You cannot use other automatic materialization methods if the primary database is not SAP ASE. The only automatic materialization option for Oracle or other databases is direct load materialization.
- You cannot drop a subscription with the **with purge** option if the replicate database is not SAP ASE.
- The **direct_load** option is available only if the replicate SAP Replication Server site version and route version are 1571100 or later.
- You can use row filtering, name mapping, customized function strings and datatype mapping with subscriptions created using the **direct_load** option.
- If you create a subscription with the **direct_load** option and if the number of concurrent subscription requests exceeds **num_concurrent_subs**, SAP Replication Server marks the subscription as PENDING. SAP Replication Server processes the subscription only after the number of concurrent subscription requests falls below **num_concurrent_subs**.

Primary Database Considerations

- Depending upon the primary database, SAP Replication Server either connects directly to the primary database, or connects to the Replication Agent for that primary database.
- You must have Replication Agent version 15.7.1 SP100 or later to materialize data from a non-SAP ASE primary database using direct load materialization.

- When invoking the **create subscription** command, if SAP Replication Server connects to Replication Agent, it needs to use the Replication Agent administrator login name and password.

Direct Load Materialization from Adaptive Server to Adaptive Server

Use this procedure to set up direct load materialization and enable replication from an Adaptive Server primary to an Adaptive Server replicate.

1. Use **isql** to log in to the replicate Replication Server:

   ```
   isql -Uiuser -Pipassword -SRRS_servername
   ```

   where:
   - *iuser* is the subscription creator, who must have **create object** permission.
   - *ipassword* is the password for *iuser*.
   - *RRS_servername* is the server name of the replicate Replication Server.
2. At the replicate Replication Server, create the subscription:

   ```
   create subscription subscription_name
   for replication_definition
   with replicate at dataserver.database
   [where search_conditions]
   without holdlock
   direct_load

   [user cusername password cpass]
   go
   ```

   The *dataserver.database* must match the Replication Server connection name you use for the replicate database. If you specify *cusername* here, this name is used to log in to the primary database and select from the primary table. If you do not specify *cusername* here, *iuser*—the name specified in **isql**—is used. Make sure that the name used to log in to the primary database has necessary permission at the primary database.
3. Monitor the progress of the subscription materialization:

   ```
   check subscription subscription_name for repdef_name
   with replicate at replicate_dataserver.replicate_database
   go
   ```

   When materialization is complete, Replication Server returns a message similar to:

   ```
   Subscription subscription_name has been MATERIALIZED at the
   replicate.
   ```

   When the subscription process is complete, Replication Server returns a message similar to:

   ```
   Subscription subscription_name is VALID at the replicate.
   ```

   If there is an error in the subscription process, the **check subscription** command returns a message similar to:

   ```
   Subscription subscription_name encountered ERROR.
   ```

When a subscription encounters an error, look at the replicate and primary Replication Server log files to diagnose the cause, drop the subscription without purge, delete data from the replicate table, correct the error, and then recreate the subscription. See the *Replication Server Troubleshooting Guide > Subscription Problems > check subscription > Materialization Status* and the *Replication Server Troubleshooting Guide > Subscription Problems > Materialization Problems*.

See the *Replication Server Reference Manual > Replication Server Commands* for information on configuring Replication Servers and materialization methods.

No Materialization

You can use **create subscription** with the **without materialization** clause to activate a subscription when materialization has already occurred..

To use this method:

- The subscription data must already exist at the replicate database
- The primary and replicate tables must be synchronized
- Activity must be stopped on the primary table so that there are no further updates in the Replication Server stable queues

When creating a subscription with the **without materialization** clause, Replication Server logs in to the primary Replication Server as the user creating the subscription. The user who executes **create subscription** must have the same login and password at the primary and replicate Replication Servers.

You can also use **create subscription** with the **without materialization** clause to subscribe to function replication definitions.

Bulk Materialization

With bulk materialization, you manually transfer subscription data between databases.

Use bulk materialization when a subscription is too large to copy through the network. Bulk materialization has very little effect on primary database clients or on the network.

You can use bulk materialization to create subscriptions for function replication definitions for replicated functions.

Bulk materialization uses these commands, which are executed at different points in the materialization process: **define subscription**, **activate subscription**, **validate subscription**. Use the **check subscription** command to check the status of the subscription.

When you use bulk materialization, you must coordinate:

- The dump to media of the subscription data at the primary site.
- The load from media into the table at the replicate site.
- The application of updates made at the primary site after you make the media dump.

Note: Bulk materialization may require special handling if the primary and replicate databases differ in, for example, table or column names.

Three bulk-materialization methods are available to ensure data consistency between the primary and replicate sites. The method you use depends mainly on whether applications using the primary data can tolerate interruptions.

You can use any of these methods for subscriptions to either table or function replication definitions. With subscriptions to function replication definitions, it may not be obvious which replicate tables will be affected by stored replicated procedures executing in the replicate database.

Before you initiate bulk materialization, you must consider these issues in relation to the existing data in the replicate database.

See also

- *Manage Replicated Functions* on page 355

Summary of Bulk Materialization Methods

There are three bulk materialization method.

Table 30. Summary of Bulk Materialization Methods

Method	Summary of process
Stop updates to the primary table and take a snapshot of the data	Stop all applications from updating the primary data and then retrieve the subscription data from the primary database with a **select** statement or database dump. Define the subscription and activate it with an option that leaves the DSI suspended for the replicate database. Clients can resume updates to the primary data. After you load the subscription data into the replicate database, you can resume the DSI and validate the subscription.
Simulate atomic materialization	Allow client applications to continue executing transactions against the primary data while the subscription data is retrieved. After defining the subscription, you lock the primary data, retrieve the subscription data, and activate the subscription. The **activate subscription** command leaves the DSI for the replicate database suspended. After you load the subscription data into the replicate database, you can resume the DSI and validate the subscription.
Simulate nonatomic materialization	This method is the same as simulating atomic materialization, except that you activate the subscription first, and then retrieve the data from the primary database without locking the data. Because of this, the data at the replicate database may be inconsistent with the data at the primary database until the subscription is validated and you are required to enable autocorrection for the replicate data.

Stop Updates at the Primary Database and Take a Snapshot

You can use either of two bulk materialization methods to stop updates at the primary database and take a snapshot.

The two methods are:

- Using the Adaptive Server **mount** command
- Using the Adaptive Server **dump** and **load**, **select**, or **bcp** command

Use these methods to retrieve data from the primary database if you are able to suspend updates to the primary data. To maintain consistency, all updates to the primary database are suspended for the duration of the materialization.

Retrieving Data from the Primary Database Using the Adaptive Server mount Command

Use the **mount** command to retrieve data from the primary database.

Prerequisites

You can use this method only if you are using Adaptive Server version 12.5.1 or later, and your primary and replicate databases are identical.

Task

1. Verify that the entire replication system is working.

   See *Replication Server Administration Guide Volume 2 > Verify and Monitor Replication Server*.
2. Suspend updates to the data in the primary database by stopping client applications that generate transactions against the primary data directly or indirectly through Replication Servers.
3. Quiesce the replication system components involved with replicating data from the primary Replication Server to the replicate Replication Server.

   Use **admin quiesce_for_rsi** at the primary and replicate Replication Servers and any intermediate Replication Servers.
4. Execute the Adaptive Server command **quiesce database** *tag_name* **hold** *db_name list* **[for external dump] to** *manifest_file* **[with override]]** to generate the manifest file.

   See the *Adaptive Server Enterprise Reference Manual*.
5. Take a snapshot of the subscription data from the primary database by creating a data dump of both the database and log devices.

   You can create a data dump using utilities such as **tar** or **zip**, or the UNIX **dd** command.
6. Use **mount database** to begin loading the snapshot data into the replicate database.
7. Resolve the mismatch of user information between the master database and the loaded user database.
8. Use **rs_init** to add the replicate database to the replication system if it is not already there.
9. Execute **define subscription** at the replicate Replication Server.
10. Use **check subscription** at the primary and at the replicate Replication Servers to verify that the subscription has been defined. When the subscription status is DEFINED at both servers, continue to step 11.

11. Execute **activate subscription** at the replicate Replication Server.
12. Use **check subscription** at the primary and at the replicate Replication Server to verify that the subscription has been activated. When the subscription status is ACTIVE at both servers, continue to step 13.
13. Execute **quiesce release** to resume updates to the primary data.
14. Execute **validate subscription** at the replicate Replication Server.
15. Use **check subscription** at the primary and at the replicate Replication Server to verify that the subscription is VALID at both servers.

When you have completed this procedure, the subscription is created, the replicate data is consistent with the primary data, and replication is active.

Retrieving Data from the Primary Database Using the Adaptive Server dump and load, select, or bcp Commands

Use the Adaptive Server **dump** and **load**, **select**, or **bcp** commands and utilities to retrieve data from the primary database.

1. Verify that the entire replication system is working.

   See *Replication Server Administration Guide Volume 2 > Verify and Monitor Replication Server.*
2. Suspend updates to the data in the primary database by stopping client applications that generate transactions against the primary data.
3. Quiesce the replication system components involved with replicating data from the primary Replication Server to the replicate Replication Server.

   Use **admin quiesce_force_rsi** at the primary and replicate Replication Servers and at any intermediate Replication Servers.
4. Execute **suspend log transfer** for the primary database.
5. Take a snapshot of the subscription data from the primary database using a **select** statement or a database dump.
6. Execute **define subscription** at the replicate Replication Server.
7. Use **check subscription** at the primary and at the replicate Replication Servers to verify that the subscription has been defined. When the subscription status is DEFINED at both servers, continue to step 9.
8. Execute the **activate subscription** command, using the **with suspension** clause, at the replicate Replication Server.
9. Use **check subscription** at the primary and at the replicate Replication Server to verify that the subscription has been activated.When the subscription becomes active at the replicate Replication Server, the DSI connection to the replicate Replication Server is suspended.

   When the subscription status is ACTIVE at both servers, continue to step 11.
10. Execute **resume log transfer** from the primary database at the primary Replication Server.

11. Begin loading the snapshot data into the replicate database.

    Note: While you wait for the data to finish loading in the replicate database, you can continue with the next step.

12. Execute **validate subscription** at the replicate Replication Server to validate the subscription.
13. Use **check subscription** at the primary and at the replicate Replication Server to verify that the subscription status is VALID for both servers.
14. When the snapshot data has finished loading in the replicate database, execute **resume connection** to resume the connection to the replicate database.

When you have completed this procedure, the subscription is created, the replicate data is consistent with the primary data, and replication is active.

Simulate Atomic Materialization

Use simulate atomic materialization as a bulk materialization method when you cannot suspend updates to the primary database.

This method ensures replicated data consistency by retrieving the subscription data, activating the subscription, and suspending the DSI connection to the replicate database all in one transaction at the primary data server.

1. Verify that the entire replication system is working.

   See *Replication Server Administration Guide Volume 2 > Verify and Monitor Replication Server*.
2. Execute the **define subscription** command at the replicate Replication Server.
3. Wait for the subscription to be defined at both the primary and replicate Replication Servers. Execute the **check subscription** command at both the primary and replicate Replication Servers to verify that the subscription status is DEFINED.
4. Activate the subscription by executing a single transaction as shown in this sample transaction that includes **select with holdlock** and the **rs_marker** stored procedure.

   ```
   begin transaction
   select from table with holdlock
   where search_conditions
   execute rs_marker
   'activate subscription subid
   with suspension'
   commit transaction
   ```

   subid is an integer that identifies the subscription. The *subid* for a subscription can be found in the `subid` field of the `rs_subscriptions` system table in the RSSD. After the subscription is defined, you can find its *subid* by executing the following query in the RSSD of the primary or replicate Replication Server:

   ```
   select subid from rs_subscriptions
   where subname = 'subscription'
   and dbid in (select connid from rs_databases
   ```

```
where dbname = 'rep_connection_dbname'
and dsname = 'rep_connection_dsname')
```

where *rep_connection_dbname* and *rep_connection_dsname* can be for the default or alternate connections.

5. Wait for the subscription to become active at both the primary and replicate Replication Servers. Execute the **check subscription** command at the replicate Replication Server to verify that the subscription status is ACTIVE. When the subscription status is ACTIVE at the replicate Replication Server, the database connection for the replicate database has been suspended.
6. As soon as the subscription becomes active at the primary Replication Server, retrieve the data from the primary database using a **select** or a database dump.
7. Find the ID number (*subid*) for the subscription by querying the `rs_subscriptions` system table.

   ```
   select subid from rs_subscriptions
   where subname = 'subscription'
   and dbid in (select connid from rs_databases
   where dbname = 'rep_connection_dbname'
   and dsname = 'rep_connection_dsname')
   ```
8. Execute the **rs_marker** stored procedure in the primary database:

   ```
   rs_marker 'validate subscription subid'
   ```

   Warning! Be sure that you execute the **rs_marker** stored procedure with the correct *subid* number for the subscription. The `subid` column in the `rs_subscriptions` system table contains the unique ID number for each subscription. Entering any other number or character string may cause serious problems.

   For more information on **rs_marker** see *Replication Server Reference Manual*.
9. Load the subscription data into the replicate database.
10. Enable autocorrection for the replication definition at the replicate database.
11. Use the **resume connection** command to resume the database connection for the replicate database.
12. Wait for the subscription to become valid at both the primary and replicate Replication Servers. Execute the **check subscription** command at the replicate Replication Server to verify that the subscription status is VALID. Once the subscription status is VALID, the replicate data is consistent with the primary data.
13. Disable autocorrection for the replicate database.

Now the subscription is created and replication is active.

See also

- *Autocorrection for Nonatomic Materialization* on page 377
- *Replicating Tables in the Example Replication System* on page 406

Simulate Nonatomic Materialization

Use simulate nonatomic materialization as a bulk materialization method when you cannot suspend updates to the primary database or if you cannot lock the primary data during the **select** or **dump** operation that retrieves the subscription data.

This method allows a period of flux at the replicate site during which the replicate data may be inconsistent with the primary data. By the time the subscription becomes VALID, however, the data should be consistent. You must set autocorrection on during materialization so that inconsistencies resulting from continuing updates in the primary database can be resolved without errors.

Warning! Do not use this method if the **replicate minimal columns** feature is set for the replication definition or if you execute applied functions or applied stored procedures from the primary database to modify data in the replicate database. In both cases, autocorrection cannot resolve the inconsistencies.

1. Verify that the entire replication system is working.

   See *Replication Server Administration Guide Volume 2 > Verify and Monitor Replication Server*.
2. Execute the **define subscription** command at the replicate Replication Server.
3. Wait for the subscription to be defined at both the primary and replicate Replication Servers. Execute the **check subscription** command at both the primary and replicate Replication Servers to verify that the subscription status is DEFINED.
4. Execute the **activate subscription** command, using the **with suspension** clause, at the replicate Replication Server.
5. Wait for the subscription to become active at both the primary and replicate Replication Servers. Execute the **check subscription** command at the replicate Replication Server to verify that the subscription status is ACTIVE. When the subscription status is ACTIVE at the replicate Replication Server, the database connection for the replicate database has been suspended.
6. As soon as the subscription becomes active at the primary Replication Server, retrieve the data from the primary database using a **select** or a database dump.
7. Find the ID number (*subid*) for the subscription by querying the `rs_subscriptions` system table.

   ```
   select subid from rs_subscriptions
   where subname = 'subscription'
   and dbid in (select connid from rs_databases
   where dbname = 'rep_connection_dbname'
   and dsname = 'rep_connection_dsname')
   ```

   where *rep_connection_dbname* and *rep_connection_dsname* can be for the default or alternate connections.
8. Execute the **rs_marker** stored procedure in the primary database:

```
rs_marker 'validate subscription subid'
```

Warning! Be sure that you execute the **rs_marker** stored procedure with the correct *subid* number for the subscription. The `subid` column in the *rs_subscriptions* system table contains the unique ID number for each subscription. Entering any other number or character string may cause serious problems.

For more information on **rs_marker** see *Replication Server Reference Manual*.

9. Load the subscription data into the replicate database.
10. Enable autocorrection for the replication definition at the replicate database.
11. Use the **resume connection** command to resume the database connection for the replicate database.
12. Wait for the subscription to become valid at both the primary and replicate Replication Servers. Execute the **check subscription** command at the replicate Replication Server to verify that the subscription status is VALID. Once the subscription status is VALID, the replicate data is consistent with the primary data.
13. Disable autocorrection for the replicate database.

Now the subscription is created and replication is active.

See also

- *Autocorrection for Nonatomic Materialization* on page 377
- *Replicating Tables in the Example Replication System* on page 406

Bulk Copy-in and Subscription Materialization

Use bulk copy-in to improve the performance of subscription materialization.

When **dsi_bulk_copy** is on, Replication Server uses bulk copy-in to materialize the subscriptions if the number of **insert** commands in each transaction exceeds **dsi_bulk_threshold**.

Note: In normal replication, bulk operation is disabled for a table if **autocorrection** is on. However, in materialization, bulk operation is applied even when **autocorrection** is enabled, if **dsi_bulk_threshold** is reached and the materialization is not a nonatomic subscription recovering from failure.

See also

- *Configuration Parameters Affecting Physical Database Connections* on page 177

Dematerialization Processing

Dematerialization removes subscriptions and, optionally, data from the replicate database. Dematerialization also removes subscription information from the RSSDs at the primary and replicate sites.

Dropping a subscription causes Replication Server to stop sending changes from a primary database to a replicate database. You can use the **drop subscription** command to drop subscriptions for either table or function replication definitions.

drop subscription removes the subscription from the RSSDs of the primary and replicate Replication Servers.

When you drop a subscription to a table replication definition, you can specify that Replication Server delete the subscription’s rows from the replicate database. Or, you can delete the rows manually.

When you drop a subscription to a function replication definition, the replicate data associated with the function is not deleted from the replicate database.

There are two methods of dematerialization:

- **with purge** dematerialization, which selectively deletes rows not used by other subscriptions
- **without purge** dematerialization, which allows you to manually delete rows in replicate tables

In either case, the primary Replication Server stops sending data for the dropped subscription, if the data is not included in other subscriptions at the same replicate site.

Note: For user defined datatypes: Subscriptions that specify columns subject to class- or column-level translations in the **where** clause cannot be dematerialized automatically. You must use the bulk or no-materialization method.

Dematerialization and Purging Rows

Use the **with purge** clause when you want to delete rows replicated by the subscriptions you are dropping.

Use the **incrementally** option to delete rows in 1000-row increments. The maintenance user for the replicate database must have **select** permission on the table to use this option.

Dematerializing a subscription and purging rows from the replicate table uses function strings for the **rs_select** or **rs_select_with_lock** system functions. You may be required to create a function string for these system functions.

- If the connection for the replicate database uses a function-string class with default-generated function strings or a function-string class inherited from such a class, Replication Server generates a corresponding default function string for the **rs_select_with_lock** or **rs_select** functions.

- If the connection uses any other function-string class, you must create the function string, with an input template that matches the subscription's **where** clause. Use the **create function string** command.

See *Replication Server Administration Guide Volume 2 > Customize Database Operations > Function-string Classes* for details.

If you are using a function-string class in which you can customize function strings, you can replace an existing default or custom function string with one that performs a select operation that your application requires, using the **alter function string** command.

For more information on creating or altering **rs_select** and **rs_select_with_lock** function strings, see *Replication Server Administration Guide Volume 2 > Customize Database Operations > Manage Function Strings*.

Dematerialization Without Purging Rows

Dropping a subscription using the **without purge** option leaves the rows replicated by the subscription in the replicate table.

Subscriptions to function replication definitions are dropped automatically using the **without purge** option. You do not need to specify this option. You must, however, specify this option if you want to keep the rows in the replicate table. If you want to manually delete rows, you must use the **with suspension** option as well.

Monitor Materialization and Dematerialization

Subscriptions pass through phases before they are fully set up or removed from the replication system. Learn the phases for setting up a subscription or removing subscription data.

The phases for setting up a subscription are:

- Definition – **create subscription** or **define subscription** add the subscription to the RSSD for the primary and replicate Replication Servers.
- Activation – takes place after subscription resolution. The primary Replication Server adds the subscription to the Subscription Resolution Engine (SRE). The SRE compares log records to the current subscriptions to determine where changes to replicated tables must be distributed.
- Materialization – for atomic and nonatomic subscriptions, the primary Replication Server retrieves subscription data from the primary database and copies it to the replicate Replication Server to be applied to the replicate database.
- Validation – both the primary and replicate Replication Server completely materialize the subscription and verify it is consistent with the primary data.

The phases for removing subscription data, using the **drop subscription** command, are:

- Dematerialization – stops sending updates for the subscription to the replicate database and, if the **with purge** clause is specified, deletes the subscription data from the replicate database (if the data is not included in other subscriptions). If the **without purge** clause is specified, then Replication Server does not delete the data from the replicate database.
- Removal – deletes the subscription from the RSSD for both the primary and replicate Replication Servers.

Materialization or dematerialization can fail during any of these stages. This is why you need to monitor the progress of a subscription using the **check subscription** command.

In addition to the **check subscription** command, you can use the **admin who** command to check the status of the Replication Server threads processing the subscription. For atomic and nonatomic materialization, Replication Server builds a materialization queue that contains rows to be added to the replicate table. The **admin who, sqm** command can monitor queue activity, and the **admin who, dsi** command can show you whether the DSI thread is running.

See *Replication Server Reference Manual > Replication Server Commands* for information about executing **admin who** and interpreting its results.

See the *Replication Server Troubleshooting Guide* for comprehensive troubleshooting information that details the status of a subscription and suggested actions.

See also

- *check subscription Command* on page 402

Verifying that the Replication System Is Ready Before You Create Subscriptions

Before creating subscriptions, verify that the replication system is ready.

1. Verify that all components in the replication system are working. See *Replication Server Administration Guide Volume 2 > Verify and Monitor Replication Server > Verify a Replication System* for details.
2. Make sure the following database objects and permissions exist:
   - One or more replication definitions exist for the primary table.
   - The primary table is marked as replicated with **sp_setreptable** or **sp_reptostandby** for warm standby applications.
   - A table corresponding to the replication definition exists in the replicate database. Its columns must match those specified for the replicate database in the replication definition. Its datatypes must match the corresponding primary columns.

     This table must also be visible to the user creating the subscription and the user maintaining it. If an owner name is included in the replication definition, the table must be visible to all database users. If an owner name is not included in the replication definition, the easiest way to make the table accessible is to have the Database Owner create it.

- The replicate database maintenance user must have:

  select, **insert**, **update**, and **delete** permissions on the replicate table, and **execute** permission for functions used in replication.

  If the subscription for the table includes the **subscribe to truncate table** clause, the maintenance user must have **replication_role**, **sa_role**, or alias the Database Owner.

3. Make sure that you meet recommended guidelines for the character sets and sort orders used throughout your replication system. These play an important role in processing subscriptions, and they must be consistent everywhere for subscriptions to be valid. Refer to the *Replication Server Design Guide* for guidelines.
4. Choose one of the subscription materialization methods and verify the following requirements for your chosen method:

   - For nonatomic materialization, you must enable autocorrection for the replicate table. See *Replication Server Reference Manual > Replication Server Commands* for **set autocorrection** command details.

     If the **replicate minimal columns** feature is set for the replication definition, you cannot create new subscriptions using nonatomic materialization.
   - For atomic and nonatomic materialization:

     A default function-string class or a function-string class inherited from a default function-string class generates default function strings for the **rs_select_with_lock** or **rs_select** functions. If you use other function-string classes, you must create function strings for the **rs_select_with_lock** or **rs_select** functions, with an input template that matches the subscription's **where** clause.

     To modify **rs_select** or **rs_select_with_lock**, use a function from the function string class associated with the primary database connection, not the functions in the replicate database connection.

     See *Replication Server Administration Guide Volume 2 > Customize Database Operations > Function-string Classes* and *Replication Server Administration Guide Volume 2 > Customize Database Operations > Managing Function Strings > Using Input Templates* for details.
   - If you are creating a subscription with either atomic or non-atomic materialization methods and you have columns that require quoted identifiers in the replication definition, you must configure the primary connection to use quoted identifiers.
   - If you are using quoted identifiers with a custom function string that includes a quoted constant, **create subscription** without a quoted constant or **without materialization** clause. Otherwise, during subscription materialization the quoted constant causes a query failure. The replicate data server identifies the quoted constant as a column instead of a constant.
5. When you create subscriptions, use the login name of a regular user. Do not create subscriptions as the maintenance user.

Make sure the user creating the subscription has the following login names and permissions:

- Same login name and password at the replicate Replication Server, the primary Replication Server, and the primary data server. If you are using bulk materialization or the no-materialization method, you are not required to have a login name for the primary data server.
- **select** permission on the primary table. This does not apply if you are using bulk materialization or no materialization.
- **execute** permission on the **rs_marker** stored procedure in the primary database or no materialization.
- **create object** or **sa** permission in the replicate Replication Server.
- **primary subscribe**, **create object**, or **sa** permission in the primary Replication Server.

See also

- *Autocorrection for Nonatomic Materialization* on page 377
- *Subscription Materialization Methods* on page 374

Subscription Commands

You can manage subscriptions with RCL commands.

You can use the RCL commands to:

- Create subscriptions for atomic and nonatomic materialization and for the no-materialization method.
- Define, activate, and validate subscriptions for bulk materialization.
- Check the status of subscriptions during the materialization process.
- Drop subscriptions to initiate the dematerialization process.
- Enable replication of the **truncate table** command when you create or define a subscription.

You can use a **where** clause to control which table rows or function invocations to replicate. The **where** clause can specify only the searchable columns or searchable parameters specified in the table or function replication definition. If you do not provide a **where** clause, all the rows of the replication definition's columns, or all the function invocations, are replicated.

If you are using Adaptive Server Enterprise version 11.5 or later, you can include the **subscribe to truncate table** keywords to reproduce execution of the **truncate table** command at the destination database.

Table 31. Commands for Managing Subscriptions

Command	Task
create subscription	Creates a subscription that transfers the initial version of the replicated data using either: • Atomic materialization, which copies the initial version of the data for a subscription as a single transaction, or • Nonatomic materialization, which copies the data in a series of transactions. Users at the replicate site can see some of the data before it all arrives. Replication Server does not create a materialization queue for the entire set of subscription data. • Direct load materialization, which copies the primary data directly to the replicate site. Users at the replicate site can see some of the data before it all arrives. Replication Server does not create a materialization queue, but it creates a catchup queue to hold DML for the primary table before the subscription status is VALID. The content of the queue is applied to the replicate Replication Server after the data initially selected from the primary is applied to the replicate database. Use **create subscription** with the **without materialization** clause to activate a subscription for which the initial version of the replicated data already exists at the replicate database. You can also use **create subscription** to create subscriptions for table replication definitions. Use **create subscription**, with the **without materialization** clause, for function replication definitions.
define subscription	The first step in bulk materialization defines a subscription. You can use **define subscription** and the other bulk materialization commands to create subscriptions for either table or function replication definitions when you create replicated functions. You must transfer data manually, as necessary. Data replication begins after materialization is complete and a subscription is activated and validated. Use **check subscription** to verify subscription status.
activate subscription	Second step in bulk materialization. Activates a subscription at both primary and replicate Replication Servers. This causes the primary Replication Server to start sending changes to the subscription's data to the replicate Replication Server.
validate subscription	Third step in bulk materialization. Changes the subscription status at both the primary and replicate sites to VALID.
check subscription	Verifies the status of a subscription at both the primary and replicate sites. Use this command with all types of subscription materialization.
drop subscription	Removes a subscription from the replication system. For subscriptions to table replication definitions, optionally removes subscription rows from the replicate table in a process known as dematerialization.

See also

- *Manage Replicated Functions* on page 355
- *Enable Replication of truncate table* on page 396

- *Commands for Managing Table Replication Definitions* on page 285
- *Commands for Managing Function Replication Definitions* on page 358

Use the where Clause

You can include one **where** clause in a subscription to create selective subscriptions.

The **where** clause syntax is a subset of the Transact-SQL **where** clause. The **where** clause is supported by the **create subscription** and **define subscription** commands for subscriptions to replication definitions. The supported syntax is the same for both commands and allows you to create very selective subscriptions. It is designed for efficient processing by the Subscription Resolution Engine in Replication Server.

Note: You cannot evaluate a Java column in a subscription expression. Thus, you cannot include a column of type `rawobject` or `rawobject in row` in a subscription **where** clause.

For subscriptions to table replication definitions, the **where** clause syntax is:

```
where column_name{< | > | <= | >= | = | &} value
    [and column_name{< | > | <= | >= | = | &}
     value]...
```

For subscriptions to function replication definitions, the **where** clause syntax is:

```
where @param_name
        {< | > | <= | >= | = | &} value
    [and @param_name
        {< | > | <= | >= | = | &} value]...
```

See *Replication Server Reference Manual > Topics > Datatypes* for entry formats for values for different datatypes.

Note: The **!=**, **!<**, **!>**, and **or** operators are not supported. You can create multiple subscriptions instead of using the **or** operator. The **&** operator is supported only on `rs_address` columns.

Each column name in a **where** clause must be listed in the **searchable columns** list of the table or function replication definition. The *value* for each column must have the same datatype as the column to which it is compared.

For example, to specify that you want to subscribe to data where *state* = CA for table replication definition **publishers_rep**, you would enter:

```
create subscription publishers_sub1
for publishers_rep
with replicate at SYDNEY_DS.pubs2
where state = 'CA'
```

Note: The maximum size of a **where** clause in a **create subscription** statement is 255 characters.

To subscribe to data in `publishers`, where *state* = CA or *state* = MA, you would need to create two subscriptions. In addition to the preceding command, you would enter:

```
create subscription publishers_sub2
for publishers_rep
with replicate at SYDNEY_DS.pubs2
where state = 'MA'
```

Note: When you use a **where** clause with a subscription for heterogeneous datatype columns subject to class- or column-level translations, you must make sure that you use the correct datatype in the comparison.

See also

- *Bitmap Subscriptions* on page 410
- *Subscriptions for Columns with Heterogeneous Datatypes* on page 409
- *Using the rs_address Datatype* on page 323

Enable Replication of truncate table

You can enable replication of the **truncate table** command to particular destination database tables when you create or define a subscription, if you are using Adaptive Server Enterprise version 11.5 or later.

The **truncate table** command can truncate one or more partitions. Replication Server will recreate the same command executed at the primary database. This requires the replicate site to have the same partition names, otherwise, DSI shuts down.

You have an option to skip **truncate table** and apply appropriate action at the replicate site, or use **rs_truncate** function string to customize the action in the replicate site. Replication Agent sends this command once the LTL version is set to 700.

To create or define a subscription that enables replication of **truncate table**, log in to Replication Server and enter:

```
create subscription subscription
    for table_rep_def
    with replicate at data_server.database
     ...
    subscribe to truncate table
```

When **truncate table** executes at the destination database, Adaptive Server deallocates whole data pages. It does not delete rows one at a time.

Note: Replication Server executes **truncate table** at the replicate database as the maintenance user. Among the permissions granted to maintenance user is **replication_role**. If you revoke the maintenance user **replication_role**, you cannot replicate **truncate table** unless the maintenance user has been granted **sa_role**, the maintenance user owns the table, or the maintenance user is aliased as the database owner.

Warm standby applications can copy the execution of **truncate table** to standby databases without a subscription. See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications > Alter Warm Standby Database Connections > Alter Logical Connections > Replicate* **truncate table** *to Standby Databases*.

See *Replication Server Reference Manual > Replication Server Commands* for complete command syntax and usage guidelines for **define subscription** and **create subscription**.

Change the Status of subscribe to truncate table

Use **sysadmin apply_truncate_table** to change the status of “subscribe to truncate table” for all subscriptions on a replicate table.

All subscriptions for a replicate table in a particular database must either support or not support replication of **truncate table**. You cannot create a subscription that enables replication of **truncate table** if all existing subscriptions for that table do not support replication of **truncate table**.

For example, to turn on replication of **truncate table** for all subscriptions to a replicate table, log in to the replicate Replication Server and execute this command at the **isql** prompt:

```
sysadmin apply_truncate_table, data_server,
 database, {table_owner|’’|””}, table_name'on'
```

where *data_server* is the name of the replicate data server, *database* is the name of the replicate database managed by the data server, *table_owner* is the owner of the replicate table, and *table_name* is the name of the replicate table.

If you specified a replicate table owner in the replication definition, you must also specify a table owner with the **sysadmin apply_truncate_table** command. If you did not specify a replicate table owner in the replication definition, enter '' (two single-quote characters) or ““ (two double-quote characters) for the table owner name.

See *Replication Server Reference Manual > Replication Server Commands >* ***sysadmin apply_truncate_table***.

create subscription Command

Use the **create subscription** command to replicate data by subscribing to a replication definition.

There are three methods for creating a subscription:

- Atomic
- Nonatomic
- Direct load materialization
- No materialization

You can use a **where** clause to replicate only certain rows from the primary table, based on values for the searchable columns specified in the table replication definition. If you do not provide a **where** clause, all rows are replicated.

If you are using Adaptive Server Enterprise version 11.5 or later, you can include the **subscribe to truncate table** keywords to reproduce execution of the **truncate table** command at the destination database.

See *Replication Server Reference Manual > Replication Server Commands >* ***create subscription***.

See also

- *Use the where Clause* on page 395
- *Enable Replication of truncate table* on page 396
- *Create Replication Definitions* on page 286

Use create subscription command for Atomic Materialization

Use **create subscription** to enable atomic materialization.

To create a subscription with atomic materialization, execute the **create subscription** command at the Replication Server managing the database where the data is to be replicated. The syntax is:

```
create subscription subscription
    for table_rep_def
    with replicate at data_server.database
    [where search_conditions]
     [incrementally]
     [subscribe to truncate table]
```

where *subscription* is the name of the subscription to activate, *table_rep_def* is the name of the table replication definition you are subscribing to, and *data_server.database* identifies the replicate database.

The *subscription* name must be unique for the replication definition and replicate database.

Subscribing to function replication definitions requires you to use **define subscription** (the bulk materialization method) or **create subscription** with the **without materialization** clause (the no materialization method).

If you use the optional keyword **incrementally**, Replication Server initializes the subscription by sending 1000-row batches of inserts.

If you do not use the keyword **incrementally**, Replication Server inserts all of the subscription rows at the replicate database in a single transaction. All of the rows are held in a stable queue at the replicate Replication Server at one time, and there must be enough partition space to accommodate them. Also, the transaction log for the replicate database must have enough space to log the transaction.

Use create subscription command for Nonatomic Materialization

Use **create subscription** with the **without holdlock** clause to create a subscription with nonatomic materialization.

The syntax is:

```
create subscription subscription
    for table_rep_def
    with replicate at data_server.database
    [where search_conditions]
    without holdlock
    [subscribe to truncate table]
```

where *subscription* is the name of the subscription to activate, *table_rep_def* is the name of the table replication definition you are subscribing to, and *data_server.database* identifies the replicate database.

Nonatomic materialization is always incremental.

Monitor materialization and dematerialization as clients at the replicate site should be suspended or warned that the data in the replicate table is incomplete and possibly inconsistent until all the subscription data has materialized.

See also

- *Monitor Materialization and Dematerialization* on page 390

Use create subscription command for Direct Load Materialization

Use **create subscription** with the **direct_load** option to create a subscription with direct load materialization.

The syntax is:

```
create subscription subscription
    for table_rep_def
    with replicate at data_server.database
    [where search_conditions]
    without holdlock
    direct_load
```

where *subscription* is the name of the subscription to activate, *table_rep_def* is the name of the table replication definition you are subscribing to, and *data_server.database* identifies the replicate database.

Unlike other automatic materialization methods, data selected from the primary table is loaded directly to the replicate database—no materialization queue is used—as soon as it is returned from the **select** command. This option is for subscriptions to table replication definitions only and is used with **without holdlock**. It cannot be used with **without materialization** or **incrementally**.

Use create subscription command for No Materialization

Execute **create subscription** with the **without materialization** clause at the Replication Server managing the replicate database to create a subscription that does not initialize the subscription data.

The syntax for **create subscription** for no materialization is:

```
create subscription subscription
for {table_rep_def | function_rep_def | publication pub |
    database replication definition db_repdef
    with primary at server_name.db }
with replicate at server_name.db
[where search_conditions]
without materialization
[subscribe to truncate table]
```

where *subscription* is the name of the subscription to create, *table_rep_def* is the name of the table replication definition the subscription is for, *function_rep_def* is the name of the function replication definition the subscription is for, *pub* is the name of the publication the subscription is for, *db_repdef* is the name of the database replication definition the subscription is for, and *server_name.db* identifies the primary or replicate database.

The **without materialization** clause activates the subscription without first initializing the subscription data. Use **create subscription** with the **without materialization** clause when there is no activity at the primary database and the data already exists in the replicate database.

define subscription Command

Use **define subscription** to create a subscription with bulk materialization.

Execute the **define subscription** command at the Replication Server that is managing the database where the data is to be replicated. **define subscription** sets the subscription status to DEFINED. The syntax for **define subscription** is:

```
define subscription subscription
for {table_rep_def | function_rep_def
    publication pub_name | database replication definition db_repdef
    with primary at data_server.db
with replicate at data_server.db
[where search_conditions]
[subscribe to truncate table]
```

where *subscription* is the name of the subscription to define, *table_rep_def* is the name of the table replication definition the subscription is for, *function_rep_def* is the name of the function replication definition the subscription is for, *pub_name* is the publication the subscription is for, *db_repdef* is the database replication definition the subscription is for, and *data_server.db* identifies the primary or replicate database.

The *subscription* name must be unique for the replication definition and replicate database.

See *Replication Server Reference Manual > Replication Server Commands >* ***define subscription***.

See also

- *Manage Replicated Tables* on page 279
- *Manage Replicated Functions* on page 355

activate subscription Command

Use **activate subscription** during bulk materialization to start the distribution of updates from the primary to the replicate database for a subscription.

activate subscription sets the subscription status to ACTIVE.

Execute **active subscription** at the Replication Server where you created the subscription using the **define subscription** command. The syntax for **activate subscription** is:

```
activate subscription subscription
    for { table_rep_def | function_rep_def | publication pub_name |
    with primary at data_server.db }
with replicate at data_server.db
[with suspension [at active replicate only] | with catchup_queue]
```

where *subscription* is the name of the subscription to activate, *table_rep_def* is the name of the table replication definition the subscription is for, *function_rep_def* is the name of the function replication definition the subscription is for, *pub_name* is the publication the subscription is for, and *data_server.db* identifies the primary or replicate database.

Use the **with suspension** clause to suspend the DSI after the subscription status changes to ACTIVE. This prevents the replicate Replication Server from sending updates for the replicated table before the subscription data is loaded. After loading the data at the replicate site, execute **resume connection** to apply the updates.

If you do not use **with suspension**, you should prohibit updates to the primary table until the subscription is materialized.

If the database is part of a warm standby application, the **with suspension** clause suspends the DSI for the active and standby databases. This let you load the data into both databases before allowing updates to the active database. If you load the data into the active database with logging, use the **with suspension at active replicate only** clause so that the standby DSI remains active. In this case, subscription data is replicated from the active database. The DSI for the active database in a warm standby application is suspended. The clause does not suspend the DSI for the standby database.

Use the **with catchup_queue** clause to instruct Replication Server to start a catchup queue to store the DMLs for the primary table. Subsequent updates to the primary table are stored in a catchup queue. After the bulk materialization is complete and when you issue the **validate subscription** command, the subscription becomes VALID after all the DML operations in the catchup queue are applied to the replicate table.

If you use the **catchup_queue** clause, you no longer need to specify **with suspension** or restrict DML operations during bulk materialization (that is, the time between **activate subscription** and **validate subscription** command execution).

Note: When DML operations in a catchup queue are applied to the replicate table, each **insert** operation is converted into a **delete** followed by an **insert**, **delete** is **delete**, and **update** is **update**. Materialization fails if an update changes the primary key.

See *Replication Server Reference Manual > Replication Server Commands >* ***activate subscription***.

validate subscription Command

Use **validate subscription** to complete the bulk materialization process and set the subscription status to VALID.

Execute **validate subscription** at the Replication Server where you created the subscription. The syntax is:

```
validate subscription subscription
for { table_ref_def | function_rep_def | publication pub_name
    with primary at data_server.db }
with replicate at data_server.db
```

where *subscription* is the name of the subscription to validate, *table_rep_def* is the name of the table replication definition the subscription is for, *function_rep_def* is the name of the function replication definition the subscription is for, *pub_name* is the publication the subscription is for, and *data_server.db* identifies the primary or replicate database.

check subscription Command

Use **check subscription** to report the status of a subscription at the Replication Server where you enter the command

The subscription status at the primary and replicate Replication Servers often differs while the subscription is being created, so you should enter **check subscription** at both sites. If the primary and replicate databases are managed by a single Replication Server, **check subscription** displays the status of the subscription for both the primary and replicate databases.

The syntax is:

```
check subscription subscription
for { table_rep_def | function_rep_def | publication pub_name |
    database replication definition db_repdef
    with primary at data_server.db }
with replicate at data_server.db
```

where *subscription* is the name of the subscription to check, *table_rep_def* is the name of the table replication definition the subscription is for, *function_rep_def* is the name of the function replication definition the subscription is for, *pub_name* is the publication the subscription is for, *db_repdef* is the database replication definition the subscription is for, and *data_server.db* identifies the primary or replicate database.

The message returned by the command contains subscription status information. If the subscription had an error, the message directs you to the log where you should look for specific error messages.

See *Replication Server Reference Manual > Replication Server Commands >* ***check subscription*** for a list of the messages **check subscription** can return.

Direct Load Materialization Progress

The **check subscription** command reports progress information for subscriptions created with the **direct_load** option that are in either the:

- initial-load phase – the period of time Replication Server consumes when it selects rowsfrom the primary database and applies the selected rows to the replicate database
- catchup-up phase – the period of time between the end of the initial load and when the subscription changes to the VALID state

In the initial-load phase for a subscription named `my_sub`, the **check subscription** command reports status similar to:

```
Subscription my_sub is ACTIVE at the replicate.
Subscription my_sub is ACTIVE at the primary.
Subscriptions my_sub progress: initial loading, xx% done, xxxxx
commands remaining.
```

In the catch-load phase for a subscription named my_sub, the check subscription command reports status similar to:

```
Subscription my_sub has been MATERIALIZED at the replicate.
Subscription my_sub is VALID at the primary.
Subscriptions my_sub progress: catchup, xx% done, xxxxx commands
remaining.
```

drop subscription Command

Use **drop subscription** to drop subscriptions for either table or function replication definitions.

Dropping a subscription causes Replication Server to stop sending changes from a primary database to a replicate database.

Execute **drop subscription** at the replicate Replication Server. It requires **create object** permission at the replicate Replication Server and **create object** or **primary subscribe** permission at the primary Replication Server.

Here is the syntax:

```
drop subscription subscription
for {table_rep_def | function_rep_def | article article_name in
pub_name |
   publication pub_name | database replication definition db_repdef
   with primary at data_server.db }
with replicate at data_server.database
[without purge
[with suspension [at active replicate only ]] |
[incrementally] with purge]
```

If you choose the **without purge** dematerialization method, Replication Server does not delete subscription data from the replicate database.

If you choose the **with purge** dematerialization method, Replication Server logs in to the replicate database and selects data from it. If this data does not belong to any other subscriptions, the subscription data is deleted from the replicate database.

When you drop subscriptions to table replication definitions, you can purge subscription rows regardless of the materialization method you used when you created the subscription. Rows are removed only if they do not match another subscription.

You can use **check subscription** to view the progress of the **drop subscription**. When the subscription status no longer exists at the primary and replicate Replication Servers, the command is complete.

Subscriptions to function replication definitions are always dropped without purging the replicate data associated with the function. You do not need to specify the **without purge** option.

When you are dropping subscriptions to table replication definitions, you have two basic methods to choose from. Because each method carries important implications, Replication Server requires that you explicitly choose one of these two methods:

- **with purge** – Replication Server removes, or dematerializes, the subscription’s rows from the replicate database, if they do not belong in other remaining subscriptions. The Replication Server logs in as the maintenance user to perform the **select** operation. Use the **incrementally** option to specify that dematerialization occurs in 1000-row increments of deletes per transaction.
- **without purge** – the subscription’s rows remain at the replicate database. The **with suspension** option leaves the connection to the replicate database suspended when **drop subscription** has completed, so that you can manually remove the rows.

For warm standby applications, the option **with suspension at active replicate only** suspends the active replicate database but not the standby replicate database.

Warning! When removing rows manually, do not remove rows for remaining overlapping subscriptions that require those rows.

Examples:

- To drop a subscription with purge, enter:

```
drop subscription publishers_sub
for publishers_rep
with replicate at SYDNEY_DS.pubs2
with purge
```

- To drop a subscription without purge, enter:

```
drop subscription publishers_sub
for publishers_rep
    with replicate at SYDNEY_DS.pubs2
without purge
```

- To drop a subscription without purge and also suspend the DSI for the replicate database so that you can manually delete the rows for the subscription, enter:

```
drop subscription publishers_sub
for publishers_rep
with replicate at SYDNEY_DS.pubs2
without purge
with suspension
```

- If you have a warm standby application for the replicate database, you may want to suspend the connection for the active database only, and leave the standby DSI up. This way, Replication Server will replicate your row deletion transactions from the active replicate database to the standby database. In this case, enter:

  ```
  drop subscription publishers_sub
  for publishers_rep
  with replicate at SYDNEY_DS.pubs2
  without purge
  with suspension at active replicate only
  ```

See *Replication Server Reference Manual > Replication Server Commands >* ***drop subscription***.

Subscription Example

The subscription example shows you how to use RCL commands to replicate the `publishers` table from a primary Adaptive Server database to a replicate Adaptive Server database by creating an atomic subscription to the table replication definition.

In the example replication system, at the:

- Primary site:
  - The Replication Server is named TOKYO_RS.
  - The primary version of the `publishers` table is in the `pubs2` database of the Adaptive Server named TOKYO_DS. You have added a connection from TOKYO_RS to the `pubs2` database using **rs_init** and set up a RepAgent for the database.
  - The system database for TOKYO_RS is named `TOKYO_RSSD` and is managed by the TOKYO_DS Adaptive Server.
  - A route exists from TOKYO_RS to SYDNEY_RS.
- Replicate site:
  - The Replication Server is named SYDNEY_RS.
  - The replicate copy of the `publishers` table is in the `pubs2` database of the Adaptive Server named SYDNEY_DS. You have added a connection from SYDNEY_RS to the `pubs2` database using **rs_init**.
  - The system database for SYDNEY_RS is named `SYDNEY_RSSD` and is managed by the SYDNEY_DS Adaptive Server.

Replicating Tables in the Example Replication System

Use either the **isql** or the SAP Control Center to replicate tables between two Adaptive Servers.

1. To prepare the replicate tables, check replication system components using **isql** to log in to the servers identified for the primary and replicate sites.
2. To prepare the primary table in the TOKYO_DS primary data server, log in to the `pubs2` database in TOKYO_DS, and verify that the `publishers` table exists:

   ```
   isql -Usa -P -STOKYO_DS
   use pubs2
   go
   sp_help publishers
   go
   ```
3. To create subscriptions, prepare login names and grant the relevant permisssions for the “pubs2_user” user that is creating the subscription in the TOKYO_DS Adaptive Server. This user must also exist in both Replication Servers:
   a) In TOKYO_DS, create the “pubs2_user” login name:

      ```
      isql -Usa -P -STOKYO_DS
      sp_addlogin pubs2_user, pubs2_pw, pubs2
      go
      ```
   b) In TOKYO_DS, add the “pubs2_user” login name to the `pubs2` database, and grant pubs2_user **select** permission on the `publishers` table:

      ```
      use pubs2
      go
      sp_adduser pubs2_user
      go
      grant select on publishers to pubs2_user
      go
      ```
   c) In the TOKYO_RS primary Replication Server, create the “pubs2_user” login name and grant **primary subscribe** permission to pubs2_user:

      ```
      isql -Usa -P -STOKYO_RS
      create user pubs2_user
      set password pubs2_pw
      go
      grant primary subscribe to pubs2_user
      go
      ```
   d) In the SYDNEY_RS replicate Replication Server, create the “pubs2_user” login name and grant **create object** permission to pubs2_user in the SYDNEY_RS replicate Replication Server:

      ```
      isql -Usa -P -SSYDNEY_RS
      create user pubs2_user
      set password pubs2_pw
      go
      ```

```
grant create object to pubs2_user
go
```

4. In TOKYO_RS, create the replication definition **publishers_rep** for the `publishers` table:

   ```
   isql -Ujohn -P -STOKYO_RS
   create replication definition publishers_rep
   with primary at TOKYO_DS.pubs2
   with all tables named 'publishers'
   (pub_id char(4), pub_name varchar(40),
   city varchar(20), state char(2))
   primary key (pub_id)
   searchable columns (pub_id, pub_name)
   replicate minimal columns
   go
   ```

   In this example, the user "john" creates the replication definition. This user requires **create object** permission in TOKYO_RS.

5. In TOKYO_DS, mark the `publishers` primary table for replication. To mark the table for replication with the **sp_setreptable** system procedure, you must be the database owner or system administrator for the data server. Enter:

   ```
   sp_setreptable publishers, 'true'
   go
   ```

6. In the SYDNEY_DS replicate data server, log in to the `pubs2` database, and verify that the `publishers` table exists:

   ```
   isql -Usa -P -SSYDNEY_DS
   use pubs2
   go
   sp_help publishers
   go
   ```

   When you add the replicate `pubs2` database using **rs_init**, the maintenance user is created and given **replication_role**. The maintenance user must have **replication_role**, **sa_role**, or alias the database owner to replicate **truncate table**.

   In SYDNEY_DS, verify that the maintenance user has **select**, **insert**, **delete**, and **update** permissions on the `publishers` table:

   ```
   grant all on publishers to SYDNEY_DS_maint
   go
   ```

7. Log in to SYDNEY_RS Replication Server as pubs2_user and create the subscription **publishers_sub** for the replication definition **publishers_rep**:

   ```
   isql -Upubs2_user -Ppubs2_pw -SSYDNEY_RS
   create subscription publishers_sub
   for publishers_rep
   with replicate at SYDNEY_DS.pubs2
   subscribe to truncate table
   go
   ```

This subscription uses the default atomic materialization. No **where** clause is included, so all rows will be replicated. Execution of the **truncate table** command will be reproduced at the destination database.

8. While still logged into SYDNEY_RS, use the **check subscription** command to monitor the status of the subscription materialization:

```
check subscription publishers_sub
for publishers_rep
with replicate at SYDNEY_DS.pubs2
go
```

9. You can verify if replication is occurring as expected by verifying that a row you insert is copied to the replicate table.

   a) In TOKYO_DS, insert a row into the `publishers` table:

   ```
   isql -Usa -P -STOKYO_DS
   use pubs2
   go
   insert publishers
   values ('9950', 'Who Donut', 'Butler', 'CA')
   go
   ```

   b) In SYDNEY_DS, verify that the row you inserted was replicated into the replicate copy of the `publishers` table:

   ```
   isql -Usa -P -SSYDNEY_DS
   use pubs2
   go
   select * from publishers
   go
   ```

Materialize text, unitext, image, and rawobject Data

In general, you can use any materialization method for subscriptions for tables with columns that use the `text`, `unitext`, `image`, or `rawobject` datatypes.

If you use atomic or nonatomic materialization, the Replication Server managing the replicate database selects all of the subscription data into a subscription materialization queue.

If you want to materialize `text`, `unitext`, `image`, or `rawobject` data, you can use automatic materialization only if the size of your data row is less than 32K. Otherwise, you must use bulk materialization.

If you are materializing many large data rows, make sure that the Replication Server has sufficient queue space for the data before you create the subscription. For tables with a large volume of `text`, `unitext`, `image`, and `rawobject` data, you may need to add temporary partitions to the Replication Server to complete the materialization.

Nonatomic Materialization

If you are using nonatomic subscription materialization and you have set the **replicate_if_changed** replication status for any `text`, `unitext`, `image`, or `rawobject` column, Replication Server displays a warning message in the error log file.

You are cautioned that data may be inconsistent if applications modify the primary table during subscription materialization. Run the **rs_subcmp** program to reconcile the data in the replicate and primary tables.

Row Migration

Under certain conditions, `text`, `unitext`, `image`, or `rawobject` column data may be missing in a replicate table as a result of row migration.

Row migration occurs in a subscription that has a **where** clause. Updating a column specified in the **where** clause can cause a row to become valid for, or migrate into, the subscription. When this happens, Replication Server executes an **insert** in the replicate table. To insert a complete row, each **insert** would require values for all columns, including `text`, `unitext`, `image`, and `rawobject` columns that did not change in the primary table.

If your application allows rows to migrate into a subscription and you have set any `text`, `unitext`, `image`, or `rawobject` columns to the **replicate_if_changed** replication status, Replication Server displays a warning message in the error log. The message states that a row has migrated into the subscription but that its `text`, `unitext`, `image`, or `rawobject` data is missing.

If a `text`, `unitext`, `image`, or `rawobject` column with the **replicate_if_changed** status was not changed in an **update** operation at the primary table, and the **update** causes the row to migrate into a subscription, the inserted row at the replicate table will be missing the `text`, `unitext`, `image`, or `rawobject` data. Run the **rs_subcmp** program to reconcile the data in the replicate and primary tables.

Subscriptions for Columns with Heterogeneous Datatypes

You create subscriptions for table replication definitions in the normal manner when class-level or column-level translations are defined and active. However, certain restrictions apply to use of the **where** clause.

- Subscriptions that specify columns subject to class- and column-level translations in the **where** clause cannot be dematerialized automatically. You must use the bulk or no-materialization method.
- Take care creating or defining subscriptions that specify class- or column-level translations in the **where** clause. Make sure that the value in the **where** clause comparison is in the declared datatype format. HDS translations take place *after* the subscription is presented.

For example, if searchable column `starttime` is declared as `datetime` but published as `rs_db2_time`, then the comparison value in the **where** clause must be described using `datetime` format.

```
create subscription db2_time_sub
for table_rep_def XXXXX
            with primary at AAAAA
            with replicate at BBBBB
where starttime > ’19000101 23:14:02’
```

and not “`where starttime > ’23:14:02,’`” which is `rs_db2_time` format.

See the information on heterogeneous datatype translations when you configure replicated tables, and see the *Replication Server Heterogeneous Replication Guide*.

See also

- *Manage Replicated Tables* on page 279

Bitmap Subscriptions

Bitmap subscriptions allow you to create subscriptions that replicate rows based on bitmap comparisons.

When you create a replication definition for a table, specify the datatype of your bitmap columns as `rs_address`. This special datatype tells Replication Server to treat these `int` columns as bitmaps.

The **create subscription** and **define subscription** commands support a bitmap comparison operator (&) in the **where** clause for `rs_address` columns or parameters.

In the Adaptive Server table, you use an `int` column to hold a bitmap, since Adaptive Server allows bitwise operators on integer values. An `int` column has 32 bits. You can have multiple `rs_address` columns in a replication definition if your application requires more than 32 bits.

When you create a subscription, specify bitmap comparisons by comparing each `rs_address` column to a bitmask using the & operator. Each subscription can have one comparison per `rs_address` column.

Bitmap Subscription Example

For example, consider an application that uses an `rs_address` column named `book_type` to record the categories of books customers are interested in reading.

Table 32. Example Bitmap Comparison

Bit Number	Book Category
0	Science fiction
1	Mystery
2	Business
3	Cooking
4	Popular computing
5	Computer science
6	Psychology
7	Reference

If a bit is set, the customer has expressed interest in books of the corresponding category. The bits are numbered from least significant to most significant. For example, if the customer is interested in mystery, cooking, computer science, and psychology books, the least significant 8 bits are 01101010 and the 32-bit integer value is 106. The `book_type` column in the customer's row contains the value 106.

To create a subscription for customers who are interested in specified book categories, form a bitmask of the desired categories and compare it, using the & operator, to the `book_type` column in the **where** clause of the **create subscription** or **define subscription** command. The & operator performs a bitwise AND operation. If the result is non-zero, the row matches the subscription.

For `rs_address` columns only, the bitmap comparison operator & is supported in the **where** clause, as follows:

```
where rs_address_column1 & bitmask
[and rs_address_column2 & bitmask]
[and other_search_conditions]
```

For example, to create a subscription for all customers who are interested in mystery or business books, the lower 8 bits of the mask are 00000110. Converted to a 32-bit integer value, the bitmask is 6. For atomic or nonatomic materialization, you can create the subscription as follows:

```
create subscription mystery_or_business
for customers
with replicate at BRANCH_22.BOOK_DB
where book_type & 6
```

You can use a similar approach in the **define subscription** command, used for bulk materialization. For subscriptions to function replication definitions, which require the no-materialization method or bulk materialization, specify parameter names instead of column names.

In addition to 32-bit integer values, you can also compare `rs_address` columns to 32-bit hexadecimal numbers in the **where** clause. If you use hexadecimal numbers, pad each number with zeros, as necessary, to create an 8-digit hexadecimal value.

Warning! Hexadecimal values are treated as binary strings by both Adaptive Server and Replication Server. Binary strings are converted to integers by copying bytes. The resulting bit pattern may represent different integer values on different platforms. For example, 0x0000100 represents 65,536 on platforms that consider byte 0 most significant, and represents 256 on platforms that consider byte 0 least significant. Because of these byte-ordering differences, bitmap subscriptions involving hexadecimal numbers might not work if a replication system involves different platforms. Be very cautious about comparing `rs_address` columns to hexadecimal numbers in the **where** clause of a subscription.

Replication Server does not replicate a row if the only changed columns are `rs_address` columns, unless the changed bits indicate that the row should be inserted or deleted at the replicate database. Because of this filtering, `rs_address` columns in replicate databases may not be identical to the corresponding columns at the primary database. This is an optimization for applications that use `rs_address` columns to specify the destination replicate databases.

See *Replication Server Reference Manual > Replication Server Commands* for more information about creating bitmap subscriptions using **create subscription** and **create replication definition**.

Refer to the *Adaptive Server Enterprise Reference Manual* and the *Open Client and Open Server Common Libraries Reference Manual* for more information about conversions between datatypes.

See also

- *Use the where Clause* on page 395

Obtain Subscription Information

Once data is replicating, you may need to obtain information about the subscriptions or verify that data is replicating consistently. Replication Server provides stored procedures for obtaining information and a standalone utility for verifying consistency.

Display Subscription Information

Use the **rs_helpsub** and **rs_helprepdb** stored procedures in the Replication Server RSSD to display information about subscriptions at a Replication Server.

Use **rs_helpsub** to display information about subscriptions at a Replication Server. The syntax is:

```
rs_helpsub [subscription_name
```

```
    [, replication_definition
    [, data_server, database]]]
```

Use the **rs_helprepdb** stored procedure to display information about databases with subscriptions for replication definitions in the current Replication Server. The syntax is:

```

rs_helprepdb [, data_server, database]
```

For parameter descriptions, see *Replication Server Reference Manual > RSSD Stored Procedures*.

Verify Subscription Consistency

Learn the types of inconsistency that may occur between primary and replicate tables.

After you create a subscription, Replication Server propagates transactions from the primary database to the replicate database. The replication system keeps the replicate copy of the table consistent with the primary copy.

The replicate data may become inconsistent with the primary version. For example, if you have not restricted update permissions on a replicate table to the maintenance user for the database, a client may update the replicate data directly, introducing inconsistencies.

Primary and replicate tables may be temporarily inconsistent because Replication Server takes some time to transfer updates from the primary table to the replicate table. However, as soon as the Replication Server applies the updates at the replicate database, inconsistency due to latency no longer exists.

There are three kinds of inconsistency that may occur between primary and replicate tables:

- Missing rows in the primary table are missing from the replicate table.
- Inconsistent rows in the primary table differ from the corresponding rows in the replicate table.
- Orphaned rows in the replicate table do not exist in the primary table or do not match subscriptions for the replicate table.

You need to differentiate between temporary inconsistencies caused by delay and real inconsistencies caused by the incorrect use of the system or by system failures. The **rs_subcmp** program described in the following section helps you make this distinction. You can correct inconsistencies by dropping and recreating subscriptions or by using **rs_subcmp**.

Use rs_subcmp To Locate and Correct Inconsistencies

Use the **rs_subcmp** standalone executable program to compare a replicate table to the primary version of the table, find—and correct if you so choose—missing, orphaned, and inconsistent rows in SAP databases.

On UNIX systems, the program is called **rs_subcmp**. On PC systems, the program is called **subcmp**. The **rs_subcmp** program is located in the `bin` subdirectory of the SAP Sybase release directory. See the installation and configuration guides for your platform for more information.

The program works by logging in to the primary data server and the replicate data server, and selecting and comparing rows from both tables.

Because some differences between primary and replicate data can be attributed to latency, **rs_subcmp** first identifies inconsistencies, and then performs iterations a specified number of times. **rs_subcmp** waits for any updates to be replicated before removing the corrected rows from its list.

It is best to use **rs_subcmp** when latency is low to avoid the program having to perform several iterations through the data.

You can instruct **rs_subcmp** to display inconsistent rows on the standard output, correct them, or both display and correct them.

Creating a configuration file avoids the need for complex command lines, which are prone to errors. Here is an **rs_subcmp** configuration file that compares the `sales` table in the `pubs2` database in the data servers TOKYO_DS and SYDNEY_DS:

```
PDS=TOKYO_DS
RDS=SYDNEY_DS
PDB=pubs2
RDB=pubs2
RTABLE=sales
RSELECT=select * from sales \
        order by stor_id, ord_num
RUSER=sa
KEY=stor_id
KEY=ord_num
RECONCILE=Y
RECONCILE_CHECK=Y
WAIT=15
NUM_TRIES=5
VISUAL=Y
```

The **PTABLE**, **PSELECT**, and **PUSER** parameters, which are used for the primary database, are not shown in this example. Their values are the same as those of corresponding parameters in the replicate databases, so they need not be included in the configuration file.

The **RSELECT** line and the **PSELECT** line (if used) must be entered on one line. To continue a line onto the next line (row), precede each newline character with a backslash as, for example:

```
RSELECT=select * from sales \
        order by stor_id, ord_num
```

Note: Due to update filtering, columns of `rs_address` datatype may not be identical between the primary and replicate databases. Do not select `rs_address` columns using **RSELECT** or **PSELECT** parameters.

When you execute **rs_subcmp**, you can override values in the configuration file with command line options. For example, rather than changing the name of the TOKYO_DS data server to TOKYO_DS2 in the configuration file, you can specify it on the command line, using the **-S** flag, as the following example illustrates:

```
rs_subcmp -f sales_cmp -S TOKYO_DS2 > sales_badrows
```

In this example, the **-f** option specifies a configuration file name, `sales_cmp`. If the **VISUAL** parameter is set to “Y” in the configuration file (equivalent to the **-V** command line option), a list of the inconsistent rows is generated. In this example, the output is redirected to a file.

Schema Comparison

Schema comparison is useful in comparing schema between two databases that may have the same data but different schemas.

For example, if you want to compare all schemas between two databases using the `config.cfg` file:

```
rs_subcmp -f config.cfg
```

A report file which details the comparison result between two tables or two databases is created after every schema comparison. The report file is named `reportPROCID.txt`. If inconsistencies exist, **rs_subcmp** creates a reconciliation script named `reconcilePROCID.sql`. The report file and the reconciliation script are saved in the same directory where you issued the **rs_subcmp**.

Note: Before running **rs_subcmp** for schema comparison, make sure that **ddlgen** is working on your environment.

See *Replication Server Reference Manual > Executable Programs >* ***rs_subcmp***.

Manual Data Reconciliation

To verify the reconciliation of statements before execution, you can create a reconciliation file using **rs_subcmp**.

Use the command line option **-g** with **rs_subcmp** or you can set the configuration file parameter RECONCILE_FILE to “Y” to indicate the creation of a reconciliation file.

rs_subcmp Performance Enhancement

Hash algorithm improves the performance of **rs_subcmp** and compresses the data in primary and replicated tables.

The compressed data is then fetched by **rs_subcmp**.

Instead of taking the entire row of data during comparison between the primary table and replicated table, **rs_subcmp** now transfers only the compressed data of each data row from the primary or replicated tables, and then verifies or reconciles inconsistencies between them.

For an improved **rs_subcmp** performance, use the command line parameters **-h** or **-H** or their equivalent configuration file parameters FASTCMP or HASH_OPTION.

Note: To support hash algorithm, **rs_subcmp** requires ASE 15.0.2 or later and cannot handle case-sensitive comparison. It also cannot handle `text`, `unitext`, or `image` datatypes and does not allow the user to specify the precision for the `float` datatype (maximum precision is used). Also, SAP suggests to set the ASE parameter **default data cache** to 128M or higher to get a better comparison performance.

The **rs_subcmp** program has a large number of options, which you can specify on the command line or in a configuration file. See *Replication Server Reference Manual > Executable Programs >* ***rs_subcmp*** for a list of these configuration file parameters and command line options.

Publication Subscriptions

With publication subscriptions, you create subscriptions for a group of replication definitions using a single command.

You collect replication definitions and their articles in a publication at the primary Replication Server. At the replicate Replication Server, you create a publication subscription against that publication.

When you create a publication subscription, Replication Server creates a subscription for each article in the publication.

Publication subscriptions and article subscriptions follow the rules and requirements for single subscriptions with one exception: They cannot contain **where** clauses. To specify a subset of rows that the replicate Replication Server receives, include **where** clauses in the article.

To use publications, the primary Replication Server must be version 11.5 or later. To use publication subscriptions, the replicate Replication Server and the route from the primary Replication Server and the replicate Replication Server must be version 11.5 or later.

The following restrictions apply:

- A valid publication must exist before you can create a publication subscription against it.
- The name of a publication subscription must be unique to the publication, to the destination data server, and to the destination database.
- You can include articles in one or more publications that reference different replication definitions for the same primary table. However, you cannot subscribe to more than one replication definition per primary table for each replicate table.

  Use the command line to create and manage publication subscriptions.

See also

- *Specifying a where Clause with the create article Command* on page 344
- *Use Publications to Replicate Data at the Command Line* on page 342
- *Use Publications* on page 341

Commands for Creating and Managing Publication Subscriptions

Learn the commands you can use to create and manage publication subscriptions.

All of the commands, except **check subscription**, require **primary subscribe** or **create object** permission at the source Replication Server and **create object** permission at the destination Replication Server. Anyone can execute **check subscription**.

Table 33. Commands for Managing Publication Subscriptions

Command	Task
create subscription *sub_name* **for publication** *pub_name*	Creates a subscription for a publication and a subscription for each article in the publication. With **create subscription**, you can: • Subscribe to table replication definitions using the atomic, nonatomic, or no-materialization method. • Subscribe to function replication definitions using the no-materialization method.
define subscription *sub_name* **for publication** *pub_name*	Defines a subscription for a publication and a subscription for each article in the publication. Use with **activate subscription** and **validate subscription**. With **define subscription**, you can subscribe to articles with table replication definitions or function replication definitions using the bulk materialization method.
activate subscription *sub_name* **for publication** *pub_name*	Activates a subscription for a publication and a subscription for each article in the publication. Use with **define subscription** and **validate subscription** for bulk materialization.
validate subscription *sub_name* **for publication** *pub_name*	Validates a subscription for a publication and a subscription for each article in the publication. Use with **define subscription** and **activate subscription** for bulk materialization.
check subscription *sub_name* **for publication** *pub_name*	Displays the status of the publication subscription and all of its article subscriptions.
check subscription *sub_name* **for article** *article_name* **in** *pub_name*	Displays the materialization status of an article subscription.
rs_helppubsub	Displays information about publication subscriptions.
drop subscription *sub_name* **for publication** *pub_name*	Removes the publication subscription and all of its article subscription from the `rs_subscriptions` system table at the primary and replicate sites.

Command	Task
drop subscription *sub_name* **for article** *article_name* **in** *pub_name*	Removes the article subscription from the publication subscription and from the `rs_subscriptions` system table at the primary and replicate sites.

See also

- *Use the create subscription Command to Create a Publication Subscription* on page 419
- *Create Publication Subscriptions with Bulk Materialization* on page 420
- *Display Subscription Information* on page 412
- *Drop Subscriptions for Publications and Articles* on page 422
- *Commands for Creating and Managing Publications* on page 342

Enable Replication of the truncate table Command

You can enable replication of **truncate table** to the replicate table when you create, refresh, or define a publication subscription.

If you do not enable replication of **truncate table** to the replicate table, you must execute **truncate table** yourself at the replicate database.

For example, to create the publication subscription **pubs2_sub** and enable replication of **truncate table**, at the destination Replication Server enter:

```
create subscription pubs2_sub
        for publication pubs2_sub
        with primary at TOKYO_DS.pubs2
        with replicate at SYDNEY_DS.pubs2
        subscribe to truncate table
```

All subscriptions to the same replicate table must use **truncate table** consistently. If a replicate table has a subscription that does not enable replication of **truncate table** and you add another subscription that does enable replication of **truncate table**, the publication subscription fails.

You do not need to include **subscribe to truncate table** when you activate and validate the publication subscription.

See also

- *Enable Replication of truncate table* on page 396

Create Publication Subscriptions

Once a publication has been validated, you can create subscriptions against it.

When you create a publication subscription, Replication Server creates a subscription for each article in the publication.

Publication subscriptions and article subscriptions specify the publication, the primary and replicate databases, and the materialization method. They do not contain **where** clauses. To specify a subset of rows to be replicated, include **where** clauses in the article description.

See also

- *Specifying a where Clause with the create article Command* on page 344

Use the create subscription Command to Create a Publication Subscription

Use **create subscription** to create a publication subscription and an article subscription for each article in the publication.

You can use **create subscription** to materialize source data at the destination database using the atomic, nonatomic, or no-materialization method.

Execute **create subscription** at the Replication Server that manages the destination database. Subscription information is stored in the `rs_subscriptions` system tables at the primary and replicate sites.

This example creates a subscription named **pubs2_sub** for the publication **pubs2_pub**. It also creates a subscription named **pubs2_sub** for each article in **pubs2_pub**. The source database is `pubs2` managed by the TOKYO_DS data server. The destination database is also named `pubs2`; it is managed by the SYDNEY_DS data server.

```
create subscription pubs2_sub
        for publication
        with primary at TOKYO_DS.pubs2
        with replicate at SYDNEY_DS.pubs2
```

Note: The maximum size of a **where** clause in a **create subscription** statement is 255 characters.

See *Replication Server Reference Manual > Replication Server Commands* for complete syntax and usage guidelines.

Specify a Materialization Method for Publication Subsciptions

Specify materialization methods for publication subscriptions in the same way you specify materialization methods for regular subscriptions.

When you use **create subscription**, you can specify atomic, nonatomic, or the no-materialization method. The default method is atomic materialization, using the **select with holdlock** operation.

Article subscriptions share the name of the parent subscription and generally, its materialization method. However, function replication definitions require the bulk or no-materialization method. If you use **create subscription**, and articles in the publication reference function replication definitions, Replication Server uses the no-materialization method for these article subscriptions—regardless of the materialization method specified in the publication subscription.

See also

- *Subscription Materialization Methods* on page 374

Refresh Publication Subscriptions

When you add articles to an existing publication, you must add article subscriptions to the existing publication subscription to subscribe to the new articles. Use **for new articles** to refresh the subscription.

This clause instructs Replication Server to check the subscription against the publication and then to create subscriptions for any unsubscribed articles.

For example, to refresh the publication subscription **pubs2_sub**, enter this command at the destination Replication Server:

```
create subscription sub for publication pub
        with primary at TOKYO_DS.pubs2
        with replicate at SYDNEY_DS.pubs2
        for new articles
```

Use **check subscription** to find out whether a subscription exists for each article in a publication.

See also

- *View Publication Subscription Information* on page 423

Create Publication Subscriptions with Bulk Materialization

Bulk materialization allows you to load subscription data from media such as magnetic tape. Use this method if the amount of data to be transferred is too large to copy through the network.

You can also use this method to create subscriptions for function replication definitions.

When you create publication subscriptions with bulk materialization, you must use **define subscription**, **activate subscription**, and **validate subscription**. You use these bulk materialization commands to create publication subscriptions in the same way you create single subscriptions. You cannot include **where** clauses in publication subscriptions.

See also

- *Specifying a where Clause with the create article Command* on page 344

Use the define subscription Command for Publication Subscriptions

Use **define subscription** to create a publication subscription and a subscription for each article in the publication.

define subscription always creates a subscription using bulk materialization. Execute **define subscription** at the Replication Server that manages the destination database. Subscription information is stored in the `rs_subscriptions` system tables at the source and destination sites.

All subscriptions in the publication subscription are created at the same time.

This example creates a subscription named **pubs2_sub** for the publication **pubs2_pub**.

```
define subscription pubs2_sub
    for publication pubs2_pub
    with primary at TOKYO_DS.pubs2
    with replicate at SYDNEY_DS.pubs2
```

When you define a publication subscription with bulk materialization, you can enable replication of **truncate table** to the destination table.

See *Replication Server Reference Manual > Replication Server Commands* for complete syntax and usage guidelines.

See also

- *Enable Replication of the truncate table Command* on page 418

Use the activate subscription Command for Publication Subscriptions

Use **activate subscription** to activate a publication subscription and its subscription subset.

Execute **activate subscription** at the Replication Server that manages the destination database.

Before you execute **activate subscription**, you must execute **define subscription**, and the publication subscription status must be DEFINED.

All subscriptions in the publication subscription are activated at the same time.

For example, to activate every subscription in the **pubs2_sub** publication subscription, enter:

```
activate subscription sub for publication pub
    with primary at TOKYO_DS.pubs2
    with replicate at SYDNEY_DS.pubs2
```

See *Replication Server Reference Manual > Replication Server Commands* for complete syntax and usage guidelines.

Use the validate subscription Command for Publication Subscriptions

Use **validate subscription** to set the subscription status to VALID for the publication subscription, and its subscription subset.

Execute **validate subscription** at the Replication Server that manages the replicate database.

Before you execute **validate subscription**, you must execute **activate subscription** and the publication subscription status must be ACTIVE.

All subscriptions in the publication subscription are validated at the same time.

The following example validates every subscription in the publication subscription **pubs2_sub**.

```
validate subscription sub for publication pub
    with primary at TOKYO_DS.pubs2
    with replicate at SYDNEY_DS.pubs2
```

See *Replication Server Reference Manual > Replication Server Commands* for complete syntax and usage guidelines.

Refresh Publication Subscriptions Using Bulk Materialization

When you refresh a publication subscription using bulk materialization, use the **for new articles** clause when you define the publication subscription.

You do not need to repeat the clause when you activate and validate the subscription.The following example refreshes the publication subscription **pubs2_sub**.

```
define subscription pubs2_sub
    for publication pubs2_pub
    with primary at TOKYO_DS.pubs2
    with replicate at SYDNEY_DS.pubs2
    for new articles
```

See *Replication Server Reference Manual > Replication Server Commands >* ***define subscription*** for syntax and usage guidelines.

To check whether a subscription exists for each article in a publication, execute **check subscription** at the primary or replicate Replication Server.

See also

- *Check Publication and Article Subscription Status* on page 423

Drop Subscriptions for Publications and Articles

Use **drop subscription** to drop a publication subscription and all of its article subscriptions, or to drop a single article subscription.

drop subscription removes information about the publication subscription and its article subscriptions from system tables at the source and destination servers. It does not remove publication information from the destination server. Thus, you can create another subscription against the publication, and Replication Server only needs to reload primary site information if it has been changed.

Include the **without purge** clause to retain existing rows replicated by the subscription to the destination database. The subscriptions are dropped all at once.

This example drops a subscription named **pubs2_sub** for the publication **pubs2_pub** using **without purge**.

```
drop subscription pubs2_sub
    for publication pubs2_pub
    with primary at TOKYO_DS.pubs2
    with replicate at SYDNEY_DS.pubs2
    without purge
```

Include the **with purge** clause to delete existing rows replicated by the subscription to the destination database. The subscriptions are dropped one at a time.

This example uses **with purge**:

```
drop subscription pubs2_sub
    for publication pubs2_pub
    with primary at TOKYO_DS.pubs2
    with replicate at SYDNEY_DS.pubs2
    with purge
```

For example, to delete the **pubs2_art** article, without removing rows replicated by the subscription, enter:

```
drop subscription sub for article pubs2_art
    with primary at TOKYO_DS.pubs2
    with replicate at SYDNEY_DS.pubs2
    without purge
```

See *Replication Server Reference Manual > Replication Server Commands* for complete syntax and usage guidelines.

View Publication Subscription Information

You can view information about publication and article subscriptions with the **check subscription** command or the **rs_helppubsub** stored procedure.

Check Publication and Article Subscription Status

Use **check subscription** at the primary Replication Server or the replicate Replication Server to check the status of a publication subscription and its article subscriptions or to check the status of an article subscription.

check subscription returns a status (such as VALID, MATERIALIZING, or ACTIVE) along with a descriptive message. See *Replication Server Reference Manual > Replication Server Commands >* ***check subscription*** for complete syntax and usage guidelines and a list of status messages.

- This example displays the subscription status of the publication subscription **pubs2_sub**.

  ```
  check subscription pubs2_sub
              for publication pubs2_pub
      with primary at TOKYO_DS.pubs2
      with replicate at SYDNEY_DS.pubs2
  ```

  If the publication subscription is valid, Replication Server also checks whether the subscription is current. When you alter a publication after the subscription is created, the publication subscription is out of sync with the publication. To create subscriptions for new articles and make the subscription current, refresh the subscription using **create subscription** or **define subscription**.
- This example displays the subscription status of the article **pubs2_art** in the subscription **pubs2_sub**.

```
check subscription sub for article pubs2_art
    in pubs2_pub
    with primary at TOKYO_DS.pubs2
    with replicate at SYDNEY_DS.pubs2
```

Display Publication and Article Subscription Information

To display information about a publication subscription and article subscriptions, use the **rs_helppubsub** stored procedure at either the primary or replicate Replication Server RSSD.

For example:

- To list all publication subscriptions at a site, enter:

  ```
  rs_helppubsub
  ```

  For each publication subscription known to the site, the display includes the names of the subscription and its associated publication, the names of the primary and replicate databases and data servers, status information, and the date of the latest change to the publication subscription.
- To display information about a particular publication subscription, enter:

  ```
  rs_helppubsub subscription_name
  ```

  The output displays the information described in the above example for all publication subscriptions named *subscription_name*.
- To display information about a particular publication subscription and its article subscriptions, enter:

  ```
  rs_helppub subscription_name, publication_name,
      primary_dataserver, primary_db,
      replicate_dataserver, replicate_db
  ```

  The output displays the information described in the above examples for all publication subscriptions named *subscription_name*. For each article subscription, the output displays subscription and article name, status information for the primary and replicate Replication Servers, replication definition name, autocorrection status, and the date of the latest change to the article subscription.

See the *Replication Server Reference Manual > RSSD Stored Procedures >* ***rs_helppubsub*** for complete syntax and usage guidelines, and sample output.

Manage Replicated Objects Using Multisite Availability

Multisite availability (MSA) can make the process of setting up a replication system both faster and easier.

Some of the features that MSA provides are:

- A simple replication methodology that requires only one replication definition for the primary database and only one subscription for each subscribing database.
- A replication filtering strategy that lets you choose whether or not to replicate individual tables, transactions, functions, system stored procedures, and data definition language (DDL).
- Replication of DDL to any replicate database—including non–warm standby databases.
- Replication to multiple replicate sites—for warm standby as well as non–warm standby databases.

You can overlay MSA scenarios over your existing replication structure. The procedures for implementing MSA are similar to those you use to replicate to warm standby or replicate databases.

Database Replication

When you use table and function replication, you describe each piece of data that is to be replicated using individual table and function replication definitions and subscriptions.

This methodology allows you to transform data and provides fine-grained control over the information being entered in the replicate database. However, it requires that you mark each table or function to be replicated, create a replication definition for each replicated table or function, and create subscriptions for each replication definition at each replicate database.

MSA lets you identify specific database objects: tables, functions, transactions, DDL, and system stored procedures in a single replication definition. You can choose to replicate the entire database, or you can choose to replicate—or not replicate—particular tables, functions, transactions, DDL, and system stored procedures in that database. If you do not need to replicate partial tables, MSA can provide replication while affording the advantages of simple setup and maintenance.

When the Replicate Is a Warm Standby Database

In the non-MSA warm standby scenario, changes to the primary database are copied directly to the warm standby database without alteration.

This methodology allows replication of DDL. To change or qualify the data sent, you must add table and function replication definitions. Each primary database can have one, and only one, standby database. See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications* for a complete discussion of this warm standby application.

MSA provides all the features of the warm standby application described in *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications*. In addition, MSA:

- Enables replication to multiple standby databases
- Allows you to replicate or not replicate specific database objects

Bidirectional Replication Support for DDL in MSA

You can configure multisite availability (MSA) to set up a two-way replication of DDL transactions between two Adaptive Server databases.

Replication Server 15.0 and later supports this bidirectional replication using a Replication Server configuration parameter called **dsi_replication_ddl**. When **dsi_replication_ddl** is set to on, DSI sends set replication off to the replicate database, which instructs it to mark the succeeding DDL transactions available in the system log not to be replicated. Therefore, these DDL transactions are not replicated back to the original database, which enables DDL transactions replication in bidirectional MSA replication environment.

MSA Mixed-Version Environment

In an MSA mixed-environment, the primary Replication Server filters the data features with higher versions.

Incompatible commands are not sent to the standby Replication Server. The configuration parameter **dist_stop_unsupported_cmd** suspends the DIST if there are incompatible commands. You can configure this parameter using one of the following syntaxL

-
  ```
  configure replication server
    set 'dist_stop_unsupported_cmd' to ['on' | 'off']
  ```

-
  ```
  alter connection srv.db
    set 'dist_stop_unsupported_cmd' to ['on' | 'off']
  ```

-
  ```
  alter logical connection lsrv.ldb
    set 'dist_stop_unsupported_cmd' to ['on' | 'off']
  ```

By default, **dist_stop_unsupported_cmd** is off. When the parameter is on, the DIST suspends itself if a command cannot be sent to some destinations. Resume DIST by skipping the entire transaction, or reset the parameter to off.

Note: To create a database subscription from a primary Replication Server with version 15.0, the replicate Replication Server must be version 15.0 or later.

See also

- *Manage Replicated Tables* on page 279
- *Manage Replicated Functions* on page 355

Setting Up Bidirectional Replication Support for DDL in MSA

Learn to set up bidirectional replication support for MSA.

1. Create a bidirectional MSA replication environment.
2. Grant "set session authorization" privilege to the maintenance user on the destination database, as shown in the following example:

   ```
   grant set session authorization to maint_user
   ```
3. Alter the connection of the destination database to set **dsi_replication_ddl** configuration parameter to "on" to enable bidirectional DDL replication, as shown in the following example:

   ```
   alter connection to dataserver.database set dsi_replication_ddl on
   ```
4. Replicate DDL transactions.

Set Up an MSA System

You can set up MSA replication using different ways.

Set up representative MSA replication architectures:

- Simple, full-database replication using the default single-path replication or multi-path replication.
- Replication of specified tables and functions
- Replication to multiple replicate databases

To replicate DDL or system stored procedures, you can easily add syntax when you are setting up these architectures.

See also
- *Replicating DDL and System Procedures* on page 449

Replicating the Database in a Simple Scenario

Use database replication definitions and subscriptions to replicate the entire primary database to one or more replicate databases in this simple scenario.

To configure multi-path replication, see *Replication Server Administration Guide Volume 2 > Performance Tuning > Multi-Path Replication > Creating Multiple Replication Paths for MSA Environments*.

You can easily add syntax to this example to replicate DDL or system stored procedures.

1. Mark the primary database for replication using **sp_reptostandby**. For example:

   ```
   sp_reptostandby primary_db, 'all'
   ```

   Note: **sp_reptostandby** does not mark user stored procedures for replication. You must mark each user stored procedure individually using **sp_setrepproc**.

   See the *Replication Server Heterogeneous Replication Guide* for non-ASE data servers.
2. Set the RepAgent parameter **send warm standby xacts** to true so that RepAgent sends system transactions and DDL to both standby and replicate databases. For example, at the primary data server, enter:

   ```
   sp_config_rep_agent primary_db,
           'send warm standby xacts', 'true'
   ```

   See the *Replication Server Heterogeneous Replication Guide* for non-ASE data servers.
3. Create a database replication definition using **create database replication definition** at the primary Replication Server. For example:

   ```
   create database replication definition repdef_1
     with primary at PDS.primary_db
   ```

   See *Replication Server Reference Manual > Replication Server Commands >* ***create database replication definition*** for complete syntax and usage information.
4. Create a database subscription for each subscribing database. In this example, we are creating a database subscription using **create subscription** and the no materialization method. The primary and replicate databases have been synchronized prior to subscription. You can also use **create subscription** if activities at the primary database can be suspended.

   For example, at the replicate Replication Server, enter:

   ```
   create subscription sub_1
     for database replication definition repdef_1
       with primary at PDS.primary_db
       with replicate at RDS.rdb
     without materialization
     subscribe to truncate table
   ```

   When creating a database subscription, you can use the no materialization method (as shown in step 4) or the bulk materialization method to synchronize databases. The procedure you use depends on which materialization method you choose and whether primary table activities can be suspended.

See also

- *Materialization* on page 445
- *Replicating DDL and System Procedures* on page 449

Replicating Tables and Functions

Use MSA capabilities to replicate particular tables or functions.

You can easily add syntax to this example to replicate DDL or system stored procedures.

1. **Mark tables, stored procedures, and database for replication and create the database replication definition.**

   In this example, we are replicating `table1` and `table2` only. You can identify particular tables in either of two ways:

   - Mark the database for replication using **sp_reptostandby.** Create the database replication definition and identify specific tables for replication using **create replication definition**. You must also tell the RepAgent to send replicate data to replicate as well as standby databases.
     At the primary data server, enter:

     ```
     sp_reptostandby primary_db, 'all'
     sp_config_rep_agent primary_db,
       'send warm standby xacts', 'true'
     ```

     At the primary Replication Server, enter:

     ```
     create database replication definition rep_1B
       with primary at PDS.pdb
         replicate tables in (table1, table2)
     ```
   - Alternatively, mark particular tables and stored procedures for replication using **sp_setreptable** and **sp_setrepproc**. Then, create the database replication definition. For example:

     ```
     sp_setreptable table1, 'true'
     ```

     ```
     sp_setrptable table2, 'true'
     ```

     ```
     create database replication definition rep_1A
       with primary at PDS.pdb
     ```

     Note: You can replicate DDL changes only if you mark its database for replication using **sp_reptostandby**.

   See the *Replication Server Heterogeneous Replication Guide* for non-ASE data servers.
2. **Create the database subscription. To subscribe without materialization, follow the procedure in the simple scenario to replicate the database. You can also subscribe using bulk materialization.**

   Note: You can also use **sp_reptostandby** to mark the database and then create table replication definitions and subscriptions—without creating a database replication definition. This method eliminates the need to mark individual tables, yet allows you to select and replicate partial tables. The database connection parameter **rep_as_standby** must be **on**.

Be aware of considerations when dealing with encrypted columns.

See also

- *Replicate Encrypted Columns* on page 321
- *Materialization* on page 445
- *Replicating the Database in a Simple Scenario* on page 427
- *Replicating DDL and System Procedures* on page 449

Using Replicate Databases as Warm Standby Databases

Use MSA to replicate DDL and other database objects to multiple replicate or warm standby databases.

You can create database replication definitions and database subscriptions to logical connections. See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications* for detailed information about setting up logical connections.

In this example of a basic setup for a multiple warm standby architecture, you replicate from one primary database— `dsA.db`, to two replicate databases—`dsB.db` and `dsC.db`. There is a single Replication Server controlling replication, and only standby replication takes place to and from the primary database. Only `dsA` can replicate DDL and system stored procedures. If users are switched to `dsB.db` or `dsC.db`, DDL and system stored procedures are not replicated.

You can easily add syntax to this example to replicate DDL or system stored procedures.

Note: This example uses a different database replication definition for each subscribing site. You could also create a single database replication definition that handles the common set of replicated tables and functions, and then create table and function subscriptions for the tables and functions that are not common to both standby databases.

1. Suspend all database activities.
2. Mark `dsA.db`, `dsB.db`, and `dsC.db` for replication using **sp_reptostandby**.
3. At each data server, set **send warm standby xacts** to true for each RepAgent. For example:

   ```
   sp_config_rep_agent dbname,
       'send warm standby xacts', 'true'
   ```
4. At Replication Server, set **dsi_replication** off for each connection. For example:

   ```
   alter connection to dsB.db
           set dsi_replication 'off'
   ```

   Note: SAP recommends that you set **dsi_replication** to off for warm standby connections as it prevents replicated data in the transaction log from being replicated again in the event of a switchover. **dsi_replication** should be turned on (the default) for normal replication.
5. Create a database replication definition for each database, defining each as the primary. For example

```
create database replication definition rep_2
  with primary at dsA.db
  replicate DDL
```

```
  replicate system procedures
```

```
create database replication definition rep_2
  with primary at dsB.db
```

```
create database replication definition rep_2
  with primary at dsC.db
```

6. As each database can be a primary or a standby database, create or define subscriptions so that each database subscribes to every other database. You can use different materialization methods for each subscription. For example:

```
create subscription sub_2B
  for database replication definition rep_2
    with primary at dsB.db
  with replicate at dsA.db
  without materialization
  subscribe to truncate table
```

```
create subscription sub_2C
  for database replication definition rep_2
    with primary at dsC.db
  with replicate at dsA.db
  without materialization
  subscribe to truncate table
```

```
define subscription sub_2A
  for database replication definition rep_2
    with primary at dsA.db
  with replicate at dsB.db
  subscribe to truncate table
  use dump marker
```

```
create subscription sub_2C
  for database replication definition rep_2
    with primary at dsC.db
  with replicate at dsB.db
  without materialization
  subscribe to truncate table
```

```
define subscription sub_2A
  for database replication definition rep_2
    with primary at dsA.db
  with replicate at dsC.db
  subscribe to truncate table
  use dump marker
```

```
create subscription sub_2B
  for database replication definition rep_2
    with primary at dsB.db
  with replicate at dsC.db
  without materialization
  subscribe to truncate table
```

7. Dump `dsA.db`.
8. With the `dsB.db` DSI suspended, load database to `dsB.db`.
9. Resume connection to `dsB.db`.
10. With the `dsC.db` DSI suspended, load database to `dsC.db`.
11. Resume connection to `dsC.db`.
12. Resume database activities.

See also

- *Replicating DDL and System Procedures* on page 449

Switchover

In any standby situation, switchover involves disconnecting users from the active database and reconnecting them to the new active database. In this case, switchover must wait for the queues to empty so that no transactions are lost.

See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications* for more information about logical connections and switchover.

Mark Data for Replication

You can mark databases, tables, and functions for replication in MSA using **sp_reptostandby**, **sp_setreptable**, and **sp_setrepproc**.

Note: See the *Replication Server Heterogeneous Replication Guide* for non-ASE data servers.

When the database is marked by **sp_reptostandby**:

- The RepAgent configuration parameter **send warm standby xacts** must be true.
- User-defined stored procedures are not replicated unless they are marked individually using **sp_setrepproc**.
- RepAgent sends DDL, system procedures, and transactions to the Replication Server. A database replication definition can filter them out at the Replication Server.
- And you use table replication definitions and table subscriptions, you can send table data to both replicate databases and warm standby databases by setting the database connection parameter **rep_as_standby** on.

When the database is not marked by **sp_reptostandby**, DDL is not replicated for the marked tables and functions. See the Data Replication table for a summary of how data is replicated using the different system procedures for marking data for replication.

The table summarizes how data is replicated.

Table 34. Data Replication

Data Marked By	Table and Function Subscriptions Only	Database Subscription Only	Table, Function, and Database Subscriptions Coexist
sp_setreptable and **sp_setrepproc**	• Replicate marked data • Do not replicate DDL	• Replicate marked data • Do not replicate DDL	• Replicate marked data • Do not replicate DDL
sp_reptostandby	• Check **rep_as_standby** • Do not replicate DDL	• Replicate all data • Replicate DDL (optional)	• Check **rep_as_standby** • Replicate DDL (optional)
sp_setreptable, **sp_setrepproc**, and **sp_reptostandby**	• Check **rep_as_standby** • Do not replicate DDL	• Replicate all data • Replicate DDL (optional)	• Check **rep_as_standby** • Replicate DDL (optional)

Manage Database Replication Definitions

A table, a function, a transaction, DDL, or a system stored procedure can be a replicated object. A database replication definition specifies filters for replicated objects—either including or excluding the same or entire replicated object from replication.

For example, to create a database replication definition:

```
create database replication definition rep_1C
  with primary at PDS.pdb
    replicate tables in (table1, table2)
    not replicate functions in (fc_a)
    not replicate system procedures
    replicate transactions
    replicate DDL
```

In this example, we are replicating:

- `table1` and `table2`
- All functions except **fc_a**
- All transactions
- Supported DDL commands

We are not replicating:

- Any database tables except `table1` and `table2`
- Function **fc_a**

- Any system procedures

See *Replication Server Reference Manual >* ***create database replication definition*** for complete syntax and usage information.

Note: Database replication definitions do not support the options **send-standby-all-columns**, **send-standby-all-parameters**, and **send_standby_repdef_cols**. Where a database replication definition exists, Replication Server sends all columns or parameters.

Altering Database Replication Definitions

Use **alter database replication definition** to change a database replication definition.

alter database replication definition allows you to replace one filter at a time. For example:

```
alter database replication definition rep_1C
  with primary at PDS.pdb
  not replicate tables in (table2)
  with dsi_suspended
```

See the *Replication Server Reference Manual* for complete syntax and usage information.

When you execute **alter database replication definition**, Replication Server writes an **rs_marker** to the inbound queue. The command does not take effect until the marker reaches the Distributor (DIST), which will by then have rebuilt the Database Subscription Resolution Engine (DSRE) to incorporate the changes.

Altering a database replication definition with associated subscriptions may desynchronize replicate tables. To resynchronize, you can either:

- Quiesce Replication Server, drain the transaction log, and apply changes manually, or
- Use the **with_dsi_suspended** option, which causes the replicate Replication Server to suspend the replicate DSI when it reads the “alter database replication definition” marker.

To alter a database replication definition and resynchronize replicate tables:

1. Execute **alter database replication definition** and include the **with dsi_suspended** phrase.
2. Wait for the replicate DSI to suspend.
3. Use bulk materialization to resynchronize replicate tables.
4. Resume the connection.

Drop Database Replication Definitions

You can drop a database replication definition, but you must first have dropped all associated database subscriptions.

See *Replication Server Reference Manual >* ***drop database replication definition*** for syntax and usage information.

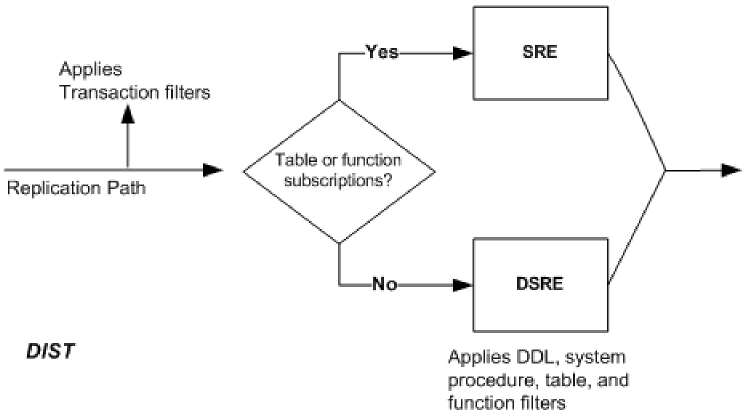
Database Replication Filters

Learn how replication filters work.

The Subscription Resolution Engine (SRE) evaluates table and function subscription rows. The Database Subscription Resolution Engine (DSRE) evaluates database objects—except transactions. When a database replication definition causes a transaction to be sent to the replicate Replication Server, the DIST evaluates the transaction before other database objects are evaluated by the DSRE and before transaction rows are evaluated by the SRE. Thus, Replication Server filters out transactions even if they contain data that satisfies a database subscription or a table or function subscription.

If a database subscription and a table or function subscription coexist for the same table or function, the table or function subscription takes precedence. In this instance, the DIST does not pass the replicated table or function to the DSRE for evaluation; the DIST passes it to the SRE.

Figure 19: Evaluation of Database Replication Filters


Applies
Transaction filters
Replication Path
Table or function subscriptions?
Yes
No
SRE
DSRE
DIST
Applies DDL, system procedure, table, and function filters

Viewing Information About Database Replication Definitions

Use **rs_helpdbrep** to view information about a specific database replication definition or all database replication definitions for a database or a data server.

For example, to view information about the **rep_1B** database replication definition, enter:

```
rs_helpdbrep rep_1B, PDS, pdb
```

See ***rs_helpdbrep*** in the *Reference Manual* for syntax and usage information.

Concurrently Using Database, Table, and Function Replication Definitions

You do not need to add table and function replication definitions when you use a database replication definition. However, to transform the data if a table needs to have a different **replicate minimal columns** or dynamic SQL setting than the target connection, you must do so.

Create and use table or function replication definitions that include the **send standby** clause to:

- Change the name of a replicated table or function
- Change the name of a replicated column
- Publish different column datatypes
- Replicate fewer columns or parameters
- Replicate minimal columns
- Not replicate dynamic SQL

Create and use table or function replication definitions where the **send standby** clause is optional to:

- Declare different table column datatypes
- Set autocorrection for materialization or dematerialization
- Use table or function subscription to override database replication
- Exclude dynamic SQL in the standby database combined with **dynamic_sql** setting

Note: As long as a database replication definition and a database subscription are in place, you can use table or function replication definitions without table or function subscriptions. You need to use table or function subscriptions only if you require the functionality they provide.

If a database replication definition and table replication definitions exist at the primary, and a database subscription but no table subscriptions exist at the replicate, replication behavior depends in part on the presence or absence of the **send standby replication definition columns/parameters** clause in the table or function replication definition.

- If the **send standby** clause is present, the database subscription honors the table or function replication definition; the table replication definition's primary key columns and replicate minimal columns settings are used to replicate into the replicate database. The database subscription always treats **send standby all columns** as **send standby replication definition columns**.
- If the table replication definition does not contain the **send standby** clause and other replication definitions exist for a given table, the database subscription replicates data using the internal table replication definition (the union of all such replication definitions). All columns are replicated, and data is converted to the declared columns or datatypes.

- If a table replication definition is made for a table whose owner is not *dbo*, the table must be individually marked to replicate the owner information, and the owner information must be included in the replication definition.

See also

- *Concurrently Using Database, Table, and Function Subscriptions* on page 447

Alter Database Replication Definitions

Adding or dropping database replication definitions does not affect table or function subscriptions

When you alter a database replication definition, you replace the existing database replication filter or add the filter category to the database replication filters, if it is a new category.

Replication Server places a marker in the inbound queue and allows the DIST to process the command. The new filter is applied to transactions committed after the marker.

- If a table subscriptions exists, no action is required.
- If no table subscription exists, you must include the **dsi_suspended** clause in the **alter database replication definition** command, or manually materialize or dematerialize the table.

To alter table and function replication definitions, use the replication definition change request process where Replication Server coordinates the propagation of replication definition changes and data replication automatically.

See also

- *Replication Definition Change Request Process* on page 327

Reduce the Use of Replication Definitions and Subscriptions

In a replication system containing only Adaptive Server databases, you can reduce the need for replication definitions and subscriptions for tables and stored procedures in a warm standby or multisite availability (MSA) environment.

You need not create a replication definition for a primary table or stored procedure if the sole purpose of the replication definition is to specify some or all of the following:

- Primary key columns
- Table or column names that may be quoted.
- Customized function strings for replicate tables or stored procedures.

See also

- *Quoted Identifiers* on page 288

Primary Key Columns and Quoted Table or Column Names

RepAgent for Adaptive Server uses Log Transfer Language (LTL) to specify a table or column name that may be quoted, and whether a table column is part of the table primary key. Since RepAgent sends the primary key and quoted identifier information to Replication Server, you do not need a replication definition if the sole purpose of the replication definition is to specify primary key and quoted identifier information, in a replication system that contains only Adaptive Server databases.

The reduced requirement for replication definitions makes it easier to manage a replication environment involving databases with many tables, tables with many columns, or tables with frequent schema changes. Replication performance improves for tables that are currently without replication definitions, as RepAgent directly provides Replication Server with table primary-key information, so that Replication Server packs only the primary-key columns in the **where** clauses of **update**, **delete**, and **select** commands.

- When a replication definition is subscribed by an MSA database, its primary key columns are used for the **where** clause packing for the database.
- When a replication definition is marked **send standby replication definition columns** or **send standby all columns**, primary-key columns of the replication definition are used for the **where** clause packing for the standby and the MSA databases that do not have a subscription to any of the replication definitions of the same table.
- When there are one or more replication definitions for a table, and none of them are marked **send standby**, Replication Server uses the union of the primary key columns for the replication definitions for the **where** clause packing for the standby and MSA databases that do not have subscriptions to any of the replication definitions for the table.
- When there is no replication definition for a table, and LTL sends information about the primary key, the primary key columns indicated by the LTL are used for the **where** clause packing.
- When there is no replication definition for a table, and an LTL command does not indicate any primary column, all columns except `text`, `image`, and `unitext` columns are used for the **where** clause packing.

See *Replication Server Administration Guide Vol 2 > Manage Warm Standby Applications*.

Quoted Table and Column Names and Replication Definitions

When Replication Server packs a DML command for the target database, and if there are one or more replication definitions for the table, Replication Server decides that a table or column name should be quoted according to a replication definition if the replication definition is:

- Subscribed by a MSA database.
- Marked **send standby [replication definition | all] columns** for MSA databases that do not have subscriptions to a replication definition.
- Marked **send standby replication definition columns** for the standby database.

Otherwise, Replication Server packs a table or column name according to the LTL.

System Requirements

RepAgent sends primary-key and quoted identifier information only with LTL version 740 or later, which is supported by Adaptive Server 15.7 and later, and Replication Server 15.7 and later.

Target-Scope Customized Function Strings

In a replication system containing only Adaptive Server databases, you need not create a replication definition for a primary table or stored procedure in a warm standby environment or multisite availability (MSA) environment if the sole purpose of the replication definition is to specify a customized function string for the replicate or standby table or stored procedure.

You can create a customized function string, called a target-scope function string, directly against a replicate or standby table or stored procedure without defining a replication definition. This further reduces the replication definition requirement in a warm standby or MSA environment. Use **create function string** to create target-scope function strings and **alter function string** and **drop function string** to manage the function strings.

Stored Procedure and System Table Support

Use **rs_helpobjfstring** to display information about target-scope function strings. See *Replication Server Reference Manual > RSSD Stored Procedures >* ***rs_helpobjfstring***.

The `rs_targetobjs` system table stores information about target tables or stored procedures. See *Replication Server Reference Manual > Replication Server System Tables > `rs_targetobjs`*.

Replication Server does not replicate the values in `rs_targetobjs` to the RSSDs of other Replictation Servers. `rs_targetobjs` is in the system table services (STS) cache with (`objname`, `objowner`, `dbid`, `objtype`) as the STS primary cache key. Use **sts_full_cache_rs_targetobjs** to enable or disable full caching of the table:

```
configure replication server set sts_full_cache_rs_targetobjs to
{on|off}
```

The default for **sts_full_cache_rs_targetobjs** is off.

Warm Standby and Multisite Availability Environments

There are several conditions that must be met before a warm standby or multisite availability (MSA) system can use target-scope function strings.

- If an MSA system subscribes to a replication definition of a table or stored procedure, Replication Server uses the function string of the replication definition, which can be a default function string or a customized function string.
- If an MSA system does not subscribe to any replication definition of a table or stored procedure, Replication Server uses the function string of a replication definition for the

target object if the replication definition is marked with the **send standby all** or **send standby replication definition columns** clauses.

- A warm standby system uses the function string of a replication definition if you have marked the replication definition with the **send standby replication definition columns** clause.

If none of the conditions are met, the warm standby or MSA system uses the target-scope function string for the replicate or standby table or stored procedure, if there is one.

Comparison of Target-Scope and Replication Definition-Scope Function Strings

There are several differences between target-scope and replication definition-scope function strings.

Replication Definition-Scope	Target-Scope
A replication definition-scope function string is associated with a function-string class.	A target-scope function string is associated with a target (standby or replicate) database.
Create replication definition-scope function strings against replication definitions for function-string classes at the Replication Server that manages the replication definition.	Create target-scope function strings for target tables or stored procedures at the Replication Servers that manage the standby or replicate databases.
Replication Server checks whether a column or parameter for a function string is valid when the function string is created or altered against the replication definition.	Replication Server does not check the validity of a column or parameter for a function string until Replication Server converts a DML command using the function string template, and applies the command to the standby or replicate database. If the column or parameter information is incorrect, the DSI connection shuts down. You can resume the DSI connection after correcting the function string.
When you create a replication definition-scope function string, Replication Server creates the full set of default function strings for the replication definition.	When you create a target-scope function string, Replication Server creates only the function string that you specify. The only exception is with the **rs_get_textptr** and **rs_writetext** function strings because they coexist. If there is a customized function string for **rs_writetext**, the function string for **rs_get_textptr** also exists. They both can exist as a customized function string, or as a system-created default function string.

Target-Scope Function String Commands

Use **create function string**, **alter function string**, and **drop function string** to create and manage target-scope function strings for replicate and standby tables and stored procedures.

Use the *[owner.]table*, *stored procedure*, , and *data_server.database* parameters to create and manage target-scope function strings.

```
{create | alter | drop} function string
        {replication_definition |
        [owner.] table |
         stored_procedure}.function[; function_string]

        for {[function class]function_class |
        [database] data_server.database}...
```

Example

create the **rs_insert** customized function string for the `dbo.authors` table at the `rdb1` target database in the NY_DS data server:

```
create function string dbo.authors.rs_insert
     for database NY_DS.rdb1
     output language
     'insert authors values (
           ?au_id!new? ,
           ?au_lname!new? ,
           ?au_fname!new? ,
           ?phone!new? ,
           ?address!new? ,
           ?city!new? ,
           ?state!new? ,
           "00000" ,
           ?contract!new?)
      update fn_monitor set insert_count = insert_count + 1'
```

See **create function string**, **alter function string**, and **drop function string** in *Replication Server Reference Manual > Replication Server Command* for full syntax, parameter descriptions, more examples, and usage information.

Listing Target-Scope Function Strings

Use the **rs_helpobjfstring** stored procedure to list target-scope function strings for databases such as Adaptive Server and Oracle, that support stored procedures.

To list customized function strings for replicate or standby tables or stored procedures, enter:

```
rs_helpobjfstring data_server, database, [owner.]object_name[,
function_name]
```

Suppose you create a target-scope function string for the **upd_datetime** stored procedure:

```
create function string upd_datetime.upd_datetime
     for database NY_DS.rdb1
     with overwrite
          output language
          'update datetime set
          row_num = ?row_num!param?,
          datecol = ?datecol!param?,
          timecol = ?timecol!param?,
          ndatecol = ?ndatecol!param?,
          ntimecol = ?ntimecol!param?,
          comment = ?comment!param?
          where
          row_num = ?row_num!param?'
```

If you enter:

- `rs_helpobjfstring NY_DS,rdb1,upd_datetime`

  or
- `rs_helpobjfstring NY_DS,rdb1,upd_datetime,upd_datetime`

You see:

```
Function String information for Target Object: 'upd_datetime'.

Object Name     Object Type        Function Name
-----------     -----------        --------------
upd_datetime    stored procedure   upd_datetime

Function String Name   Output Type Option       System Generated
--------------------   -------------------      ----------------
upd_datetime           language not applicable  no


         --- Beginning of Function String Text ---

FString Text
-----------------------------------------------------------------
 update datetime set
         row_num = ?row_num!param?,
         datecol = ?datecol!param?,
         timecol = ?timecol!param?,
         ndatecol = ?ndatecol!param?,
         ntimecol = ?ntimecol!param?,
         comment = ?comment!param?
         where
         row_num = ?row_num!param?

         --- End of Function String Text ---


(return status = 0)
```

See *Replication Server Reference Manual > RSSD Stored Procedures >* **rs_helpobjfstring** for more examples and usage information.

Configuring the Replication System to Reduce Replication Definitions

Configure the replication system to reduce replication definitions in an Adaptive Server warm standby or multisite availability environment.

See *Replication Server Reference Manual* for the full syntax of the commands and system procedures.

1. At the primary Replication Server, suspend log transfer:
   ```
   suspend log transfer from all
   ```
2. At the primary data server, stop the RepAgent:
   ```
   sp_stop_rep_agent dbname
   ```
3. At the primary and replicate Replication Servers, set the site version to the upgraded Replication Server version if necessary. The new site version must be 1571 or later.
   ```
   sysadmin site_version, new site version
   ```
4. Drop all replication definitions that exist only to define primary keys, quoted identifiers, and customized function strings.
   a) At the RSSD or ERSSD of the primary Replication Server, use **rs_helpcheckrepdef** to identify such replication definitions.
   b) At the primary Replication Server, use **drop replication definition** to drop the replication definitions listed by **rs_helpcheckrepdef**.
5. At the primary database, create a unique index for tables that do not have a primary key or a unique index, and that do not have replication definitions.

   RepAgent selects as the primary key:

   - The primary index defined on a table, or
   - A unique index with the lowest index identifier if there is no primary index

   Note: If there is no primary key or unique index defined on the table, RepAgent does not send primary key information to the LTL. If the table does not have a replication definition, Replication Server treats all columns in the table, except `text`, `image`, or `unitext` columns, as primary key columns. This may degrade replication performance for the table.

   a) Execute **sp_setreptable** without any parameters to see primary key and index information for all tables that you had marked for replication with **sp_setreptable**.
   ```
   Name        Repdef Mode   Index Mode   Primary Key
   ---------   ------------  -----------  -------------------
   hola        owner_off     no index     hola_index
   inds        owner_off     no index     inds_1335724833
   t applied   owner_off     no index     t applied_855723122
   t5          owner_off     no index     con_pk_t5
   ```
   You can also specify a single table. For example:
   ```
   sp_setreptable inds
   ```
   b) Create a unique index for any table without a unique index or primary key.

See *Adaptive Server Enterprise > Transact-SQL Users Guide > Creating Indexes on Tables*.

6. If any of the replication definitions that you dropped in step 4 have customized function strings, re-create them as customized target-scope function strings at the Replication Server that controls the standby or MSA database. If there is more than one target database, re-create the function strings for each of them.
7. Resume log transfer and start the RepAgent.
   a) At the primary data server, start RepAgent:

   ```
   sp_start_rep_agent dbname
   ```

   b) At the primary Replication Server, resume log transfer:

   ```
   resume log transfer from all
   ```

Note: If you change the primary key for a table schema, you must suspend and resume all connections from databases that subscribe to the table and have **dynamic_sql** turned on.

Manage Database Subscriptions

When you create a database replication definition at the primary database, you must also create a database subscription at each subscribing database.

You can use the no materialization method or the bulk materialization method. If you create a database subscription, you cannot use a **where** clause to set the criteria for subscribed data; all data is subscribed.

If you need to set criteria for particular tables or functions, you can add table or function subscriptions concurrently.

When there is a database subscription, the DSI for that connection is always treated as if for regular replication. That is, the **dsi_replication** parameter is off, and the **dsi_keep_triggers** parameter is on.

When there is a database subscription—and table and function replication definitions—but there are no table or function subscriptions:

- If the table and function replication definitions contain the **send standby** clause, the database subscription honors the table or function replication definition.
- If the table and function replication definitions do *not* contain the **send standby** clause, all columns and parameters are replicated and the data is converted to the declared column and parameter datatypes.

See also

- *Concurrently Using Database, Table, and Function Subscriptions* on page 447

Materialization

Database subscription requires either the none method (no materialization) or the bulk method of materialization.

Subscription Without Materialization

Use **create subscription** with the **without materialization** clause to create a database subscription when the primary and replicate databases have been synchronized prior to subscription, or activities at the primary database can be suspended.

When you use the no materialization method as described in the simple scenario for replicating a database, you can materialize the replicate databases using **bcp**, **dump** and **load**, **mount** and **unmount**, or other methods. Because Replication Server does not coordinate the initial database synchronization process, you will likely need to suspend database applications. Use this method if you are materializing the replicate database with a cross-platform **dump** and **load** (XPDL). See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications > Set up ASE Warm Standby Databases > Task Four: Adding the Standby Database > Determine How to Initialize the Standby Database > Cross-Platform Dump and Load* for instructions.

See also

- *Replicating the Database in a Simple Scenario* on page 427

Subscription with Bulk Materialization

You can use **dump** and **load** or manual coordination methods to synchronize databases.

To create a database subscription using dump and load coordination, use **define subscription** with the **use dump marker** clause. Both the primary and replicate databases and Replication Servers, must have the same server user ID, password, and role settings.

```
define subscription sub_2
  for database replication definition repdef_1
    with primary at PDS.primary_db
```

```
  with replicate at RDS.rdb
  subscribe to truncate table
  use dump marker
```

Synchronizing Databases After Defining the Subscription

Synchronize databases after defining the subscription.

1. Dump *PDS.pdb*. The DSI connection to the replicate database is suspended when the dump marker reaches the replicate Replication Server. It is suspended so that no data will be replicated until you finished step 2. Replication Server activates and validates the subscription automatically when the dump marker is replicated.

Warning! Do not execute **activate subscription** or it will override the wait for dump marker at the Replication Server.

2. Load *PDS.primary_pdb* to *RDS.rdb*.
3. Bring *RDS.rdb* online:
   online database *RDS.rdb*
4. Prepare *RDS.rdb* as a replicate:
   a) In *RDS.rdb*, disable the secondary truncation point, if necessary:
   ```
   dbcc settrunc('ltm', 'ignore')
   ```
   b) Optionally, disable RepAgent:
   ```
   sp_config_rep_agent primary_db, 'disable'
   ```
   c) Dump the transaction log.
5. Resume the DSI connection to *RDS.rdb*.

Alter Database Subscriptions

You cannot alter a database subscription directly. To alter a database subscription, delete the existing database subscription using **drop subscription**, and then create a new one.

Drop Database Subscriptions

Use **drop subscription** to delete a database subscription.

You must include the **without purge** option so that Replication Server will not remove rows added by the subscription to the replicate. For example:

```
drop subscription sub_1a
  for database replication definition rep_1
    with primary at PDS.pdb
  with replicate at RDS.rdb
```

```
  without purge ...
```

Dropping a database subscription does not affect existing table or function subscriptions. Similarly, dropping a table or function subscription does not affect existing database subscriptions. However, in this case, the replicate tables may need to be rematerialized.

See the *Replication Server Reference Manual* for complete syntax and usage information.

Viewing Information About Database Subscriptions

Use **rs_helpdbsub** to view information about a specific database subscription or all database replication definitions for a database or a data server.

For example, to view information about the **sub_2B** database subscription, enter:

```
rs_helpdbsub sub_2B, dsA, db
```

See *Replication Server Reference Manual > RSSD Stored Procedures >* **rs_helpdbsub** *for syntax and usage information.*

Concurrently Using Database, Table, and Function Subscriptions

If a database subscription and table or function subscriptions coexist, the table or function subscription overrides the database subscription.

That is, Replication Server replicates the table or function according to the table or function subscription, not the database subscription.

Database subscriptions do not support the **where** clause or the **for new articles** clause. When using a database subscription, you need to create a table subscription only to:

- Use the **where** clause of a table subscription.
- Replicate a table filtered out by the database replication definition.

  Note: A database subscription supports the **subscribe to truncate table** clause, but not for those tables with a table subscription.
- Implement autocorrection on a table.

See also

- *Concurrently Using Database, Table, and Function Replication Definitions* on page 436

Create and Drop Subscriptions

When database and table or function subscriptions are used concurrently, there are several procedures to follow when you create or drop those subscriptions

- If you create a database subscription that references a table with an existing table subscription, make sure you do not overwrite the replicated table when synchronizing databases:
  1. Back up the replicated table.
  2. Use **dump** and **load** to synchronize the replicate database.
  3. Copy the replicated table back into the replicate database.
- Drop a table or function subscription with suspension. After the replicate DSI is suspended, you can dematerialize or resynchronize the replicate table or function.
- When a database subscription exists that includes a table and you want to add a table subscription, make sure you define the table subscription using bulk materialization. Defining the table subscription does not stop database replication for the table. Database replication for a table stops when its table subscription is activated.
- When dropping a database subscription, you must manually purge all replicated tables that do not have table subscriptions. Replication Server does not dematerialize replicated tables.

Replicating the Master Database in an MSA Environment

You can replicate Adaptive Server logins from one master database to another. Master database replication is limited to DDL, and the system commands used to manage logins and roles.

Master database replication does not replicate data from system tables, or replicate data or procedures from any other user tables in the master database.

Both the source Adaptive Server, and the target Adaptive Server must be the same hardware architecture type (32-bit versions and 64-bit versions are compatible) and the same operating system (different versions are also compatible).

For restrictions and limitations, and a list of supported DDL and system procedures that apply to the master database, in *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications > Replicated Information for Warm Standby > Use* ***sp_reptostandby*** *to Enable Replication > Restrictions and Requirements When Using* ***sp_reptostandby***, see:

- *Supported DDL Commands and System Procedures*
- *Replication of the Master Database: Limitations*

Replication Server versions 12.0 and later support master database replication with warm standby, and with MSA in Replication Server 12.6 and later. The primary or active Adaptive Server must be version 15.0 ESD #2 and later.

See *Replication Server Administration Guide Volume 2 > Manage Warm Standby Applications > Replication of the Master Database in a Warm Standby Environment for ASE* for master database replication in a warm standby environment.

1. Use **rs_init** to set up the primary and replicate master databases.
2. Use **bcp** or manually synchronize **syslogins** and **suids** at each master database. Do not use **dump** and **load** to materialize the replicate master database.
3. Mark the primary master database:

   ```
   sp_reptostandby master, ‘all’
   ```
4. Stop the RepAgent on the primary master database:

   ```
   sp_stop_rep_agent master
   ```
5. Configure the replication primary master database to send warm standby transactions:

   ```
   sp_config_rep_agent master,‘send warm standby
   xacts’,‘true’
   ```
6. Restart the RepAgent on the primary master database:

   ```
   sp_start_rep_agent master
   ```
7. Create a database replication definition to replicate the system procedures:

```
create database replication definition master_dbrep
with primary at PDS.master
replicate system procedures
```

8. Create a database subscription for each subscribing master database; do not materialize the data:

```
create subscription master_dbsub1
for database replication definition master_dbrep
with primary at PDS.master
with replicate at RDS.master
without materialization
```

Replicating DDL and System Procedures

Learn how to use MSA to replicate DDL to nonstandby databases.

See *Supported DDL Commands and System Procedures* in the *Administration Guide Volume 2* for a list of DDL commands supported for replication.

These constraints apply:

- When replicating system procedures, and the primary and replicate databases have different names – filter out the **sp_config_rep_agent** and the **sp_add_user** system procedures in the database replication definition as they use database names as parameters. For example:

  ```
  create database replication definition myrepdef
    with primary at PDS.pdb
    not replicate system procedures in
    (sp_config_rep_agent, sp_add_user)
  ```

- When replicating DDL – the primary and replicate databases must have the same login names and passwords; the DSI uses the original server login name and password to log in to the replicate database.
- When replicating DDL contained in user-defined transactions – make sure that the SAP ASE database option **ddl in tran** is set to **true**. Otherwise, the DSI will shut down when replicating DDL.
- SAP Replication Server does not support the replication of DDL commands after **set proxy** is executed on the primary SAP ASE. If **set proxy** is executed on the primary SAP ASE, SAP Replication Server returns error 5517:

  ```
  A REQUEST transaction to database '...' failed because the
  transaction    owner's password is missing. This prevents the
  preservation of transaction ownership.
  ```

Note: In a heterogeneous environment, non-SAP data servers can replicate DDL if the Replication Agent can capture and send DDL commands in Transact-SQL or ANSI SQL (preferred).

To replicate DDL and system procedures:

1. Mark the primary database using **sp_reptostandby**.
2. Set the SAP ASE RepAgent parameter **send warm standby xacts to true**—even if there is no standby database.
3. Create a database subscription.
4. Make sure that both the primary and replicate data servers are the same version of SAP ASE.

See also

- *Setting Up Bidirectional Replication Support for DDL in MSA* on page 427

Replicate User Stored Procedures

To replicate user stored procedures, mark each procedure individually using **sp_setrepproc**. Database replication definitions do not check for owner information for user stored procedures.

Customize Function Strings

You can customize only those function strings that are not in the **rs_default_function_class** function-string class.

For functions with replication-definition scope:

- The DSI uses **rs_default_function_class** for functions that do not use a table or function replication definition with the **send standby** clause.
- Otherwise, the DSI uses the function-string class associated with the connection.

For functions with function-string class scope, the DSI always uses the function-string class associated with the connection.

Manage Replication Schedules

You can schedule replication tasks in Replication Server. Replication Server also provides support for delaying replication by a fixed period of time.

Schedule Replication Tasks

Learn to create and manage replication schedules

Create Schedules

Use **create schedule** to create a schedule to execute shell commands at a time you specify.

For example, you can report on a specific state of the replicate database while the replicate database is frozen and not receiving data from the primary database. In this example, you can schedule replication to happen only during specific night hours, so that the processing of the next day does not change the replicate database, and reporting can occur on the data of the day before, that is frozen in the replicate database. You can do this by creating schedules to suspend and resume connections to the replicate database at specific times of the day.

Syntax:

```
create schedule sched_name as 'sched_time' [set {on | off}] for exec
'command'
```

Parameters:

- *sched_name* – the name of the schedule you provide, which:
  - Must conform to the rules for identifiers
  - Must be unique
  - Can be 1 – 30 bytes long
- '*sched_time*' – specifies the time and day to execute '*command*'. Provide the day and time in the restricted UNIX **cron** style with a single space separating the time and date parameters:

  ```
  [mm] [HH] [DOM] [MON] [DOW]
  ```

  The time and date parameters are:

Parameter	Description	Values
mm	Minutes past the hour	0 – 59. Use "*" to include all legal values.
HH	Hour in 24-hour notation	0 – 23. Use "*" to include all legal values.
DOM	Day of the month	1 – 31. Use "*" to include all days of the month.

Parameter	Description	Values
MON	Month of the year	1 – 12. Use "*" to include all months of the year.
DOW	Day of the week	0 – 6 with 0=Sunday. Use "*" to include all days of the week.

- Use an asterisk "*" to specify all valid values. For example, "17 20 * * *" represents a daily schedule at 8:17 p.m.
- Use a comma "," to separate values that are not part of a range. For example, "17 20 1,15 * *" represents 8:17 p.m. on the 1st and 15th of every month, where 1 and 15 are the values for the *DOM* parameter.
- Use a hyphen "-" between two values to specify a range of values, inclusive of the two values. For example, "17 20 * * 1-5" represents 8:17 p.m. from Monday to Friday where "1-5" are the range of values for the *DOW* parameter.
- For the *DOM*, *MON*, or *DOW* parameters, you can specify the day using both the *DOM* and *DOW* parameters. Replication Server follows all schedules you specify in the string. For example, "0 12 16 * 1" represents 12:00 p.m.every Monday and 12:00 p.m. on the 16th of every month.

- **set {on | off}** – enables or disables the schedule when you create it. By default, the schedule is on.
- '*command*' – specifies the shell command, such as scripts, executables, or batch files to execute at the specified schedule.

  Shell commands:

  - Must be in `$SYBASE/$SYBASE_REP/sched` for UNIX or `%SYBASE%\%SYBASE_REP%\sched` for Windows
  - Can include parameters delimited with a space within the shell command.
  - In Windows, **create schedule** executes the command specified in the last parameter within the shell command or batch file. You must also include **stdout** to a file in the **create schedule** command line.

  In shell command names, you:

  - Can use only ASCII alphanumeric characters, such as A – Z, a – z, and 0 – 9
  - Can use the ".", "-", and "_" characters
  - Cannot use the "\" and "/" characters
  - Must include the `.bat` suffix if you are executing on Windows. For example, the name should be `suspend_conn.bat` on Windows and `suspend_conn.sh` on UNIX.

Example 1

Create "schedule1" in Windows that suspends the connection to the `pubs2` database in the SYDNEY_DS data server at 12:00p.m.every Monday and 12:00p.m. on the 16th of every month:

1. Create a text file, such as `sql.txt` that contains the actual Replication Server command line that you want to schedule. For example, `sql.txt` can contain:

```
suspend connection to SYDNEY_DS.pubs2
go
```

2. Create a batch file, such as `suspend_conn.bat` in Windows that contains **isql** and relevant parameters to run the command line in `sql.txt`. For example, `suspend_conn.bat` can contain:

   `%SYBASE\OCS-15_0\bin\isql.exe` **-Usa -P -S** SYDNEY_DS **-I** `%SYBASE%\sql.ini` **-i** `%SYBASE%\REP-15_5\sched\sql.txt`
3. Create the schedule, "schedule1":

```
create schedule schedule1 as ‘0 12 16 * 1’ for exec
‘test.bat > c:\temp\test.out’
go
```

Example 2

Create "schedule2" to execute the `suspend_conn.sh` script in UNIX that suspends the connection to the `pubs2` database in the SYDNEY_DS data server every day at 8:17p.m.:

```
create schedule schedule2 as ‘17 20 * * *’ for exec
‘suspend_conn.sh’
```

Example 3

Create "schedule3" to execute the `resume_conn.sh` script that resumes the connection to the `pubs2` database in the SYDNEY_DS data server every day at 7:15a.m.:

```
create schedule schedule2 as '15 7 * * *' for exec
‘resume_conn.sh’
```

System Table Support for Schedules

Replication Server provides the `rs_schedule` and `rs_scheduletxt` system tables to store schedules you create.

See *Replication Server Reference Manual > Replication Server System Tables*.

Alter Schedules

Use **alter schedule** to enable or disable a schedule.

Syntax:

alter schedule *sched_name* **set [on|off]**

For example, to disable schedule1 enter:

```
alter schedule schedule1 set off
```

Drop Schedules

Use **drop schedule** to delete a schedule from Replication Server.

For example, to delete schedule1 enter:

```
drop schedule schedule1
```

Display Schedules

Use **admin “schedule”** to display a schedule.

Syntax:

admin "schedule", ' *sched_name*'

For example, to display a schedule named schedule1, enter:

```
admin “schedule”, ‘schedule1’
```

Note: For **admin “schedule”**, you must enclose the **“schedule”** clause in double quotes.

The output is:

```
Schedule  Schedule    Status  Type  Owner  Sequence  Command
Name      Time
--------  ----------  ------  ----  -----  --------  -------

s1        27 * * * *  1       0     sa     1         suspend_conn.sh
```

If you do not specify a schedule name, **admin “schedule”** displays all schedules in Replication Server.

Delay Replication

You can configure Replication Server to delay replication by a fixed period of time.

You can use the replicate database as a failback system by keeping the replicate database a certain amount of time behind the primary database to provide a window of time during which to recover any human error committed on the primary database, such as a table or records dropped by mistake.

Use the **dsi_timer** parameter with **alter connection** or **alter logical connection** to specify a delay between the time transactions commit at the primary database and the time transactions commit at the standby or replicate database. Replication Server processes transactions in the outbound queue in commit order after the period of delay is over.

You can specify a maximum delay of 24 hours. The default delay value is 00:00 which means there is no delay

After you execute **dsi_timer** with **alter connection** or **alter logical connection**, suspend and resume the connection.

Note: Replication Server does not support time zone differences between the RepAgent at the primary database and the Replication Server with the DSI connection where you want to execute **dsi_timer**.

To delay by two hours the time transactions commit at the `pubs2` replicate database in the SYDNEY_DS data server, enter:

```
alter connection to SYDNEY_DS.pubs2
set dsi_timer to ‘02:00’
```

Display Delayed Replication Status

Use **admin who** to provide the status of any delay in replication that you configure with **dsi_timer**.

Table 35. Delayed Replication Status

State	Description
Active, DSI timer	Actively processing a command. **dsi_timer** is on.
Awaiting Command, DSI timer	The thread is waiting for a client to send a command. **dsi_timer** is on.
Awaiting Message, DSI timer	The thread is waiting for a message from an SAP Open Server message queue. **dsi_timer** is on.

Glossary

Glossary of terms used in replication systems.

- **active database –** A database that is replicated to a standby database in a warm standby application. See also *warm standby application*.
- **application programming interface (API) –** A predefined interface through which users or programs communicate with each other. Open Client™ and SAP Open Server are examples of APIs that communicate in a client/server architecture. RCL, the Replication Command Language, is the SAP Replication Server API.
- **applied function –** A replicated function, associated with a function replication definition, that SAP Replication Server delivers from a primary database to a subscribing replicate database. See also *replicated function delivery*, *request function*, and *function replication definition*.
- **article –** A replication definition extension for tables or stored procedures that can be an element of a publication. Articles may or may not contain **where** clauses, which specify a subset of rows that the replicate database receives.
- **asynchronous procedure delivery –** A method of replicating, from a source to a destination database, a stored procedure that is associated with a table replication definition.
- **asynchronous command –** A command that a client submits to SAP Replication Server where the client is not prevented from proceeding with other operations before the completion status is received. Many SAP Replication Server commands function as asynchronous commands within the replication system.
- **atomic materialization –** A materialization method that copies subscription data from a primary to a replicate database through the network in a single atomic operation, using a select operation with a holdlock. No changes to primary data are allowed until data transfer is complete. See also *nonatomic materialization*, *bulk materialization* and *no materialization*.
- **autocorrection –** Autocorrection is a setting applied to replication definitions, using the **set autocorrection** command, to prevent failures caused by missing or duplicate rows in a copy of a replicated table. When autocorrection is enabled, SAP Replication Server converts each update or insert operation into a delete followed by an insert. Autocorrection should only be enabled for replication definitions whose subscriptions use nonatomic materialization.
- **base class –** A function-string class that does not inherit function strings from a parent class. See also *function-string class*.
- **bitmap subscription –** A type of subscription that replicates rows based on bitmap comparisons. Create columns using the int datatype, and identify them as the `rs_address` datatype when you create a replication definition.
- **bulk copy-in –** A feature that improves SAP Replication Server performance when replicating large batches of **insert** statements on the same table in SAP ASE 12.0 and later.

SAP Replication Server implements bulk copy-in in Data Server Interface (DSI), the SAP Replication Server module responsible for sending transactions to replicate databases, using the Open Client™ Open Server™ Bulk-Library.

Bulk copy-in also improves the performance of subscription materialization. When **dsi_bulk_copy** is on, SAP Replication Server uses bulk copy-in to materialize the subscriptions if the number of **insert** commands in each transaction exceeds **dsi_bulk_threshold**.

- **bulk materialization –** A materialization method whereby subscription data in a replicate database is initialized outside of the replication system. You can use bulk materialization for subscriptions to table replication definitions or function replication definitions. For example, data may be transferred from a primary database using media such as magnetic tape, diskette, CDROM, or optical storage disk. Bulk materialization involves a series of commands, starting with define subscription. See also *atomic materialization*, *nonatomic materialization*, and *no materialization*.
- **centralized database system –** A database system where data is managed by a single database management system at a centralized location.
- **class –** See *error class* and *function-string class*.
- **class tree –** A set of function-string classes, consisting of two or more levels of derived and parent classes, that derive from the same base class. See also *function-string class*.
- **client –** A program connected to a server in a client/server architecture. It may be a frontend application program executed by a user or a utility program that executes as an extension of the system.
- **Client/Server Interfaces (C/SI) –** The SAP interface standard for programs executing in a client/server architecture.
- **concurrency –** The ability of multiple clients to share data or resources. Concurrency in a database management system depends upon the system protecting clients from conflicts that arise when data in use by one client is modified by another client.
- **connection –** A connection from an SAP Replication Server to a database. See also *Data Server Interface (DSI)* and *logical connection*.
- **connection profile –** Information required to establish a database connection.
- **coordinated dump –** A set of database dumps or transaction dumps that is synchronized across multiple sites by distributing an rs_dumpdb or rs_dumptran function through the replication system.
- **database –** A set of related data tables and other objects that is organized and presented to serve a specific purpose.
- **database generation number –** Stored in both the database and the RSSD of the SAP Replication Server that manages the database, the database generation number is the first part of the origin queue ID (*qid*) of each log record. The origin queue ID ensures that the SAP Replication Server does not process duplicate records. During recovery operations, you may need to increment the database generation number so that SAP Replication Server does not ignore records submitted after the database is reloaded.

- **database replication definition –** A description of a set of database objects—tables, transactions, functions, system stored procedures, and DDL—for which a subscription can be created.

  You can also create table replication definitions and function replication definitions. See also *table replication definition* and *function replication definition*.
- **database server –** A server program, such as SAP ASE, that provides database management services to clients.
- **data definition language (DDL) –** The set of commands in a query language, such as Transact-SQL, that describes data and their relationships in a database. DDL commands in Transact-SQL include those using the **create**, **drop**, and **alter** keywords.
- **data manipulation language (DML) –** The set of commands in a query language, such as Transact-SQL, that operates on data. DML commands in Transact-SQL include **select**, **insert**, **update**, and **delete**.
- **data server –** A server whose client interface conforms to the SAP Client/Server Interfaces and provides the functionality necessary to maintain the physical representation of a replicated table in a database. Data servers are usually database servers, but they can also be any data repository with the interface and functionality SAP Replication Server requires.
- **Data Server Interface (DSI) –** SAP Replication Server threads corresponding to a connection between an SAP Replication Server and a database. DSI threads submit transactions from the DSI outbound queue to a replicate data server. They consist of a scheduler thread and one or more executor threads. The scheduler thread groups the transactions by commit order and dispatches them to the executor threads. The executor threads map functions to function strings and execute the transactions in the replicate database. DSI threads use an Open Client connection to a database. See also *outbound queue* and *connection*.
- **data source –** A specific combination of a database management system (DBMS) product such as a relational or non-relational data server, a database residing in that DBMS, and the communications method used to access that DBMS from other parts of a replication system. See also *database* and *data server*.
- **decision support application –** A database client application characterized by ad hoc queries, reports, and calculations and few data update transactions.
- **declared datatype –** The datatype of the value delivered to the SAP Replication Server from the Replication Agent:

  - If the Replication Agent delivers a base SAP Replication Server datatype, such as `datetime`, to the SAP Replication Server, the declared datatype is the base datatype.
  - Otherwise, the declared datatype must be the UDD for the original datatype at the primary database.
- **default function string –** The function string that is provided by default for the system provided classes `rs_sqlserver_function_class` and

`rs_default_function_class` and classes that inherit function strings from these classes, either directly or indirectly. See also *function string*.

- **dematerialization –** The optional process, when a subscription is dropped, whereby specific rows that are not used by other subscriptions are removed from the replicate database.
- **derived class –** A function-string class that inherits function strings from a parent class. See also *function-string class* and *parent class*.
- **direct route –** A route used to send messages directly from a source to a destination SAP Replication Server, with no intermediate SAP Replication Servers. See also *indirect route* and *route*.
- **disk partition –** See *partition*.
- **distributed database system –** A database system where data is stored in multiple databases on a network.
- **Distributor –** An SAP Replication Server thread (DIST) that helps to determine the destination of each transaction in the inbound queue.
- **dump marker –** A message written by SAP ASE in a database transaction log when a dump is performed. In a warm standby application, when you are initializing the standby database with data from the active database, you can specify that SAP Replication Server use the dump marker to determine where in the transaction stream to begin applying transactions in the standby database. See also *warm standby application*.
- **Embedded Replication Server System Database (ERSSD) –** The SAP SQL Anywhere database that stores SAP Replication Server system tables. You can choose whether to store SAP Replication Server system tables on the ERSSD or the SAP ASE RSSD. See also *Replication Server System Database (RSSD)*.
- **Enterprise Connect Data Access (ECDA) –** An integrated set of software applications and connectivity tools that allow access to data within a heterogeneous database environment, such as a variety of LAN-based, non-ASE data sources, and mainframe data sources.
- **error action –** An SAP Replication Server response to a data server error. Possible SAP Replication Server error actions are **ignore**, **warn**, **retry_log**, **log**, **retry_stop**, and **stop_replication**. Error actions are assigned to specific data server errors.
- **error class –** A name for a collection of data server error actions that are used with a specified database.
- **exceptions log –** A set of three SAP Replication Server system tables that holds information about transactions that failed on a data server. The transactions in the log must be resolved by a user or by an intelligent application. You can use the **rs_helpexception** stored procedure to query the exceptions log.
- **ExpressConnect for HANA DB –** A set of libraries that can be used to provide direct communication between SAP Replication Server and an SAP HANA database.
- **ExpressConnect for Oracle –** A set of libraries that can be used to provide direct communication between SAP Replication Server and an Oracle database.

- **Failover –** SAP Failover allows you to configure two version 12.0 and later SAP ASEs as companions. If the primary companion fails, that server's devices, databases, and connections can be taken over by the secondary companion.

  For more detailed information about how SAP Failover works in SAP ASE, refer to *Using SAP Failover in a High Availability System*, which is part of the SAP ASE documentation set.
- **fault tolerance –** The ability of a system to continue to operate correctly even though one or more of its component parts is malfunctioning.
- **function –** An SAP Replication Server object that represents a data server operation such as insert, delete, select, or begin transaction. SAP Replication Server distributes such operations to other SAP Replication Servers as functions. Each function consists of a function name and a set of data parameters. In order to execute the function in a destination database, SAP Replication Server uses function strings to convert a function to a command or set of commands for a type of database. See also *user-defined function*, and *replicated function delivery*.
- **function replication definition –** A description of a replicated function used in replicated function delivery. The function replication definition, maintained by SAP Replication Server, includes information about the parameters to be replicated and the location of the primary version of the affected data. See also *replicated function delivery*.
- **function scope –** The range of a function's effect. Functions have replication definition scope or function-string class scope. A function with replication definition scope is defined for a specific replication definition, and cannot be applied to other replication definitions. A function with function-string class scope is defined once for a function-string class and is available only within that class.
- **function string –** A string that SAP Replication Server uses to map a function and its parameters to a data server API. Function strings allow SAP Replication Server to support heterogeneous replication, in which the primary and replicate databases are different types, with different SQL extensions and different command features.
- **function-string class –** A named collection of function strings used with a specified database connection. Function-string classes include those provided with SAP Replication Server and those you have created. Function-string classes can share function string definitions through function-string inheritance. The three system-provided function-string classes are `rs_sqlserver_function_class`, `rs_default_function_class`, and `rs_db2_function_class`. See also *base class*, *class tree*, *derived class*, *function-string inheritance*, and *parent class*.
- **function-string inheritance –** The ability to share function string definitions between classes, whereby a derived class inherits function strings from a parent class. See also *derived class*, *function-string class*, and *parent class*.
- **function-string variable –** An identifier used in a function string to represent a value that is to be substituted at run time. Variables in function strings are enclosed in question marks (?). They represent column values, function parameters, system-defined variables, or user-defined variables.

- **function subscription –** A subscription to a function replication definition used in both applied and request function delivery.
- **gateway –** Connectivity software that allows two or more computer systems with different network architectures to communicate.
- **generation number –** See *database generation number*.
- **heterogeneous data servers –** Multi-vendor data servers used together in a distributed database system.
- **hibernation mode –** An SAP Replication Server state in which all data definition language (DDL) commands, except admin and sysadmin commands, are rejected; all routes and connections are suspended; most service threads, such as Data Server Interface (DSI) and SAP Replication Server Interface (RSI), are suspended; and RSI and Replication Agent users are logged off and not allowed to log on. This is used during route upgrades, and may be turned on for an SAP Replication Server to debug problems.
- **high-performance analytic appliance (HANA) –** An SAP® in-memory online transaction processing and online analytical processings solution.
- **high-performance analytic appliance database (SAP HANA Database) –** The SAP in-memory database.
- **high availability (HA) –** Very low downtime. Computer systems that provide HA usually provide 99.999% availability, or roughly five minutes unscheduled downtime per year.
- **high volume adaptive replication (HVAR) –** Compilation of a group of **insert**, **delete**, and **update** operations to produce a net result and the subsequent bulk application of the net result to the replicate database.
- **hot standby application –** A database application in which the standby database can be placed into service without interrupting client applications and without losing any transactions. See also *warm standby application*.
- **ID Server –** One SAP Replication Server in a replication system is the ID Server. In addition to performing the usual SAP Replication Server tasks, the ID Server assigns unique ID numbers to every SAP Replication Server and database in the replication system, and maintains version information for the replication system.
- **inbound queue –** A stable queue used to spool messages from a Replication Agent to an SAP Replication Server.
- **indirect route –** A route used to send messages from a source to a destination SAP Replication Server, through one or more intermediate SAP Replication Servers. See also *direct route* and *route*.
- **interfaces file –** A file containing entries that define network access information for server programs in an SAP client/server architecture. Server programs may include SAP ASE, gateways, SAP Replication Servers, and Replication Agents. The interfaces file entries enable clients and servers to connect to each other in a network.
- **latency –** The measure of the time it takes to distribute to a replicate database a data modification operation first applied in a primary database. The time includes Replication Agent processing, SAP Replication Server processing, and network overhead.

- **local-area network (LAN) –** A system of computers and devices, such as printers and terminals, connected by cabling for the purpose of sharing data and devices.
- **locator value –** The value stored in the `rs_locater` table of the SAP Replication Server RSSD that identifies the latest log transaction record received and acknowledged by the SAP Replication Server from each previous site during replication.
- **logical connection –** A database connection that SAP Replication Server maps to the connections for the active and standby databases in a warm standby application. See also *connection* and *warm standby application*.
- **login name –** The name that a user or a system component such as SAP Replication Server uses to log in to a data server, SAP Replication Server, or Replication Agent.
- **Log Transfer Language (LTL) –** A subset of the Replication Command Language (RCL). A Replication Agent such as RepAgent uses LTL commands to submit to SAP Replication Server the information it retrieves from primary database transaction logs.
- **Log Transfer Manager (LTM) –** The Replication Agent program for SAP SQL Server. See also *Replication Agent* and *RepAgent thread*.
- **maintenance user –** A data server login name that SAP Replication Server uses to maintain replicate data. In most applications, maintenance user transactions are not replicated.
- **materialization –** The process of copying data specified by a subscription from a primary database to a replicate database, thereby initializing the replicate table. Replicate data can be transferred over a network, or, for subscriptions involving large amounts of data, loaded initially from media. See also *atomic materialization*, *bulk materialization*, *no materialization*, and *nonatomic materialization*.
- **materialization queue –** A stable queue used to spool messages related to a subscription being materialized or dematerialized.
- **missing row –** A row missing from a replicated copy of a table but present in the primary table.
- **mixed-version system –** A replication system containing SAP Replication Servers of different software versions that have different capabilities based on their different software versions and site versions. Mixed-version support is available only if the system version is 11.0.2 or greater.

  For example, a replication system containing SAP Replication Servers version 11.5 or later and version 11.0.2 is a mixed-version system. A replication system containing SAP Replication Servers of releases earlier than release 11.0.2 is not a mixed-version system, because any newer SAP Replication Servers are restricted by the system version from using certain new features. See also *site version* and *system version*.
- **more columns –** Columns in a replication definition exceeding 250, but limited to 1024. More columns are supported by SAP Replication Server version 12.5 and later.
- **multi-site availability (MSA) –** Methodology for replicating database objects—tables, functions, transactions, system stored procedures, and data definition language (DDL) statements from the primary to the replicate database. See also *database replication definition*.

- **Multi-Path Replication™ –** SAP Replication Server feature that improves performance by enabling parallel paths of data from the source database to the target database. You can configure multi-path replication in warm standby and multisite availability (MSA) environments. These multiple paths process data independently of each other and are applicable when sets of data can be processed in parallel without transactions consistency requirements between them while still maintaining data consistency within a path, but not adhering to the commit order across different paths.
- **name space –** The scope within which an object name must be unique.
- **nonatomic materialization –** A materialization method that copies subscription data from a primary to a replicate database through the network in a single operation, without a holdlock. Changes to the primary table are allowed during data transfer, which may cause temporary inconsistencies between replicate and primary databases. Data is applied in increments of ten rows per transaction, which ensures that the replicate database transaction log does not fill. Nonatomic materialization is an optional method for the **create subscription** command. See also *autocorrection*, *atomic materialization*, *no materialization*, and *bulk materialization*.
- **network-based security –** Secure transmission of data across a network. SAP Replication Server supports third-party security mechanisms that provide user authentication, unified login, and secure message transmission between SAP Replication Servers.
- **no materialization –** A materialization method that lets you create a subscription when the subscription data already exists at the replicate site. Use the **create subscription** command with the **without materialization** clause. You can use this method to create subscriptions to table replication definitions. See also *atomic materialization* and *bulk materialization*.
- **online transaction processing (OLTP) application –** A database client application characterized by frequent transactions involving data modification (inserts, deletes, and updates).
- **Origin Queue ID (qid) –** Formed by the Replication Agent, the qid uniquely identifies each log record passed to the SAP Replication Server. It includes the date and timestamp and the database generation number. See also *database generation number*.
- **orphaned row –** A table row that is present in the replicate, but not in the primary database.
- **outbound queue –** A stable queue used to spool messages. The DSI outbound queue spools messages to a replicate database. The RSI outbound queue spools messages to a replicate SAP Replication Server.
- **parallel DSI –** Configuring a database connection so that transactions are applied to a replicate data server using multiple Data Server Interface (DSI) threads operating in parallel, rather than a single DSI thread. See also *connection* and *Data Server Interface (DSI)*.
- **parameter –** An identifier representing a value that is provided when a procedure executes. Parameter names are prefixed with an @ character in function strings. When a procedure is called from a function string, SAP Replication Server passes the parameter values, unaltered, to the data server. See also *searchable parameter*.

- **parent class –** A function-string class from which a derived class inherits function strings. See also *function-string class* and *derived class*.
- **partition –** A raw disk partition or operating system file that SAP Replication Server uses for stable queue storage. Only use operating system files in a test environment.
- **physical connection –** A connection from an SAP Replication Server to a database.
- **primary data –** The definitive version of a set of data in a replication system. The primary data is maintained on a data server that is known to all of the SAP Replication Servers with subscriptions for the data.
- **primary database –** Any database that contains data that is replicated to another database via the replication system.
- **primary fragment –** A horizontal segment of a table that holds the primary version of a set of rows.
- **primary key –** A set of table columns that uniquely identifies each row.
- **primary site –** The location or facility at which primary data servers and primary databases are deployed to support normal business operations. Sometimes called the active site or main site. See *error class* and *function-string class*.
- **principal user –** The user who starts an application. When using network-based security, SAP Replication Server logs in to remote servers as the principal user.
- **profile –** Allows user to configure a connection with a pre-defined set of properties relative to the server SAP Replication Server is connecting to.
- **projection –** A vertical slice of a table, representing a subset of the table's columns.
- **publication –** A group of articles from the same primary database. A publication lets you collect replication definitions for related tables and/or stored procedures and then subscribe to them as a group. You collect replication definitions as articles in a publication at the source SAP Replication Server and subscribe to them with a publication subscription at the destination SAP Replication Server. See also *article* and *publication subscription*.
- **publication subscription –** A subscription to a publication. See also *article* and *publication*.
- **published datatype –** The datatype of the column after the column-level translation (and before a class-level translation, if any) at the replicate data server. The published datatype must be either an SAP Replication Server base datatype or a UDD for the datatype in the target data server. If the published datatype is omitted from the replication definition, it defaults to the declared datatype.
- **query –** In a database management system, a query is a request to retrieve data that meets a given set of criteria. The SQL database language includes the **select** command for queries.
- **quiescent –** A state in which log scanning has stopped and all scanned records have been propagated to their destinations in a replication system. Some Replication Agent and SAP Replication Server commands require that you first quiesce the replication system.
- **quoted identifiers –** Object names that contain special characters such as spaces and nonalphanumeric characters, start with a character other than alphabet, or correspond to a

reserved word and need to be enclosed in quote (single or double) characters to be parsed correctly.

- **real time loading (RTL) –** High volume adaptive replication (HVAR) to an SAP® IQ database. Uses relevant commands and processes to apply HVAR changes to an SAP IQ replicate database. See *high volume adaptive replication*.
- **remote procedure call (RPC) –** A request to execute a procedure that resides in a remote server. The server that executes the procedure could be an SAP ASE, an SAP Replication Server, or a server created using SAP Open Server. The request can originate from any of these servers or from a client application. The RPC request format is a part of the SAP Client/Server Interfaces.
- **RepAgent thread –** The Replication Agent for SAP ASE databases. Replication Agent is an SAP ASE thread; it transfers transaction log information from the primary database to an SAP Replication Server for distribution to other databases.
- **replicate database –** A database that contains data replicated from another database (the primary database) through a replication system. The replicate database is the database that receives replicated data in a replication system. Contrast with primary database.
- **replicated function delivery –** A method of replicating, from a source to a destination database, a stored procedure that is associated with a function replication definition. See also *applied function*, *request function*, and *function replication definition*.
- **replicated stored procedure –** An SAP ASE stored procedure that is marked as replicated using the **sp_setrepproc** system procedure. Replicated stored procedures can be associated with function replication definitions or table replication definitions. See also *replicated function delivery* and *asynchronous procedure delivery*.
- **replicated table –** A table that is maintained by SAP Replication Server, in part or in whole, in databases at multiple locations. There is one primary version of the table, which is marked as replicated using the **sp_setreptable** system procedure; all other versions are replicated copies.
- **Replication Agent –** A program or module that transfers transaction log information representing modifications made to primary data from a database server to an SAP Replication Server for distribution to other databases. RepAgent is the Replication Agent for SAP ASE databases.
- **Replication Command Language (RCL) –** The commands used to manage information in SAP Replication Server.
- **replication definition –** Usually, a description of a table for which subscriptions can be created. The replication definition, maintained by SAP Replication Server, includes information about the columns to be replicated and the location of the primary version of the table.

  You can also create function replication definitions; sometimes the term “table replication definition” is used to distinguish between table and function replication definitions. See also *function replication definition*.

- **Replication Management Agent (RMA) –** A distributed management agent that you can use to easily set up and manage replication from any supported databases to an SAP HANA database.
- **Replication Server Interface (RSI) –** A thread that logs in to a destination SAP Replication Server and transfers commands from the source SAP Replication Server RSI outbound stable queue to the destination SAP Replication Server. There is one RSI thread for each destination SAP Replication Server that is a recipient of commands from a primary or intermediate SAP Replication Server. See also *outbound queue* and *route*.
- **replication system administrator –** The system administrator that manages routine operations in the Replication Server.
- **Replication Server System Database (RSSD) –** The SAP ASE database containing an SAP Replication Server system tables. The user can choose whether to store SAP Replication Server system tables on SAP ASE or embedded in an SAP SQL Anywhere database hosted by SAP Replication Server. See also *Embedded Replication Server System Database (ERSSD)*.
- **Replication Server system Adaptive Server –** The SAP ASE with the database containing an SAP Replication Server system tables.
- **replication system –** A data processing system where data is replicated in multiple databases to provide remote users with the benefits of local data access. Specifically, a replication system that is based upon SAP Replication Server and includes other components such as Replication Agents and data servers.
- **replication system domain –** All replication system components that use the same ID Server.
- **request function –** A replicated function, associated with a function replication definition, that SAP Replication Server delivers from a primary database to a replicate database. The function passes parameter values to a stored procedure that is executed at the replicate database. The stored procedure is executed at the replicate site by the same user as it is at the primary site. See also *replicated function delivery*, *request function*, and *function replication definition*.
- **resync marker –** When you restart Replication Agent in resync mode, Replication Agent sends the resync database marker to SAP Replication Server to indicate that a resynchronization effort is in progress. The resync marker is the first message Replication Agent sends before sending any SQL data definition language (DDL) or data manipulation language (DML) transactions.
- **route –** A one-way message stream from a source Replication Server to a destination Replication Server. Routes carry data modification commands (including those for RSSDs) and replicated functions or stored procedures between Replication Servers. See also *direct route* and *indirect route*.
- **route version –** The lower of the site version numbers of the route’s source and destination SAP Replication Servers. The supported SAP Replication Server versions use the route version number to determine which data to send to the replicate site. See also *site version*.

- **row migration –** The process whereby column value changes in rows in a primary version of a table cause corresponding rows in a replicate version of the table to be inserted or deleted, based on comparison with values in a subscription's **where** clause.
- **SAP Adaptive Server Enterprise (SAP ASE) –** The SAP version 11.5 and later relational database server. If you choose the RSSD option when configuring SAP Replication Server, SAP ASE maintains SAP Replication Server system tables in the RSSD database.
- **SAP Replication Server –** The SAP server program that maintains replicated data, typically on a LAN, and processes data transactions received from other SAP Replication Servers on the same LAN or on a WAN.
- **schema –** The structure of the database. DDL commands and system procedures change system tables stored in the database. Supported DDL commands and system procedures can be replicated to standby databases when you use SAP Replication Server version 11.5 or later and SAP ASE version 11.5 or later.
- **searchable column –** A column in a replicated table that can be specified in the **where** clause of a subscription or article to restrict the rows replicated at a site.
- **searchable parameter –** A parameter in a replicated stored procedure that can be specified in the **where** clause of a subscription to help determine whether or not the stored procedure should be replicated. See also *parameter*.
- **secondary truncation point –** An SAP ASE database that holds primary data has an active truncation point, marking the transaction log location where SAP ASE has completed processing. This is the primary truncation point.
- **site –** An installation consisting of, at minimum, an SAP Replication Server, data server, and database, and possibly a Replication Agent, usually at a discrete geographic location. The components at each site are connected over a WAN to those at other sites in a replication system. See also *primary site*.
- **site version –** The version number for an individual SAP Replication Server. Once the site version has been set to a particular level, the SAP Replication Server enables features specific to that level, and downgrades are not allowed. See also *software version*, *route version*, and *system version*.
- **software version –** The version number of the software release for an individual SAP Replication Server. See also *site version* and *system version*.
- **SQL Server –** The SAP relational database pre-11.5 server.
- **SQL statement replication –** The process in which the SAP Replication Server receives the SQL statement that modified the primary data, rather than the individual row changes from the transaction log. SAP Replication Server applies the SQL statement to the replicated site. RepAgent sends both the SQL Data Manipulation Language (DML) and individual row changes. Depending on your configuration, SAP Replication Server chooses either individual row change log replication or SQL statement replication.
- **Stable Queue Manager (SQM) –** A thread that manages the stable queues. There is one Stable Queue Manager (SQM) thread for each stable queue accessed by the SAP Replication Server, whether inbound or outbound.
- **Stable Queue Transaction (SQT) interface –** A thread that reassembles transaction commands in commit order. A Stable Queue Transaction (SQT) interface thread reads

from inbound stable queues, puts transactions in commit order, then sends them to the Distributor (DIST) thread or a DSI thread, depending on which thread required the SQT ordering of the transaction.

- **stable queues –** Store-and-forward queues where SAP Replication Server stores messages destined for a route or database connection. Messages written into a stable queue remain there until they can be delivered to the destination SAP Replication Server or database. SAP Replication Server builds stable queues using its disk partitions. See also *inbound queue*, *outbound queue*, and *materialization queue*.
- **standalone mode –** An SAP Replication Server mode used for initiating recovery operations.
- **standby database –** In a warm standby application, a database that receives data modifications from the active database and serves as a backup of that database. See also *warm standby application*.
- **stored procedure –** A collection of SQL statements and optional control-of-flow statements stored under a name in an SAP ASE database. Stored procedures supplied with SAP ASE are called system procedures. Some stored procedures for querying the RSSD are included with the SAP Replication Server software.
- **subscription –** A request for SAP Replication Server to maintain a replicated copy of a table, or a set of rows from a table, in a replicate database at a specified location. You can also subscribe to a function replication definition, for replicating stored procedures.
- **subscription dematerialization –** The optional process, when a subscription is dropped, whereby specific rows that are not used by other subscriptions are removed from the replicate database.
- **subscription materialization –** The process of copying data specified by a subscription from a primary database to a replicate database, thereby initializing the replicate table. Replicate data can be transferred over a network, or, for subscriptions involving large amounts of data, loaded initially from media.
- **subscription migration –** The process whereby column value changes in rows in a primary version of a table cause corresponding rows in a replicate version of the table to be inserted or deleted, based on comparison with values in a subscription's where clause.
- **SAP Control Center for Replication –** A Web-based solution for monitoring the status and availability of servers in a replication environment.
- **symmetric multiprocessing (SMP) –** On a multiprocessor platform, the ability of an application's threads to run in parallel. SAP Replication Server supports SMP, which can improve server performance and efficiency.
- **synchronous command –** A command that a client submits where the client is prevented from proceeding with other operations before the completion status is received.
- **system function –** A function that is predefined and part of the SAP Replication Server product. Different system functions coordinate replication activities, such as **rs_begin**, or perform data manipulation operations, such as **rs_insert**, **rs_delete**, and **rs_update**.
- **system-provided classes –** SAP Replication Server provides the error class `rs_sqlserver_error_class` and the function-string classes `rs_sqlserver_function_class`, `rs_default_function_class`, and

`rs_db2_function_class`. Function strings are generated automatically for the system-provided function-string classes and for any derived classes that inherit from these classes, directly or indirectly. See also *error class* and *function-string class*.

- **system version –** The version number for a replication system that represents the version for which new features are enabled, for SAP Replication Servers of release 11.0.2 or earlier, and below which no SAP Replication Server can be downgraded or installed. For an SAP Replication Server version 11.5, your use of certain new features requires a site version of 1150 and a system version of at least 1102. See also *mixed-version system*, *site version*, and *software version*.
- **table replication definition –** Identifies a primary table and marks in order for SAP Replication Server to replicate its contents when inserted, updated or deleted. It 'publishes' the data in the publish-subscribe methodology used by SAP Replication Server.
- **table subscription –** A subscription to a table replication definition.
- **thread –** A process running within SAP Replication Server. Built upon SAP Open Server, SAP Replication Server has a multi-threaded architecture. Each thread performs a certain function such as managing a user session, receiving messages from a Replication Agent or another SAP Replication Server, or applying messages to a database. See also *Data Server Interface (DSI)*, *Distributor*, and *Replication Server Interface (RSI)*.
- **transaction –** A mechanism for grouping statements so that they are treated as a unit: either all statements in the group are executed or no statements in the group are executed.
- **Transact-SQL –** The relational database language used with SAP ASE. It is based on standard Structured Query Language (SQL), with Sybase extensions.
- **truncation point –** An SAP ASE database that holds primary data has an active truncation point, marking the transaction log location where SAP ASE has completed processing. This is the primary truncation point.
- **user-defined function –** A function that allows you to create custom applications that use SAP Replication Server to distribute replicated functions or asynchronous stored procedures between sites in a replication system. In replicated function delivery, a user-defined function is automatically created by SAP Replication Server when you create a function replication definition.
- **variable –** See *function-string variable*.
- **version –** *mixed-version system*

  See *mixed-version system*, *site version*, *software version*, and *system version*.
- **warm standby application –** An application that employs SAP Replication Server to maintain a standby database for a database known as the active database. If the active database fails, SAP Replication Server and client applications can switch to the standby database.
- **wide-area network (WAN) –** A system of local-area networks (LANs) connected together with data communication lines.
- **wide columns –** Columns in a replication definition containing `char`, `varchar`, `binary`, `varbinary`, `unichar`, `univarchar`, or Java `inrow` data that are wider that 255 bytes.

- **wide data –** Wide data rows, limited to the size of the data page on the data server. SAP ASE supports page sizes of 2K, 4K, 8K, and 16K.
- **wide messages –** Messages larger that 16K that span blocks.

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