SYBASE®

Primary Database Guide

Mirror Replication Agent™

15.2

Linux, Microsoft Windows, and UNIX

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Contents

About This Book

Mirror Replication Agent™ version 15.2 extends the capabilities of Replication Server® by supporting Sybase® and non-Sybase primary data servers in a Sybase disaster recovery system.

Mirror Replication Agent is the software solution for replicating transactions from a primary database in one of the following data servers:

- Adaptive Server ® Enterprise (ASE)
- Oracle

Audience

This book is for anyone who needs to administer a Sybase replication system with Sybase and non-Sybase primary data servers.

If you are new to Sybase replication technology, see the following documents:

- The *Replication Server Design Guide* for an introduction to basic data replication concepts and Sybase replication systems
- The *Replication Server Heterogeneous Replication Guide* for an introduction to heterogeneous replication concepts and the issues peculiar to Sybase replication systems with non-Sybase data servers.

How to use this book

Refer to this book when you need detailed information about Mirror Replication Agent support for Sybase and non-Sybase data servers.

This book is organized as follows:

Chapter 1, "Mirror Replication Agent for Oracle," describes replication system issues that are specific to Oracle, and details of Mirror Replication Agent for Oracle.

Chapter 2, "Mirror Replication Agent for ASE," describes replication system issues that are specific to ASE and details of Mirror Replication Agent for ASE.

Appendix A, "Upgrading Mirror Replication Agent," describes Mirror Replication Agent upgrades.

Related documents

A Sybase replication system consists of several components. You may find it helpful to have the following documentation available.

Mirror Replication Agent

- The *Mirror Activator Release Bulletin* and *Mirror Replication Agent Release Bulletin* contain last-minute information that was too late to be included in the books.

  A more recent version of the release bulletins may be available on the World Wide Web. To check for critical product or document information that was added after the release of the product CD, use the Sybase Product Manuals Web site.

- The *Mirror Replication Agent Installation Guide* describes how to install the Mirror Replication Agent software. It includes an installation and setup worksheet that you can use to collect the information you need to complete the software installation and Mirror Replication Agent setup.
- The *Mirror Activator Administration Guide* introduces replication concepts and Sybase replication technology. This document also describes Mirror Replication Agent features and operations, and how to set up, administer, and troubleshoot the Mirror Replication Agent software.
- The *Mirror Replication Agent Reference Manual* describes all Mirror Replication Agent commands and configuration parameters in detail, including syntax, examples, and usage notes.

Java environment

Mirror Activator 15.2 installs and uses a Java Runtime Environment (JRE) on the machine that acts as the Mirror Replication Agent host.

- The *Mirror Activator Release Bulletin* and *Mirror Replication Agent Release Bulletin* contain the most up-to-date information about Java and JRE requirements.
- Java documentation available from your operating system vendor describes how to set up and manage your Java environment.

Replication Server

- *Administration Guide* – includes information and guidelines for creating and managing a replication system, setting up security, recovering from system failures, and improving performance.
- *Configuration Guide* for your platform – describes configuration procedures for Replication Server and related products, and explains how to use the rs_init configuration utility.
- *Design Guide* – contains information about designing a replication system and integrating non-Sybase data servers into a replication system.
- *Getting Started with Replication Server* – provides step-by-step instructions for installing and setting up a simple replication system.

- *Heterogeneous Replication Guide* – describes how to implement a Sybase replication system with heterogeneous or non-Sybase data servers.
- *Reference Manual* – contains the syntax and detailed descriptions of Replication Server commands in the replication Command Language (RCL); Replication Server system functions; Replication Server executable programs; and Replication Server system tables.
- *Troubleshooting Guide* – contains information to aid in diagnosing and correcting problems in the replication system.

Primary data servers

Sybase recommends that you or someone at your site be familiar with the software and database administration tasks for the data servers supported by Mirror Replication Agent:

- ASE
- Oracle

ASE

If your replication system includes databases in Sybase ASE® Enterprise, make sure you have documentation that is appropriate for the version of ASE that you use.

You can find more information about ASE on the Sybase Web site at http://www.sybase.com/support/manuals/.

Other sources of information

Use the Sybase Getting Started CD, the SyBooks™ CD, and the Sybase Product Manuals Web site to learn more about your product:

- The Getting Started CD contains release bulletins and installation guides in PDF format, and may also contain other documents or updated information not included on the SyBooks CD. It is included with your software. To read or print documents on the Getting Started CD, you need Adobe Acrobat Reader, which you can download at no charge from the Adobe Web site using a link provided on the CD.
- The SyBooks CD contains product manuals and is included with your software. The Eclipse-based SyBooks browser allows you to access the manuals in an easy-to-use, HTML-based format.

  Some documentation may be provided in PDF format, which you can access through the PDF directory on the SyBooks CD. To read or print the PDF files, you need Adobe Acrobat Reader.

  Refer to the *SyBooks Installation Guide* on the Getting Started CD, or the *README.txt* file on the SyBooks CD for instructions on installing and starting SyBooks.

- The Sybase Product Manuals Web site is an online version of the SyBooks CD that you can access using a standard Web browser. In addition to product manuals, you will find links to EBFs/Maintenance, Technical Documents, Case Management, Solved Cases, newsgroups, and the Sybase Developer Network.

  To access the Sybase Product Manuals Web site, go to Product Manuals at http://www.sybase.com/support/manuals/.

Sybase certifications on the Web

Technical documentation at the Sybase Web site is updated frequently.

❖ **To find the latest information on product certifications**

1. Point your Web browser to Technical Documents at http://www.sybase.com/support/techdocs/.
2. Click Certification Report.
3. In the Certification Report filter, select a product, platform, and time frame, and then click Go.
4. Click a Certification Report title to display the report.

❖ **To find the latest information on component certifications**

1. Point your Web browser to Availability and Certification Reports at http://certification.sybase.com/.
2. Either select the product family and product under Search by Base Product, or select the platform and product under Search by Platform.
3. Select Search to display the availability and certification report for the selection.

❖ **To create a personalized view of the Sybase Web site (including support pages)**

Set up a MySybase profile. MySybase is a free service that allows you to create a personalized view of Sybase Web pages.

1. Point your Web browser to Technical Documents at http://www.sybase.com/support/techdocs/.
2. Click MySybase and create a MySybase profile.

Sybase EBFs and software maintenance

❖ **To find the latest information on EBFs and software maintenance**

1. Point your Web browser to the Sybase Support Page at http://www.sybase.com/support.
2. Select EBFs/Maintenance. If prompted, enter your MySybase user name and password.
3. Select a product.
4. Specify a time frame and click Go. A list of EBF/Maintenance releases is displayed.

   Padlock icons indicate that you do not have download authorization for certain EBF/Maintenance releases because you are not registered as a Technical Support Contact. If you have not registered, but have valid information provided by your Sybase representative or through your support contract, click Edit Roles to add the "Technical Support Contact" role to your MySybase profile.
5. Click the Info icon to display the EBF/Maintenance report, or click the product description to download the software.

Conventions

The following sections describe the style, syntax, and character case conventions used in this book.

Style conventions The following style conventions are used in this book:

- In a sample screen display, commands that you should enter exactly as shown appear like this:

  ```
  pdb_setreptable authors, mark
  ```
- In the regular text of this document, variables or user-supplied words appear like this:

  Specify the value of *table_name* to mark the table.
- In a sample screen display, variables or words that you should replace with the appropriate value for your site appear like this:

  ```
  pdb_setreptable table_name, mark
  ```

  Here, *table_name* is the variable you should replace.
- In the regular text of this document:

- Names of programs, utilities, procedures, and commands appear like this:

  Use the pdb_setreptable command to mark a table for replication.

- Names of database objects (such as tables, columns, stored procedures) appear like this:

  Check the price column in the widgets table.

- Names of datatypes appear like this:

  Use the date or datetime datatype.

- Names of files and directories appear like this:

  Log files are located in the *$SYBASE/MA-15_2/inst_name/log* subdirectory.

Syntax conventions The following syntax conventions are used in this book:

Table 1: 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.
( )	Type parentheses 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.

Statements that show the syntax of commands appear like this:

ra_config *param*[, *value*]

The words *param* and *value* in the syntax are variables or user-supplied words.

Character case The following character case conventions are used in this book:

- All command syntax and command examples are shown in lowercase. However, Mirror Replication Agent command names are not case-sensitive. For example, PDB_XLOG, Pdb_Xlog, and pdb_xlog 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 is interpreted as an invalid parameter name.
- Database object names are not case-sensitive in Mirror Replication Agent commands. However, to use a mixed-case object name in a command (to match a mixed-case object name in the database), delimit the object name with quote characters. For example:

```
pdb_setreptable "TableName", mark
```

Accessibility features

This document is available in an HTML version that is specialized for accessibility. You can navigate the HTML with an adaptive technology such as a screen reader, or view it with a screen enlarger.

Mirror Replication Agent 15.2 and the HTML documentation have been tested for compliance with U.S. government Section 508 Accessibility requirements. Documents that comply with Section 508 generally also meet non-U.S. accessibility guidelines, such as the World Wide Web Consortium (W3C) guidelines for Web sites.

Note You might need to configure your accessibility tool for optimal use. Some screen readers pronounce text based on its case; for example, they pronounce ALL UPPERCASE TEXT as initials, and MixedCase Text as words. You might find it helpful to configure your tool to announce syntax conventions. Consult the documentation for your tool.

For information about how Sybase supports accessibility, see Sybase Accessibility at http://www.sybase.com/accessibility. The Sybase Accessibility site includes links to information on Section 508 and W3C standards.

For a Section 508 compliance statement for Mirror Replication Agent 15.2, see Sybase Accessibility at http://www.sybase.com/detail?id=1028493.

If you need help

Each Sybase installation that has purchased a support contract has one or more designated people who are authorized to contact Sybase Technical Support. If you cannot resolve a problem using the manuals or online help, please have the designated person contact Sybase Technical Support or the Sybase subsidiary in your area.

CHAPTER 1

Mirror Replication Agent for Oracle

The term “Mirror Replication Agent for Oracle” refers to an instance of Mirror Replication Agent 15.2 software that is installed and configured for a primary database that resides in an Oracle data server.

Note For information on the basic functionality of Mirror Replication Agent 15.2, see the *Mirror Activator Administration Guide* and the *Mirror Replication Agent Reference Manual*.

Oracle-specific considerations

- Unsupported software features
- Mirror Replication Agent connectivity
- Mirror Replication Agent permissions
- Redo and archive log setup
- Supplemental logging
- Recycle bin setup
- Setting ddl_username and ddl_password
- Character case of database object names
- Format of origin queue ID
- Replication Server and RSSD scripts
- Datatype compatibility

- Oracle datatype restrictions
- Oracle large object (LOB) support
- Oracle user-defined types
- Marking and unmarking sequences
- Enabling and disabling replication for sequences
- Real Application Clusters (RAC)
- Automatic Storage Management
- Replication Server set autocorrection command
- Partitioned tables
- Materialized views
- Unsupported table types

Unsupported software features

The following features are not supported for Sybase replication:

- Oracle index-organized tables
- Oracle materialized views
- Oracle packaged stored procedures and functions (standalone procedures and functions are supported)
- Oracle procedures and functions having a BOOLEAN parameter
- Oracle 10g Flashback and Flashback Recovery Area
- Oracle RMAN utility
- Replication Server parallel DSI (for non-ASE databases)
- Replication Server warm standby (for non-ASE databases)
- Replication Server rs_init utility (for non-ASE databases)
- Replication Server rs_subcomp utility (for non-ASE databases)
- Replication Server automatic materialization (for non-ASE databases)
- Replication Server when replicating in an environment where other vendors are replicating (for non-ASE databases)

Oracle 11g support

While most Oracle 11g features are supported as of Mirror Replication Agent 15.1 ESD #1, the following features are not supported:

- SecureFiles – this feature is a redesign of the implementation of large object (LOB) storage in Oracle 11g. You can mark tables containing these types of columns for replication, but the columns are not replicated.
- Virtual columns – Mirror Replication Agent supports the replication of tables containing computed (or virtual) columns in Oracle 11g. However, the replication of individual computed columns is not supported. You can mark virtual columns for replication using the force option, but these columns are not replicated.
- Encrypted tablespaces – you cannot mark encrypted tables and columns in encrypted tables for replication.
- Encrypted columns – you can mark tables containing encrypted columns for replication using the force option, but these columns are not replicated.

Mirror Replication Agent connectivity

Connectivity between Mirror Replication Agent for Oracle and the Oracle data server is through the Oracle JDBC thin driver.

The Oracle JDBC driver must be installed on the Mirror Replication Agent host machine, and the directory this driver is installed in must be in the CLASSPATH environment variable.

The TNS Listener Service must be installed and running on the primary database so the Mirror Replication Agent instance can connect to it. See the *Oracle Database Net Services Administrator's Guide*.

Mirror Replication Agent permissions

Mirror Replication Agent for Oracle uses the pds_username to connect to Oracle and must have the following Oracle permissions:

- create session – required to connect to Oracle.
- select_catalog_role – required to select from the DBA_* views.
- alter system – required to perform redo log archive operations.

- alter on *TABLE_NAME* – required to replicate user-defined datatypes if table-level supplemental logging has not been enabled for the specified *TABLE_NAME*.
- execute on DBMS_FLASHBACK – required to execute DBMS_FLASHBACK.get_system_change_number.
- alter any procedure – required to manage procedures for replication.
- create table – required to create tables in the primary database.
- create procedure – required to create rs_marker and rs_dump proc procedures.
- create public synonym – required to create synonyms for created tables in the primary database.
- create sequence – required to support replication.
- drop public synonym – required to drop created synonyms.
- select on SYS.ARGUMENT$ – required to process procedure DDL commands.
- SYS.ATTRIBUTE$ – required to process Oracle types.
- select on SYS.CCOL$ – required to support table replication (column constraint information).
- select on SYS.CDEF$ – required for table (constraint information) replication support.
- select on SYS.COL$ – required for table (column information) replication support.
- select on SYS.COLLECTION$ – required for VARRAY replication support.
- select on SYS.COLTYPE$ – required to support table replication.
- select on SYS.CON$ – required for table (constraint information) replication support
- select on SYS.IND$ – required to identify indexes.
- select on SYS.INDCOMPART$ – required to identify indexes.
- select on SYS.INDPART$ – required to identify indexes.
- select on SYS.INDSUBPART$ – required to identify indexes.
- select on SYS.LOB$ – required for LOB replication support.

- select on SYS.LOBCOMPPART$ – required to support partitioned LOB replication.
- select on SYS.LOBFRAG$ – required to support partitioned LOB replication.
- select on SYS.MLOG$ – required to filter materialized view log tables.
- select on SYS.NTAB$ – required to support table replication.
- select on SYS.OBJ$ – required for processing procedure DDL commands in the repository.
- select on SYS.PROCEDUREINFO$ – required for procedure replication support.
- select on SYS.SEQ$ – required to support sequence replication.
- select on SYS.SNAP$ – required to filter out materialized view tables.
- select on SYS.TAB$ – required to support table replication.
- select on SYS.TABCOMPART$ – required to support partitioned table replication.
- select on SYS.TABPART$ – required to support partitioned table replication.
- select on SYS.TABSUBPART$ – required to support partitioned table replication.
- select on SYS.TS$ – required to identify tablespace encryption in Oracle 11g.
- select on SYS.TYPE$ – required to process Oracle predefined and user-defined types.
- select on SYS.USER$ – required for Oracle user identification.

Note The permissions for SYS.CON$ and SYS.CDEF$ are required to handle the constraint information in the CREATE and ALTER TABLE DDL operations.

In addition, the user who starts Mirror Replication Agent for Oracle instance must have read access to mirror copies of the Oracle redo log files and the archive directory that contains the archive log files to be accessed for replication. If Mirror Replication Agent is configured to remove old archive files, the user must have update authority to the directory and the archive log files. If the redo logs or archived redo logs are stored within Automatic Storage Management (ASM), the user who starts Mirror Replication Agent for Oracle must have read access to the ASM disk devices that contain the redo log data.

Mirror Replication Agent for Oracle requires the alter system privilege to issue the alter system archive log command. If Mirror Replication Agent is configured to access only online Oracle redo logs, Mirror Replication Agent issues the alter system archive log sequence command when the online redo log is no longer needed for replication (as when all data from the log has been replicated). Regardless of online or archive log processing, Mirror Replication Agent uses the alter system privilege to issue the alter system archive log current command when Mirror Replication Agent is instructed to move processing to the end of the Oracle log. By issuing the alter system archive log current command, Mirror Replication Agent insures that the current redo log file does not contain old data. Mirror Replication Agent moves processing to the end of the Oracle redo log when requested by the move_truncpt options of the pdb_xlog init command. Mirror Replication Agent may also move processing to the end of the Oracle redo log during migration from one version of Mirror Replication Agent to another.

Redo and archive log setup

Note The Mirror Replication Agent for Oracle must be installed on a machine where it can directly access mirrored copies of the Oracle redo log and archive log files.

By default, you can access both online and archive logs. You can configure Mirror Replication Agent to access only the online logs, but doing so requires you to turn auto-archiving off and requires Mirror Replication Agent to issue manual archive log commands to Oracle.

Accessing archive logs

When you are using the default, for archive log files to be accessed, configure Mirror Replication Agent to use a directory path where archive log files are located. By default, an Oracle instance creates multiple directories under the flash recovery area specified by the DB_RECOVERY_FILE_DEST parameter of the Oracle ALTER SYSTEM command, each directory corresponding to and named after a separate day. However, Mirror Replication Agent requires mirrored archived redo log files to reside in a single directory. Consequently, you must configure Oracle to archive to a single directory to be read by Mirror Replication Agent.

Note To prevent conflicts with other archive file processes, you may want to configure Oracle to duplex the archive log files into an additional destination directory that is used only for replication.

For information on specifying archive log destinations for your Oracle environment, see the Oracle ALTER SYSTEM command and LOG_ARCHIVE_DEST_n parameter.

Note This section discusses how to access Oracle archived redo logs that are stored as file-system files. If the archived redo logs are stored using Oracle ASM, see “Automatic Storage Management” on page 35.

Mirror Replication Agent for Oracle requires the following settings in your Oracle database:

- Redo log archiving must be enabled:

  ```
  alter database ARCHIVELOG;
  ```

  Note If you are using Oracle Real Application Clusters (RAC), you must enable redo log archiving for each instance in the cluster.

  Verify that log archiving is enabled:

  ```
  select log_mode from v$database;
  ```

  If you are using Oracle RAC, use the following SQL to verify that log archiving has been enabled:

  ```
  select instance, name, log_mode from gv$database;
  ```

  If ARCHIVELOG (ARCHIVELOG or MANUAL in Oracle 10g) is returned, then log archiving is enabled.

Accessing archive log files from a remote site

Because archive log files are always files, rather than raw devices, ensure the disk replication system and file system at the remote site allows the archive logs to be accessed from the remote site. If the disk replication system or remote file system does not provide a means to access archived log files from the primary site, the archive log files must be provided to the remote site outside of disk replication.

For example, if the file system on the remote site does not recognize files that have been replicated using disk replication, you can write a copy of the archive log files directly from the primary to a remote system device using a remote mount. Make a remote site device mountable to the primary system and mount that device at the primary site. Then configure Oracle to write an additional copy of the archive log files to this remote device. See the Oracle ALTER SYSTEM command and LOG_ARCHIVE_DEST_n parameter for details on adding additional archive log destinations to your Oracle environment.

In the Mirror Replication Agent, set the pdb_archive_path configuration property to the remote device location. You can also set the Mirror Replication Agent pdb_remove_archives configuration parameter to true to allow the Mirror Replication Agent to remove these archive log files when they are no longer needed to support replication.

Setting archiving for Mirror Replication Agent

When pdb_include_archives is set to true (the default), Mirror Replication Agent does not archive, and Sybase recommends that you configure Oracle to perform automatic archiving of redo logs.

When the pdb_include_archives configuration parameter is set to false, Mirror Replication Agent for Oracle also requires you to disable automatic archiving of Oracle redo logs. Archiving is performed manually by Mirror Replication Agent as the data in the mirrored redo log files is replicated.

Mirror Replication Agent for Oracle requires the following settings in your Oracle database depending on the Oracle version.

For Oracle 10g

❖ **Disabling automatic archiving**

1 Make sure you have sysdba administrator privileges, and close the database.

2 Enter the following:

```
alter database ARCHIVELOG MANUAL;
```

3 Verify that log archiving is disabled:

```
select log_mode from v$database;
```

If MANUAL is returned, then automatic log archiving is disabled.

For Oracle 11g

❖ **Disabling automatic archiving**

1. To change the log_archive_start parameter, either manually edit the server start-up parameter file, or use the following Oracle command:

   ```
   alter system set log_archive_start=false
   scope=spfile;
   ```

2. Check the setting of the log_archive_start parameter:

   ```
   select value from v$system_parameter where name =
   'log_archive_start';
   ```

3. If false is returned, the value in the server parameter file has been correctly modified to prevent automatic archiving when you restart the Oracle server. For information about the log_archive_start parameter or the alter system command, see the *Oracle Database Reference Manual*.

4. Automatic archiving must be disabled in the active server and when you restart the Oracle server. To stop automatic archiving in the active server, enter the following:

   ```
   alter system archive log stop;
   ```

5. To disable automatic archiving when you restart the Oracle server, change the value of the server's log_archive_start parameter to false.

Note If pdb_include _archives is set to false: For redo log file processing after Mirror Replication Agent for Oracle is initialized, automatic archiving must never be enabled, even temporarily. If automatic archiving is enabled or if manual archiving is performed, causing a redo log file not yet processed by Mirror Replication Agent to be overwritten, the data in the lost redo log file is not replicated. You can recover from this situation by reconfiguring Mirror Replication Agent to access archive log files. Set pdb_include_archives to true, set pdb_archive_path to the directory location that contains the archive of the file that has been overwritten, and resume. After catching up, suspend Mirror Replication Agent, and reset pdb_include_archives to false.

Forced logging of all database changes

You can enable the forced logging of all database changes to the Oracle redo log file. Sybase recommends setting this option to insure that all data that should be replicated is logged. To enable the force logging command, execute the following statement on the primary database:

```
alter database FORCE LOGGING;
```

To verify the current setting of the force logging command, execute the following statement on the primary database:

```
select force_logging from v$database;
```

Supplemental logging

In Oracle release 9.2 and later, minimal supplemental logging and supplemental logging of primary key data and index columns must be enabled. To enable supplemental logging, execute the following Oracle commands, enter the following:

```
alter database add SUPPLEMENTAL LOG DATA;
alter database add SUPPLEMENTAL LOG DATA (PRIMARY KEY,
UNIQUE INDEX) COLUMNS;
```

To verify that minimal supplemental logging and supplemental logging of primary key and unique index information is enabled:

```
select SUPPLEMENTAL_LOG_DATA_MIN,
SUPPLEMENTAL_LOG_DATA_PK, SUPPLEMENTAL_LOG_DATA_UI
from v$database;
```

If `YES` is returned for each column, supplemental logging of primary key information is enabled.

Table-level supplemental logging

To replicate updates to user-defined object type attributes, Mirror Replication Agent must enable table-level supplemental logging. Table-level supplemental logging can be enabled manually as follows:

```
alter table THE_TABLE add supplemental log data (ALL)
columns;
```

Here, *THE_TABLE* is the name of the table on which supplemental logging is being enabled. Verify that table-level supplemental logging has been enabled with the following command:

```
select count(*) from ALL_LOG_GROUPS where
LOG_GROUP_TYPE='ALL COLUMN LOGGING' and OWNER=THE_OWNER
and TABLE_NAME=THE_TABLE
```

Here, *THE_OWNER* is the table owner. If this command returns a value of 1, table-level supplemental logging has been enabled for this table.

Recycle bin setup

The Oracle flashback feature added in Oracle 10g is not supported in Mirror Replication Agent for Oracle. Mirror Replication Agent requires that you disable the recycle bin. To disable the Oracle 10g recycle bin (which requires sysdba privileges), enter the following command, and then restart Oracle:

```
purge dba_recyclebin;
alter system set recyclebin=OFF scope=spfile;
```

Note If you are using Oracle RAC, disable the recycle bin for each instance in the cluster.

To view the contents of the recycle bin, enter the following:

```
select * from dba_recyclebin;
```

To view the current recycle bin configuration, enter the following:

```
select inst_id, value from gv$parameter
```

Setting *ddl_username* and *ddl_password*

To replicate DDL in Oracle, in addition to setting the value of pdb_setrepddl to enable, you must set the Mirror Replication Agent ddl_username and ddl_password parameters. The ddl_username parameter is the database user name included in LTL for replicating DDL commands to the standby or target database. This user must have permission to execute all replicated DDL commands at the target database. The ddl_password parameter is the password corresponding to the database user name. In addition, the ddl_username database user must have permission to issue the ALTER SESSION SET CURRENT_SCHEMA command for any primary database user that might issue a DDL command to be replicated.

See the *Mirror Replication Agent Reference Manual*.

Special usage notes

The value of the ddl_username parameter cannot be the same as the value of the maintenance user defined in Replication Server for the standby connection. If these names are the same, a Replication Server error results.

The value of the ddl_username parameter is sent in the LTL for all replicated DDL statements. When DDL is replicated, Replication Server connects to the standby database using the user ID and password specified by the ddl_username and ddl_password parameters. Replication Server then issues the following command:

```
ALTER SESSION SET CURRENT_SCHEMA=user
```

Here, *user* is the user ID that generated the DDL operation at the primary database. The actual DDL command is then executed against the standby database. If the user ID specified in ddl_username does not have permission to issue the ALTER SESSION SET CURRENT_SCHEMA or to execute the DDL command against the user schema, the command fails.

Note To replicate DDL, Replication Server must have a database-level replication definition with replicate DDL set in the definition. See the *Replication Server Reference Manual*.

DDL commands and objects filtered from replication

The following DDL commands are not replicated:

alter database
alter system
create database link
drop database link
alter session
create snapshot
create snapshot log
alter snapshot
alter snapshot log
drop snapshot
drop snapshot/log
alter rollback segment
create rollback segment
drop rollback segment
create control file
create pfile from spfile
create schema authorization
create spfile from pfile
explain
lock table
rename

set constraints
set role
set transaction
analyze
audit
no audit
create tablespace
alter tablespace
drop tablespace

The following objects are not replicated:

- Any objects that are owned by SYS.
- Any object owned by users defined in the list of non-replicated users. You can modify this list using the pdb_ownerfilter command. In addition, Sybase has provided a default list of owners whose objects will not be replicated. However, you cannot remove the SYS owner. Use the pdb_ownerfilter command to return, add, or remove the list of owners whose objects will not be replicated. See the *Mirror Replication Agent Reference Manual*.

Note The truncate table command is replicated as rs_truncate.

Character case of database object names

Database object names must be delivered to the primary Replication Server in the same format as they are specified in replication definitions; otherwise, replication fails. For example, if a replication definition specifies a table name in all lowercase, then that table name must appear in all lowercase when it is sent to the primary Replication Server by Mirror Replication Agent.

To control the way Mirror Replication Agent 15.2 treats the character case of database object names when it sends LTL to the primary Replication Server, set the ltl_character_case configuration parameter to one of the following values:

- asis – (the default) database object names are passed to Replication Server in the same format in which they are actually stored in the primary data server.
- lower – database object names are passed to Replication Server in all lowercase, regardless of the way in which they are actually stored in the primary data server.

- upper – database object names are passed to Replication Server in all uppercase, regardless of the way in which they are actually stored in the primary data server.

In the Oracle data server, database object names are stored in all uppercase by default. However, if you create a case-sensitive name, the case sensitivity is retained in Oracle.

See the following examples using the asis option:

- `create table tabA` is stored as `TABA`
- `create table Tabb` is stored as `TABB`
- `create table 'TaBc'` is stored as `TaBc`

See the following examples using the upper option:

- `create table tabA` is rendered in LTL as `TABA`
- `create table Tabb` is rendered in LTL as `TABB`
- `create table 'TaBc'` is rendered in LTL as `TABC`

Format of origin queue ID

Each record in the transaction log is identified by an origin queue ID that consists of 64 hexadecimal characters (32 bytes). The format of the origin queue ID is determined by the Mirror Replication Agent instance, and it varies according to the primary database type.

Table 1-1 illustrates the format of the origin queue ID for Mirror Replication Agent for Oracle.

Table 1-1: Mirror Replication Agent for Oracle origin queue ID

Character	Bytes	Description
0–3	2	Database generation ID
4–15	6	System change number
16–19	2	Redo log thread
20–23	2	System change number subindex
24–43	10	Redo log record block address
44–55	6	System change number of the oldest active transaction begin
56–63	4	Locator ID

Replication Server and RSSD scripts

The Mirror Replication Agent installation includes supplemental script changes to support additional Replication Server user-defined datatypes for new Oracle datatypes and replication of DDL commands.

The following revised Replication Server scripts are shipped with Mirror Replication Agent 15.2 and must be applied when the installed Replication Server is version 15.0.1 or earlier:

$SYBASE/MA-15_2/scripts/oracle/hds_oracle_new_setup_for_replicate.sql
$SYBASE/MA-15_2/scripts/oracle/oracle_create_error_class_1_rs.sql
$SYBASE/MA-15_2/scripts/oracle/oracle_create_error_class_2_rssd.sql
$SYBASE/MA-15_2/scripts/oracle/oracle_create_error_class_3_rs.sql

The following Replication Server scripts should be run manually against the RSSD when the installed Replication Server is version 15.0.1 or earlier:

$SYBASE/MA-15_2/scripts/oracle/hds_oracle_funcstrings.sql
$SYBASE/MA-15_2/hds_oracle_udds.sql
$SYBASE/MA-15_2/hds_clt_ase_to_oracle.sql

❖ **Applying the script changes for user-defined datatypes**

1 If your Replication Server is version 15.0.1 or earlier, apply the following script to support replication of DDL to an Oracle standby database:

$SYBASE/MA-15_2/scripts/oracle/hds_oracle_new_setup_replicate.sql

This script defines Replication Server objects that must be created in the standby database. Use this script instead of the *hds_oracle_setup_replicate.sql* script provided in the Replication Server installation directory. This revised script contains additional changes to support Oracle-to-Oracle DDL replication.

2 To correctly define the Oracle error class for Replication Server 15.0.1 or an earlier version:

- Apply the following script at Replication Server:

  $SYBASE/MA-15_2/scripts/oracle/oracle_create_error_class_1_rs.sql

- Apply the following against your RSSD:

  $SYBASE/MA-15_2/scripts/oracle/oracle_create_error_class_2_rssd.sql

- Apply the following script at Replication Server:

  $SYBASE/MA-15_2/scripts/oracle/oracle_create_error_class_3_rs.sql

See Chapter 4, "Database Server Issues," in the *Replication Server Heterogeneous Replication Guide*.

Datatype compatibility

Mirror Replication Agent for Oracle processes Oracle transactions and passes data to the primary Replication Server. In turn, the primary Replication Server uses the datatype formats specified in the replication definition to receive the data from Mirror Replication Agent for Oracle.

Table 1-2 describes the conversion of Oracle datatypes to Sybase datatypes.

Table 1-2: Recommended Oracle datatype mapping

Oracle datatype	Oracle length/range	Sybase datatype	Sybase length/range	Notes
BINARY_FLOAT	5 bytes, 32-bit single precision floating point number datatype	rs_oracle_float	4 or 8 bytes, depending on precision	• Maximum positive finite value is 3.40282E+38F. • Minimum positive finite value is 1.17549E-38F.

Oracle datatype	Oracle length/range	Sybase datatype	Sybase length/range	Notes
BINARY_DOUBLE	9 bytes, 64-bit single precision floating point number datatype	double	8 bytes	• Maximum positive finite value is 1.79769313486231E+308. • Minimum positive finite value is 2.22507485850720-308.
CHAR	255 bytes	char	32K	
DATE	8 bytes, fixed-length	datetime or rs_oracle_datetime	8 bytes	Replication Server supports dates from January 1, 1753 to December 31, 9999. Oracle supports dates from January 1, 4712 BC to December 31, 9999 AD. If pdb_convert_datetime is true, the Sybase datatype used should be datetime. The value replicated is YYYYMMDD HH:MM:SS.sss. If pdb_convert_datetime is false, the Sybase datatype used should be rs_oracle_datetime. The format replicated is MM/DD/YYYY HH:MI:SS.
TIMESTAMP(n)	21-31 bytes, variable-length	datetime or rs_oracle_timestamp9	8 bytes	Replication Server supports dates from January 1, 1753 to December 31, 9999. Oracle supports dates from January 1, 4712 BC to December 31, 4712 AD. If pdb_convert_datetime is true, the Sybase datatype used should be datetime. If pdb_convert_datetime is false, the Sybase datatype used should be rs_oracle_timestamp9.

Oracle datatype	Oracle length/range	Sybase datatype	Sybase length/range	Notes
TIMESTAMP(n) WITH [LOCAL] TIME ZONE	Variable-length	rs_oracle_timestamptz		
INTERVAL YEAR(n) TO MONTH	Variable-length	rs_oracle_interval		
INTERVAL DAY(n) TO SECOND(n)	Variable-length	rs_oracle_interval		
LONG	2GB, variable-length character data	text		
LONG RAW	2GB, variable-length binary data	image		
BLOB	4GB, variable-length binary large object	image	2GB	
CLOB	4GB, variable-length character large object	text	2GB	
NCHAR	255 bytes, multi-byte characters	unichar or char	32K	
NCLOB	4GB, variable-length multibyte character large object	unitext or text	2GB	For Replication Server 15.0 and later versions, the NCLOB datatype maps to unitext. For earlier versions of Replication Server, the NCLOB datatype maps to image.
NVARCHAR2	2000 bytes, variable-length, multibyte character data	univarchar or varchar	32K	
MLSLABEL	5 bytes, variable-length binary OS label			Not supported.

Oracle datatype	Oracle length/range	Sybase datatype	Sybase length/range	Notes
NUMBER (p,s)	21 bytes, variable-length numeric data	float, int, real, number, decimal, or rs_oracle_decimal	float is 4 or 8 bytes. int is 4 bytes. real is 4 bytes. number and decimal are 2 to 17 bytes.	The float datatype can convert to scientific notation if the range is exceeded. Integers (int) are truncated if they exceed the Replication Server range of 2,147,483,647 to -2,147,483,648 or 1x10^{-130} to 9.99x10^{25}. The number and decimal datatypes are truncated if they exceed the range of -10^{38} to 10^{38}-1. Oracle precision ranges from 1 to 38 digits. Default precision is 18 digits. Oracle scale ranges from -84 to 127. Default scale is 0.
RAW	2000 bytes, variable-length binary data	rs_oracle_binary	32K	
ROWID	6 bytes, binary data representing row addresses	rs_oracle_rowid	32K	
SIMPLE_INTEGER	4 bytes representing signed integers	integer		SIMPLE_INTEGER is an extension of the Oracle PLS_INTEGER datatype. Both are only for use with PL/SQL. The SIMPLE_INTEGER datatype is new as of Oracle 11g.
UDD object type	Variable length character data	rs_rs_char_raw	32K	See “Oracle user-defined types” on page 24.
VARCHAR2	2000 bytes, variable-length character data	varchar	32K	

Replication Server 15.0 unsigned datatype mapping

For Replication Server 15.0, unsigned datatypes are supported and can be specified in the replication definitions.

For versions of Replication Server earlier than 15.0, these datatypes cannot be specified, and Table 1-3 identifies the replication definition datatypes that should be used.

Table 1-3: Unsigned integer replication definition datatype mapping

Replication Server 15.0 unsigned datatypes	Replication definition datatypes
unsigned bigint	NUMERIC (20)
unsigned int	NUMERIC (10)
unsigned smallint	INT
unsigned tinyint	TINYINT

Oracle datatype restrictions

Note See the *Mirror Activator Release Bulletin* for the latest information on datatype restrictions.

Replication Server and Mirror Replication Agent impose the following constraints on the Oracle NUMBER datatype:

- In the integer representation:
    - The corresponding Sybase int datatype has a smaller absolute maximum value.

      The Oracle NUMBER absolute maximum value is 38 digits of precision, between 9.9 x 10^{125} and 1 x 10^{-130}. The Sybase int value is between 2^{31} - 1 and -2^{31} (2,147,483,647 and -2,147,483,648), inclusive.
    - Oracle NUMBER values greater than the Sybase int maximum are rejected by Replication Server.
- In the floating point representation:
    - The precision of the floating point representation has the same range limitation as the integer representation.

- If the floating point value is outside the Sybase range of 2^{31} - 1 and -2^{31} (2,147,483,647 and -2,147,483,648), Mirror Replication Agent for Oracle converts the number into exponential format to make it acceptable to Replication Server. No loss of precision or scale occurs.

Replication Server and Mirror Replication Agent impose the following constraints on the Oracle TIMESTAMP WITH [LOCAL] TIME ZONE datatype:

- When a TIMESTAMP WITH TIME ZONE datatype is replicated, the time zone information is used to resolve the timestamp value to the "local" time zone and then the resolved value is replicated. (The time zone information itself is not replicated.)
- For example, if a TIMESTAMP WITH TIME ZONE datatype is recorded in Oracle as "01-JAN-05 09:00:00.000000 AM -8:00" and the "local" time zone is -6:00, the replicated value is "01-JAN-05 11:00:00.000000". The timestamp value is adjusted for the difference between the recorded timezone of -8:00 and the local time zone of -6:00, and the adjusted value is replicated.

If you use a version of Replication Server earlier than 12.5, the following size restrictions are imposed on Oracle datatypes:

- Oracle BLOB, CLOB, NCLOB, and BFILE datatypes that contain more than 2GB are truncated to 2GB.
- Oracle CHAR, RAW, ROWID, and VARCHAR2 datatypes that contain more than 255 bytes are truncated to 255 bytes.
- Oracle NCHAR and NVARCHAR2 multibyte character datatypes are replicated as char or varchar single-byte datatypes.

The following Oracle datatypes are not supported:

- Oracle BFILE type
- Oracle NESTED TABLE type
- Oracle REF type
- Oracle UROWID type
- Oracle VARRAY type
- Oracle-supplied types

See also

Replication Server Reference Manual for information on replication definitions and the create replication definition command.

Oracle SQL Reference Manual for a complete list of Oracle-supplied types.

Oracle large object (LOB) support

Oracle LOB data can exist in several formats in Oracle:

- Character datatypes:
  - LONG
  - CLOB
  - NCLOB
- Binary datatypes:
  - LONG RAW
  - BLOB
  - BFILE

  BFILE points to file contents stored outside of the Oracle database.

For those types stored in the database (all types except BFILE), Oracle records the content of the LOB in the redo files. The Mirror Replication Agent reads the LOB data from the redo file and submits the data for replication. Because BFILE type data is stored outside of the database, Mirror Replication Agent does not support BFILE data.

Special handling for off-row LOBS

LOB types that are stored within the Oracle database (BLOB, CLOB and NCLOB) can be defined with certain storage characteristics. One of those characteristics, “disable storage in row,” indicates that the data for the LOB should always be recorded separately from the rest of the data in the row the LOB belongs to. This off-row storage requires special handling for replication of updates to these LOB values.

When an off-row LOB value is updated, the change recorded in the redo log is for the index that holds the LOB’s data; the row the LOB belongs to is not changed. As a result, information is missing from the redo log to identify which row in the table the LOB belongs to.

For example, when a non-LOB column is updated in a table, all column data that identifies the changed values and lookup columns is recorded. The command `updated myTable set col2 = 2 where col1 = 1` records values in the redo log for the values of both “col2” and “col1.”

In contrast, a command that only updates a LOB that has been defined with the disable storage in row clause records only the LOB data's change to its index, and not the table that holds the LOB. So the command `updated myTable set ClobColumn = 'more data' where col1 = 1` only records the value changed and does not include the value of "col1".

Because the value of the columns in the where clause are not logged in that update, there is insufficient information to build the correct where clause to be used to apply the data at the standby site. To resolve this problem, Mirror Replication Agent for Oracle requires that an update to a LOB column defined with disable storage in row must be immediately accompanied by an insert or update to the same row in the table the LOB belongs to.

The Mirror Replication Agent uses the additional column data from the associated operation to correctly build the where clause required to support replication.

For example, the following transaction sequences support replication of updates to LOB column "ClobColumn" when it has been defined with the disable storage in row clause:

```
begin
insert into myTable (col1, col2, ClobColumn, updated)
values (1,1,empty_clob(), sysdate);
update myTable set ClobColumn = 'more data' where col1
= 1;
commit

begin
update myTable set updated = sysdate() where col1 = 1;
update myTable set ClobColumn = 'more data' where col1
= 1;
commit

begin
update myTable set ClobColumn = 'more data' where col1
= 1;
update myTable set updated = sysdate() where col1 = 1;
commit
```

Note For purposes of replication, LOB objects populated with the empty_clob or empty_lob function are replicated as NULL values. Replication definitions for LOB columns should therefore include the "null" keyword as part of the column definition.

The following transaction sequences are not supported for LOB columns defined with the disable storage in row clause and result in a failure to supply the LOB data to the standby site:

- Missing accompanying change to the same row:

```
begin
update myTable set ClobColumn = 'more data' where
col1 = 1;
commit
```

- Accompanying change for the same row is not immediately adjacent to the LOB change:

```
begin
update myTable set updated = sysdate where col1 = 1;
update myTable set col2 = 5 where col1 = 5;
update myTable set ClobColumn = 'more data' where
col1 = 1;
commit
```

This limitation only applies to LOB columns that have been defined with the disable storage in row clause.

You can identify the LOB columns in your database that have this constraint using the following query against your Oracle database:

```
select owner, table_name, column_name from dba_lobs where in_row = 'NO';
```

Oracle user-defined types

User-defined datatypes (UDD) use Oracle built-in datatypes and other user-defined datatypes as building blocks that model the structure and behavior of data in applications.

Mirror Replication Agent for Oracle 15.2 supports replication of user-defined object types. Object types are abstractions of real-world entities, such as purchase orders, that application programs deal with. An object type is a schema object with three kinds of components:

- A name, which identifies the object type uniquely within that schema.
- Attributes, which are built-in types or other user-defined types. Attributes model the structure of the real-world entity.

- Methods, which are functions or procedures written in PL/SQL and stored in the database, or written in a language such as C or Java and stored externally. Methods implement operations the application can perform on the real-world entity.

Replicating UDDs

To replicate user-defined datatypes in Oracle, the datatype specified in the replication definition must be rs_rs_char_raw. If you are using Replication Server 15.1 or earlier, see “Replication Server and RSSD scripts” on page 15 first.

❖ Creating a datatype definition in Replication Server

To create the datatype requires Replication Server administrator privileges or granted permission.

1 Log in to the RSSD.

2 Add a row to the rs_datatype table using the following example as a guide:

```
/*  rs_oracle_udd_raw - char with no delimiters */
insert into rs_datatype values(
0,                     /* prsid */
0x0000000001000008,   /* classid */
'rs_oracle_udd',       /* name */
0x0000000000010210,   /* dtid */
0,                     /* base_coltype */
255,                   /* length */
0,                     /* status */
1,                     /* length_err_act */
'CHAR',                /* mask */
0,                     /* scale */
0,                     /* default_len */
'',                    /* default_val */
0,                     /*-delim_pre_len-*/
'',                    /* delim_pre */
0,                     /*-delim_post_len-*/
'',                    /* delim_post */
0,                     /* min_boundary_len */
'',                    /* min_boundary */
3,                     /* min_boundary_err_act */
0,                     /* max_boundary_len */
'',                    /* max_boundary_err_act */
0                      /* rowtype */
)
go
```

3 You must restart Replication Server after adding a new type.

4 In Replication Server, test the new type:

```
admin translate, 'The quick brown fox jumped over the lazy dog.',
'char(255)', 'rs_oracle_udd'
go
Delimiter Prefix   Translated                  Value Delimiter Postfix
----------------------------------------------------------------------
NULL               The quick brown fox jumped over the lazy dog.  NULL
```

The new type has been defined correctly if the sentence was translated correctly.

Example

The following example demonstrates how to create a replication definition, using the rs_rs_char_raw type defined in Replication Server. The following Oracle table and type definitions are used in the example:

- Oracle UDD object type name: NAME_T
- Oracle table name: USE_NAME_T
- Oracle table columns: PKEY INT, PNAME NAME_T

```
create replication definition use_name_t_repdef
with primary at ma_source_db.ma_source_ds
with all tables named 'USE_NAME_T'
(
   PKEY int,
   PNAME rs_rs_char_raw
)
primary key (PKEY)
searchable columns (PKEY)
go
```

Note The ltl_character_case must be upper for this example.

Replicating object type attributes

To replicate updates to user-defined object type attributes, Mirror Replication Agent must enable table-level supplemental logging. Table-level supplemental logging can be enabled manually. Mirror Replication Agent also attempts to enable this logging when marking a table that contains a user-defined object type. However, for Mirror Replication Agent to mark such a table, there must already be an Oracle user specified by the pds_username parameter that has ALTER permission granted for the table.

If table-level supplemental logging has not been enabled for a table containing a user-defined object type and Mirror Replication Agent encounters an update log record in the Oracle log, Mirror Replication Agent changes its status from Replicating to Admin with the following error:

```
There is insufficient column data in the log to support
Oracle UDD update command processing. Please make sure
table-level supplemental logging is enabled.
```

In this case, use the pdb_skip_op to skip this log record. See the *Mirror Replication Agent Reference Manual*.

Marking and unmarking sequences

Support for Oracle sequence replication is supported for replication to Oracle only. No support is provided for replicating a sequence value to a non-Oracle standby database.

Mirror Replication Agent supports replication of sequences in the primary database. To replicate a sequence invoked in a primary database, the sequence must be marked for replication, and replication must be enabled for that sequence. This is analogous to marking and enabling replication for tables.

Note Marking a sequence for replication is separate from enabling replication for the sequence. If the value of the pdb_dflt_object_repl parameter is true, replication is enabled automatically at the time a sequence is marked. See "Enabling and disabling replication for sequences" on page 31.

Oracle does not log information every time a sequence is incremented. Sequence replication occurs when Mirror Replication Agent captures the system table updates that occur when the sequence cache is refreshed. Therefore, the sequence value replicated when a sequence is marked for replication is the "next" sequence value to be used when the current cache expires. The result is that not every individual increment of a sequence is replicated, but the standby site will always have a value greater than the primary site's currently available cached values.

To temporarily suspend replication of a marked sequence, disable replication for the sequence.

Replication Server changes to support sequence replication

By default, Replication Server is not installed with support for replication of Oracle sequence objects. Changes are required to Replication Server and the standby Oracle database before replication of Oracle sequences is possible.

For Replication Server, you must create a replication definition that defines a stored procedure to assist with sequence replication. Execute the *$SYBASE/MA-15_2/scripts/oracle/oracle_create_rs_sequence_repdef.sql* script against your primary Replication Server after editing the script to replace values *{pds}* and *{pdb}* with the name of your primary Replication Server connection. These values can also be found in the rs_source_ds and rs_source_db Mirror Replication Agent configuration properties.

Note The replication definition assumes that a database replication definition exists. You may need to alter the definition if a database replication definition does not exist. For details, see comments in the *oracle_create_rs_sequence_repdef.sql* script.

In the standby Oracle database, you must create a stored procedure to support sequence replication. Log in to the standby Oracle database as the maintenance user defined in your Replication Server connection to the standby database. Execute the *$SYBASE/MA-15_2/scripts/oracle/oracle_create_replicate_sequence_proc.sql* script to create the necessary stored procedure.

Note The maintenance user defined in your Replication Server connection to the standby database must have sufficient privileges to execute functions in the Oracle DBMS_SQL package. Also, this maintenance user must have authority at the standby Oracle database to update any sequence that is replicated.

❖ Marking a sequence for replication

1 Log in to the Mirror Replication Agent instance with the administrator login.

2 Determine if the sequence is already marked in the primary database:

```
pdb_setrepseq pdb_seq
```

Here, *pdb_seq* is the name of the sequence in the primary database that you want to mark for replication.

- If the pdb_setrepseq command returns information that the specified sequence is marked, you do not need to continue this procedure.

- If the pdb_setrepseq command returns information that the specified sequence is not marked, continue this procedure to mark the sequence for replication.

3 Mark the sequence for replication.

The pdb_setrepseq command allows you to mark the primary sequence to be replicated and specify a different sequence name to use in the standby database.

- Use the following command to mark the sequence for replication when the sequence name you wish to increment at the standby site has the same name:

  ```
  pdb_setrepseq pdb_seq, mark
  ```

  Here, *pdb_seq* is the name of the sequence in the primary database that you want to mark for replication.

  Note Replicating a sequence with a different name that is provided is consistent with other marking commands but is not a typical configuration.

- Use the following command to mark the sequence for replication using a different sequence name:

  ```
  pdb_setrepseq pdb_seq, rep_seq, mark
  ```

  Here, *pdb_seq* is the name of the sequence in the primary database that you want to mark for replication, and *rep_seq* is the name of the sequence in the standby database that you want to increment.

  Note Replicating sequence values to a sequence with a different name at the standby site assumes that the standby site sequence has the same attributes and starting value as the primary site sequence.

  - If the value of the pdb_dflt_object_repl parameter is true, the sequence marked for replication with the pdb_setrepseq command is ready for replication after you invoke the pdb_setrepseq command successfully.
  - If the value of the pdb_dflt_object_repl parameter is true (the default value), you can skip step 4 in this procedure.
  - If the value of the pdb_dflt_object_repl parameter is false, you must enable replication for the sequence before replication can take place.

4 Enable replication for the marked sequence:

```
pdb_setrepseq pdb_seq, enable
```

Here, *pdb_seq* is the name of the marked sequence for which you want to enable replication.

After replication is enabled for the sequence, you can begin replicating invocations of that sequence in the primary database.

Note To replicate a sequence, you must also run the *oracle_create_replicate_sequence_proc.sql* script in the *$SYBASE/MA-15_2/scripts/oracle* directory at the standby site to create a procedure named rs_update_sequence.

❖ Unmarking a sequence

1 Log in to the Mirror Replication Agent instance with the administrator login.

2 Confirm that the sequence is marked in the primary database:

```
pdb_setrepseq pdb_seq
```

Here, *pdb_seq* is the name of the sequence that you want to unmark.

- If the pdb_setrepseq command returns information that the specified sequence is marked, continue this procedure to unmark the sequence.
- If the pdb_setrepseq command does not return information that the specified sequence is marked, you do not need to continue this procedure.

3 Disable replication of the sequence:

```
pdb_setrepseq pdb_seq, disable
```

Here, *pdb_seq* is the name of the sequence that you want to unmark.

4 Remove the replication marking from the sequence:

```
pdb_setrepseq pdb_seq, unmark
```

Here, *pdb_seq* is the name of the sequence that you want to unmark.

To force the unmark, use the following command:

```
pdb_setrepseq pdb_seq, unmark, force
```

5 Confirm that the sequence is no longer marked for replication:

```
pdb_setrepseq pdb_seq
```

Here, *pdb_seq* is the name of the sequence in the primary database that you unmarked.

Enabling and disabling replication for sequences

To temporarily suspend replication of a sequence, use the pdb_setrepseq command to disable replication for the marked sequence. When you are ready to resume replication of the marked sequence, use the pdb_setrepseq command to enable replication.

Note By default, no sequences are marked for replication.

To replicate updates of a sequence in the primary database, the sequence must be marked for replication and replication must be enabled for that sequence.

Marking a sequence for replication is separate from enabling replication for the sequence. See "Marking a sequence for replication" on page 28.

❖ **Enabling replication for a marked sequence**

1. Log in to the Mirror Replication Agent instance with the administrator login.
2. Verify that replication is disabled for the sequence:

   ```
   pdb_setrepseq pdb_seq
   ```

   Here, *pdb_seq* is the name of the marked sequence you want to enable replication for.

   If the pdb_setrepseq command returns information that the sequence is marked and has replication disabled, continue this procedure to enable replication for the sequence.

   Note A sequence must be marked for replication before replication can be enabled or disabled for the sequence.

3. Enable replication for the sequence:

   ```
   pdb_setrepseq pdb_seq, enable
   ```

   Here, *pdb_seq* is the name of the marked sequence for which you want to enable replication.

After replication is enabled for the sequence, any invocation of that sequence is replicated.

4. Use the pdb_setrepseq command again to verify that replication is now enabled for the sequence:

   ```
   pdb_setrepseq pdb_seq
   ```

   Here, *pdb_seq* is the name of the marked sequence for which you want to verify that replication is enabled.

❖ Disabling replication for a marked sequence

1. Log in to the Mirror Replication Agent instance with the administrator login.
2. Verify that replication is enabled for the sequence:

   ```
   pdb_setrepseq pdb_seq
   ```

   Here, *pdb_seq* is the name of the marked sequence you want to disable replication for.

   If the pdb_setrepseq command returns information that the sequence is marked and has replication enabled, continue this procedure to disable replication for the sequence.

   Note A sequence must be marked for replication before replication can be enabled or disabled for that sequence.

3. Disable replication for the sequence:

   ```
   pdb_setrepseq pdb_seq, disable
   ```

   Here, *pdb_seq* is the name of the marked sequence for which you want to disable replication.

   After replication is disabled for the sequence, any invocation of that sequence will not be captured for replication until replication is enabled again.

4. Use the pdb_setrepseq command again to verify that replication is now disabled for the sequence:

   ```
   pdb_setrepseq pdb_seq
   ```

   Here, *pdb_seq* is the name of the marked sequence for which you want to verify that replication is disabled.

Real Application Clusters (RAC)

Mirror Replication Agent for Oracle 15.2 provides support for Oracle 10g RAC environments. When a Mirror Replication Agent for Oracle instance is initialized, the Oracle database is queried to determine how many nodes are supported by the cluster. Based on this information, Mirror Replication Agent automatically configures itself to process the mirrored redo log information from all nodes.

To process the mirrored redo log data from all nodes in an Oracle RAC cluster, Mirror Replication Agent must execute from a location that has access to the mirrored data. The Mirror Replication Agent must also have read access to the shared storage where the mirrored online and archived redo logs exist.

Configure Mirror Replication Agent to connect to a single Oracle instance by supplying the required host, port, and Oracle SID values to the pds_host_name, pds_port_number and pds_database_name configuration parameters. In an Oracle RAC environment, Mirror Replication Agent must be able to connect to any node in the cluster in the event that a node fails or otherwise becomes unavailable. To support the configuration of multiple node locations, Mirror Replication Agent supports connectivity to all possible RAC nodes by obtaining needed information from an Oracle *tnsnames.ora* file for one specified entry. As a result, instead of configuring individual host, port and instance names for all nodes, Mirror Replication Agent only requires the location of a *tnsnames.ora* file and the name of the TNS connection to use.

Sybase recommends that you point Mirror Replication Agent to a *tnsnames.ora* entry that contains the address for all nodes in the cluster.

For example, if the following entry exists in a *tnsnames.ora* file for a three-node cluster, Mirror Replication Agent can be instructed to use that entry by providing the *tnsnames.ora* file location to the pds_tns_filename configuration property and specifying RAC10G as the value for the pds_tns_connection configuration property:

```
RAC10G =
  (DESCRIPTION =
    (ADDRESS = (PROTOCOL = TCP)(HOST = node1-vip)(PORT = 1521))
    (ADDRESS = (PROTOCOL = TCP)(HOST = node2-vip)(PORT = 1521))
    (ADDRESS = (PROTOCOL = TCP)(HOST = node3-vip)(PORT = 1521))
    (CONNECT_DATA =
      (SERVER = DEDICATED)
      (SERVICE_NAME = rac10g.sybase.com)
    )
   )
```

See the *Mirror Replication Agent Reference Manual* for details about the pds_tns_filename and pds_tns_connection parameters.

Note Mirror Replication Agent must have read access to the *tnsnames.ora* file, which you should copy from the machine on which the primary database is running to the machine on which Mirror Replication Agent is running.

---

pdb_archive_path

The pdb_archive_path configuration parameter identifies the directory path where Mirror Replication Agent expects to find archived Oracle redo log files. In an Oracle RAC environment, each Oracle instance can be configured to point to one or more archive log destinations. To support replication, all instances in the Oracle RAC cluster must provide a copy of their archive log files to a shared location that Mirror Replication Agent for Oracle can use to access all archived redo logs. The pdb_archive_path configuration parameter must be configured to point to a location to which all Oracle instances write archived log data. Mirror Replication Agent must have read access to this directory and all archived redo logs within that directory.

Note Archived redo logs can also be stored within ASM. See “Automatic Storage Management” on page 35 for details on how the pdb_archive_path configuration should be specified for ASM usage.

Mirror Replication Agent can be configured to remove archived logs from the location specified by pdb_archive_path, using the pdb_archive_remove configuration parameter. This allows Mirror Replication Agent to remove archived log files that are no longer needed to support replication. If pdb_archive_remove is set to true, Mirror Replication Agent must have update authority to the archive log directory and delete authority on the individual archive log files.

Oracle instance failover

If the Oracle instance to which Mirror Replication Agent is connected fails for any reason, Mirror Replication Agent attempts to reconnect to any surviving instance, choosing from the list of instances defined in the *tnsnames.ora* file entry Mirror Replication Agent is configured to use. No manual intervention or configuration is required. If none of the instances are available, Mirror Replication Agent reports an error and continues processing as long as mirrored redo log file information is still available.

Automatic Storage Management

Mirror Replication Agent for Oracle supports the use of the ASM feature. ASM provides file system and volume management support for an Oracle database environment. ASM can be used in both Real Application Cluster (RAC) and non-RAC environments.

ASM provides similar benefits as a redundant array of independent disks (RAID) or a logical volume manager (LVM). Similar to those technologies, ASM allows the definition of a single disk group from a collection of individual disks. ASM attempts to balance loads across all devices defined in the disk group. ASM also provides striping and mirroring capabilities.

Unlike RAID or LVMs, ASM only supports files created and read by the Oracle database. ASM cannot be used for a general-purpose file system and cannot store binaries or flat files. Also, ASM files cannot be directly accessed by the operating system.

ASM striping and mirroring

ASM provides striping by dividing files into equal-sized extents. Fine-grained striping extents are 128KB in size. For Oracle 10g, coarse-grained striping extents are 1MB in size. For Oracle 11g, coarse-grained striping extents can be 1, 2, 4, 8, 16, 32, or 64MB in size. Striping spreads each file extent evenly across all disks in the assigned disk group.

ASM also provides automatic mirroring of ASM files and allows the mirroring level to be specified by group. This mirroring occurs at the extent level. If a disk group is mirrored, each extent has one or more mirrored copies, and mirrored copies are always kept on different disks in the disk group.

There are three ASM mirroring options:

- Two-way mirroring – each extent has one mirrored copy in this option.

- Three-way mirroring – each extent has two mirrored copies in this option.
- Unprotected mirroring – ASM provides no mirroring in this option, which is used when mirroring is provided by the disk subsystem.

ASM features supported by Mirror Replication Agent for Oracle

When using Mirror Replication Agent for Oracle:

- Online redo log files managed by ASM can be used for replication.
- Archive log files managed by ASM can be used for replication.
- ASM disk groups can be changed without interfering with replication. When disks are added or dropped from an ASM disk group, Mirror Replication Agent for Oracle recognizes the change and automatically updates its device information for affected log devices.
- Mirror Replication Agent for Oracle tolerates multiple disk failures within the same disk group without affecting replication.

Archive log removal and configuration

Archive logs that are managed by ASM can be removed from ASM when they are no longer needed by Mirror Replication Agent for Oracle. When the pdb_archive_remove configuration parameter is set to true and the archive logs are managed by ASM, the pdb_archive_path configuration parameter must be set to the name of the ASM disk group in which the archive logs are stored. The disk group name must be preceded with a plus sign (+) indicating that the path is an ASM path. For example:

```
pdb_archive_remove=true
pdb_archive_path=+DISK_GROUP1
```

Archive logs stored in and managed by ASM are owned by the corresponding unique Oracle database name. If the Oracle database name differs from the global unique database name, the pdb_archive_path configuration parameter must be set to both the name of the ASM disk group and the globally unique name of the database in which the archive logs are stored:

```
pdb_archive_path=+DISK_GROUP1/database_name
```

In addition to automatic removal of archive logs from ASM, manual removal is supported with the pdb_truncate_xlog command. The pdb_archive_path must be set to the ASM disk group name and preceded with a plus (+) sign for archive logs to be manually removed.

Disk failure recovery

ASM provides automatic recovery for disk failures. When a disk fails, ASM reconfigures all ASM-managed files in the disk group with the failed disk and removes the failed disk from the disk group. This is known as a rebalance.

When Mirror Replication Agent for Oracle detects a disk failure, it automatically switches to reading disk group mirrors. If the disk group is configured to have the mirror and mirror copy, Mirror Replication Agent for Oracle can recover from multiple disk failures. If the disk group is configured for no mirroring or if too many disks have failed and the log cannot be read, Mirror Replication Agent for Oracle checks to see if an ASM rebalance is occurring or has occurred. Log device information is updated with new ASM information when the rebalance is complete. The time required for a complete rebalance can vary, depending on how many disk are in the failing disk group.

Log device information can be manually updated by issuing the ra_updatedevices command. If a disk group must be changed by adding or removing a disk, ra_updatedevices can be issued to ensure log devices obtain the new disk group configuration. This command must be issued only after the disk group is changed and ASM has completed its rebalance.

If Mirror Replication Agent for Oracle cannot recover on its own from a disk failure or disk group change, ra_updatedevices can be used to update log device information before resuming replication.

Configuration parameters

The following configuration parameters must be set if your log files are being managed by ASM:

asm_password
asm_tns_connection
asm_tns_filename
asm_username

The ASM user ID for asm_username must have sysdba permission. For Oracle 10g or 11g, set asm_username as follows:

```
asm_username="sys as sysdba"
```

Alternately, for Oracle 11g, you can set asm_username as follows:

```
asm_username="sys as sysasm"
```

See the *Mirror Replication Agent Reference Manual*.

Redo log management with ASM

Because Oracle redo log files managed by ASM use multiple disks within a disk group, a simple path cannot be specified for a log device. The following Mirror Replication Agent commands accommodate this ASM functionality.

- pdb_asmdiskmap – is available only for Oracle and creates a file with default disk mirror paths for all disks in the ASM disk groups that are used to store online redo logs and archive redo logs. The disks required for online logs are automatically selected by querying ASM.
- ra_helpdevice – returns one row output for each disk in the group where the device is stored. For the device ID, the command returns the value of the Oracle log device group ID. The disk mirror path returned is the path obtained from the ASM disk map file.
- ra_updatedevices – when you change a disk group by adding or dropping disks, you must also invoke use this command to be sure the log device repository is updated with correct ASM storage information.

For a full description of these commands and their usage, see the *Mirror Replication Agent Reference Manual*.

Replication Server *set autocorrection* command

The Replication Server set autocorrection command prevents failures that would otherwise be caused by missing or duplicate rows in a replicated table. The set autocorrection command corrects discrepancies that may occur during materialization by converting each update or insert operation into a delete followed by an insert. To use this command, a replication definition must specify replicate minimal columns so that Mirror Replication Agent can send all columns for a row, not just those that have changed, in the autocorrection insert statement. However, Mirror Replication Agent for Oracle does not send all columns for an update statement to Replication Server. Consequently, when autocorrection is set on a replication definition for an Oracle primary, the insert statement applied by Replication Server may omit some columns. Mirror Replication Agent for Oracle therefore does not support use of the Replication Server set autocorrection command.

Partitioned tables

Mirror Replication Agent supports Oracle partitioning functionality. Partitioning allows a table, index, or index-organized table to be subdivided into smaller pieces, where each piece of such a database object is called a partition. Each partition has its own name and may optionally have its own storage characteristics. Any table can be partitioned into many separate partitions except those tables containing columns with LONG or LONG RAW datatypes.

Unstructured data (such as images and documents) stored in a LOB column in the database can also be partitioned. When a table is partitioned, all the columns reside in the tablespace for that partition, with the exception of LOB columns, which can be stored in their own tablespace. For additional information about Oracle Partitioning, see the Oracle Database VLDB and Partitioning Guide.
at http://download.oracle.com/docs/cd/B28359_01/server.111/b32024/toc.htm

Note Index Organized Tables (IOTs) whether partitioned or not, are not supported.

Replicating the *truncate partition* command

There are two ways to replicate the truncate partition command:

- Use the lr_send_trunc_partition_ddl configuration property
- Wrap the truncate partition command in a stored procedure, and replicate the procedure

Using lr_send_trunc_partition_ddl

A configuration property has been added to Mirror Replication Agent, lr_send_trunc_partition_ddl, which can be used to determine whether truncate partition commands are sent as DDL or DML to the standby database. The configuration can be:

- true (default) – the truncate partition command is sent as a DDL command (alter table). Use this setting to replicate to Oracle.
- false – the truncate partition is sent as a DML operation.Use this setting when replicating to databases that treat truncate partition commands as DML (for example, Microsoft SQL Server).

For information about Mirror Replication Agent configuration properties, see the *Mirror Replication Agent Reference Manual*.

Wrapping the *truncate partition* command

Alternately, you can wrap the truncate partition command in a stored procedure definition and replicate the procedure.

For example, to replicate truncate partition commands from an Oracle primary to an ASE standby, create the following stored procedure at the primary database:

```
create procedure sp_truncate_partition
as
begin
execute immediate ‘ALTER TABLE myTable TRUNCATE
PARTITION part1’;
end;
```

Create a corresponding stored procedure at the standby database:

```
create proc sp_truncate_partition as
truncate table myTable part1
```

Mark the sp_truncate_partition procedure for replication. When sp_truncate_partition is executed at the primary database, the truncate partition command is replicated to the standby database.

Materialized views

A materialized view is a stored view query result. The data on which the view is defined is referred to as the master table or tables. The materialized view is stored in its own table, which is refreshed based on changes to the master table or tables. Oracle supports the following types of materialized views:

- Read-only – content is based entirely on the master table or tables.
- Writable – content can be changed temporarily, but changes are overwritten when the table containing the materialized view is refreshed.

- Updateable – updates are also made to the corresponding master table or tables. Updates to the master tables are still reflected in the materialized view upon refresh, so updates can be made in two ways. Additionally, changes to the master table or tables are also reflected in any remote updateable materialized view upon refresh. Here, remote means that the materialized view is defined in a database other than that containing the master table or tables.

For a complete description of materialized view architecture and behavior, see the Oracle documentation.

Instead of replicating the table containing a materialized view, Mirror Replication Agent replicates only the master table or tables on which the view query is defined. The materialized view table is subsequently refreshed according to the contents of the replicated master tables. Mirror Replication Agent does not support direct replication of the table containing a materialized view. Do not attempt to replicate such a table.

Note If you are using replication for disaster recovery, and your primary database contains the master table or tables for a remote materialized view, and you fail over to the standby database, the database containing the remote materialized view must be redirected to point to the standby database before a refresh of the remote materialized view occurs. Otherwise, the refresh fails.

Unsupported table types

Mirror Replication Agent does not support Oracle Index Organized Tables (IOTs) or Oracle nested tables.

Mirror Replication Agent objects in the Oracle primary database

Note This section describes Mirror Replication Agent objects for an Oracle database. For more general information, see the *Mirror Activator Administration Guide*.

Mirror Replication Agent creates objects in the Oracle primary database to assist with replication tasks.

The Mirror Replication Agent objects are created by invoking the pdb_init command. When you invoke this command, Mirror Replication Agent generates a SQL script that contains the SQL statements for the objects created or modified in the primary database. This script is stored in the *partinit.sql* file in the *MA-15_2\inst_name\scripts\xlog* directory. The objects must be created before any primary database objects can be marked for replication.

Note The generated scripts are for informational purposes only and cannot be run manually to initialize the primary database or Mirror Replication Agent. This is also true for the procedure marking and unmarking scripts that are generated when you use pdb_setrepproc. Scripts are no longer generated when marking and unmarking tables with pdb_setreptable.

Mirror Replication Agent object names

There are two variables in Mirror Replication Agent database object names shown in this chapter:

- prefix – represents the one- to three-character string value of the pdb_xlog_prefix parameter (the default is ra_).
- xxx – represents an alphanumeric counter, a string of characters that is (or may be) added to a database object name to make that name unique in the database.

The value of the pdb_xlog_prefix parameter is the prefix string used in all Mirror Replication Agent object names.

The value of the pdb_xlog_prefix_chars parameter is a list of the nonalphanumeric characters allowed in the prefix string specified by pdb_xlog_prefix. This list of allowed characters is database-specific. For example, in Oracle, the only nonalphanumeric characters allowed in a database object name are the $, #, and _ characters.

Use the ra_helpsysinfo command to view the names of Mirror Replication Agent transaction log components in the primary database.

See the *Mirror Activator Administration Guide* for details on setting up object names.

❖ **Finding the names of the objects created**

- At the Mirror Replication Agent administration port, invoke the ra_helpsysinfo command with no keywords:

  ```
  ra_helpsysinfo
  ```

  The ra_helpsysinfo command returns a list of all Mirror Replication Agent objects.

Table objects

Table 1-4 lists the tables that are considered Mirror Replication Agent objects.

Table 1-4: Mirror Replication Agent tables

Table	Database name
Procedure-active table	*prefix*PROCACTIVE_[*xxx*]

Marker objects

Table 1-5 lists Mirror Replication Agent objects related to Replication Server markers. No permissions are granted when these objects are created.

Table 1-5: Mirror Replication Agent marker objects

Object	Database name
Transaction log marker procedure	RS_MARKER[*xxx*]
Dump marker procedure	RS_DUMP[*xxx*]
Transaction log marker shadow table	*prefix*SH_RS_MARKER_[*xxx*]
Dump marker shadow table	*prefix*SH_RS_DUMP_[*xxx*]

Sequences

Table 1-6 lists the Oracle sequences that are considered Mirror Replication Agent objects.

Table 1-6: Mirror Replication Agent sequences

Sequence	Database name
Assign procedure call	*prefix*PCALL_[*xxx*]

Marked procedures

Table 1-7 lists Mirror Replication Agent objects that are created for each primary procedure that is marked for replication. These objects are created only when a procedure is marked for replication.

Table 1-7: Mirror Replication Agent objects for each marked procedure

Object	Database name
Shadow table	*prefix*SH_*xxx*

Transaction log truncation

Mirror Replication Agent provides features for both automatic and manual log truncation.

Mirror Replication Agent provides two options for automatic transaction log truncation:

- Periodic truncation, based on a time interval you specify
- Automatic truncation whenever Mirror Replication Agent receives a new LTM Locator value from the primary Replication Server

You also have the option to switch off automatic log truncation. By default, automatic log truncation is enabled and is set to truncate the log whenever Mirror Replication Agent receives a new LTM locator value from the primary Replication Server.

When pdb_include_archives is set to true, the default, and pdb_remove_archives is set false, Mirror Replication Agent does not perform any online or archived transaction log truncation.

When pdb_include_archives is set to true, the default, and pdb_remove_archives is set true, Mirror Replication Agent deletes from the pdb_archive_path location the archive redo logs that have already been processed. The Mirror Replication Agent is not responsible for archiving online transaction logs.

Note Sybase recommends that you configure Mirror Replication Agent to remove archive log files only if an additional archive log directory is used.

When the configuration parameter pdb_include_archives is set to false, Mirror Replication Agent performs online redo log truncation (either scheduled or manual) by issuing the alter system command with the archive log sequence keywords. The command uses the log sequence number of the redo log file whose contents have been processed by Mirror Replication Agent and are ready to be archived.

Note The alter system command syntax in Oracle allows redo log files to be archived in addition to the single log sequence specified in the command. To avoid the possibility of unintentional archiving, Mirror Replication Agent only issues this command when it is processing the redo log file whose status is current.

Automatic transaction log truncation

You can specify the automatic truncation option you want (including none) by using the ra_config command to set the value of the truncation_type configuration parameter.

If you want to truncate the transaction log automatically based on a time interval, use the ra_config command to set the value of the truncation_interval configuration parameter.

Manual transaction log truncation

You can truncate the Mirror Replication Agent transaction log manually, at any time, by invoking the pdb_truncate_xlog command at the Mirror Replication Agent administration port.

CHAPTER 2 Mirror Replication Agent for ASE

The term “Mirror Replication Agent for ASE” refers to an instance of Mirror Replication Agent 15.2 software that is configured for a primary database that resides in an ASE server.

Note For information on the basic features and operation of Mirror Replication Agent 15.2, see the *Mirror Activator Administration Guide* and the *Mirror Replication Agent Reference Manual*.

ASE database-specific considerations

This section describes general issues and considerations that are specific to using Mirror Replication Agent 15.2 with the ASE database.

- ASE-specific issues
- Converting a warm standby application to a Mirror Activator system
- Materializing databases in ASE 12.5.1 or later
- Datatype support

ASE-specific issues

- Mirror Replication Agent connectivity
- Mirror Replication Agent permissions
- Format of origin queue ID
- ASE Cluster Edition

Mirror Replication Agent connectivity

For network connections, Mirror Replication Agent uses the Java Database Connectivity (JDBC) protocol, as implemented by the Sybase JDBC driver, jConnect™ for JDBC™. Each Mirror Replication Agent for ASE instance uses a single instance of jConnect for JDBC to communicate with all Open Client™ and Open Server™ applications, including the ASE primary data server.

Note Mirror Replication Agent uses file or device I/O for access to the mirror log devices.

Mirror Replication Agent permissions

Mirror Replication Agent requires client access to the primary database to acquire information about the database schema and database log devices, and to reserve the logscan context. This permission can be obtained by granting replication_role to the Mirror Replication Agent user ID that is used to access the primary ASE database.

Grant the replication role to the Mirror Replication Agent login name as in the following example:

```
grant role replication_role to ma_pds_user
```

where *ma_pds_user* is the Mirror Replication Agent user login name assigned to configuration parameter pds_username.

Format of origin queue ID

Each record in the transaction log is identified by an origin queue ID that consists of 64 hexadecimal characters (32 bytes). The format of the origin queue ID is determined by the Mirror Replication Agent instance, and it varies according to the primary database type.

Table 2-1 illustrates the format of the origin queue ID for the Mirror Replication Agent for ASE.

Table 2-1: Mirror Replication Agent for ASE origin queue ID

Character	Bytes	Description
0–3	2	Database generation ID.
4–15	6	Log page timestamp for the current record.
16–27	6	Row ID of the current row. Row ID = page number (4 bytes) + row number (2 bytes).
28–39	6	Row ID of the begin record for the oldest open transaction.
40–55	8	Date and time of the begin record for the oldest open transaction.
56–59	2	An extension used by the Mirror Replication Agent to roll back orphan transactions.
60–63	2	Unused.

ASE Cluster Edition

Mirror Replication Agent for ASE 15.2 provides support for ASE Cluster Edition (CE).

In an ASE CE replication environment, the Mirror Replication Agent must be able to connect to any node in the cluster in the event that a node fails or otherwise becomes unavailable. To support the configuration of multiple node locations, Mirror Replication Agent supports connectivity to all possible ASE CE database instances using the Sybase *interfaces* (UNIX) or *sql.ini* (Windows) file. Instead of configuring individual host, port, and instance names for all nodes, the Mirror Replication Agent requires only the location of the *interfaces* or *sql.ini* file, the ASE CE server name, and the primary database name. The *interfaces* or *sql.ini* file specified should contain an entry that includes the address for each node in the database cluster.

For example, if the following entry exists in the *interfaces* file for a two-node cluster, Mirror Replication Agent can be instructed to use that entry by providing the *interfaces* file location to the pds_interfaces_file configuration property and specifying “clustA” as the value for the pds_server_name configuration property:

```
clustA
    query tcp ether suse9364asece1.sybase.com 4311
    query tcp ether suse9364asece2.sybase.com 4312
```

See the *Mirror Replication Agent Reference Manual* for details about the pds_interfaces_file and pds_server_name parameters.

Note Mirror Replication Agent must have read access to the *interfaces* or *sql.ini* file, which you should copy from the machine on which the primary database is running to the machine on which Mirror Replication Agent is running.

On initialization, the Mirror Replication Agent automatically determines that the primary database is a cluster database so, besides database connectivity, Mirror Replication Agent does not require any other unique configuration to support ASE CE database replication.

ASE instance failover

If the ASE CE instance to which Mirror Replication Agent is connected fails for any reason, Mirror Replication Agent attempts to reconnect to any surviving instance, choosing from the list of instances defined in the *interfaces* or *sql.ini* file entry Mirror Replication Agent is configured to use. No manual intervention or configuration is required. If none of the instances are available, Mirror Replication Agent reports a warning and continues replication processing.

Converting a warm standby application to a Mirror Activator system

This section describes the setup and configuration tasks that are required to convert an existing Replication Server warm standby application to a Mirror Activator system.

If you are setting up a new Mirror Activator system (that is, using a primary database that was not previously configured for a warm standby application), see the *Mirror Activator Administration Guide*, Chapter 2, “Setting Up and Configuring Mirror Replication Agent.”

Table 2-2 provides a checklist of the tasks required to configure software components and set up the Mirror Activator system for replication when you convert an existing warm standby application to a Mirror Activator system.

The checklist in Table 2-2 assumes the following:

- The Replication Server and primary and standby databases are already configured for a warm standby application, and the warm standby application is functioning properly to replicate transactions from the primary database to the standby database.
- You do not need to materialize the standby database because it has been maintained by the Replication Server, and it already contains data and schema that are identical to the primary database.
- You have already completed all tasks described in the *Mirror Activator Administration Guide*, Chapter 2, “Setting Up and Configuring Mirror Replication Agent,” except:
  - Creating the Replication Server user login name (for the Mirror Replication Agent), and
  - Setting up the Mirror Replication Agent configuration parameters for the Replication Server connection.

Note If the Replication Server and primary and standby databases are not already configured for a Replication Server warm standby application, do not use the task checklist in Table 2-2. Instead, use the setup and configuration tasks described in “Setting Up a new Mirror Activator system,” in Chapter 2 of the *Mirror Activator Administration Guide*.

When converting an existing warm standby application to a Mirror Activator system, you must perform all tasks in Table 2-2 in the order they are shown. If you deviate from this sequence, the results may be unpredictable, and you may have to back out of the entire process and start over.

Table 2-2: Tasks for converting a warm standby application to a Replication Server Heterogeneous Replication Options system

Task	Description
1	Materialize the mirror log devices, and set up the disk replication system for synchronous replication to the mirror log devices.
2	Set up the Mirror Replication Agent configuration parameters for the Replication Server connection.
3	Stop and disable the Replication Agent thread in the primary database. **Note** You must preserve the secondary truncation point when you disable the Replication Agent thread.
4	Initialize the primary database using the Mirror Replication Agent pdb_init command. **Note** After the primary database is initialized, you must not allow any DDL operations before it is quiesced in step 5.
5	Quiesce the primary database.
6	Initialize the Mirror Replication Agent using the ra_init command, and set the paths to the mirror log devices.
7	Resume update activity in the primary database after Mirror Replication Agent initialization is complete.
8	Resume the Mirror Replication Agent to put it in Replicating state.

The following sections contain detailed procedures for each setup and configuration task.

Materialize the mirror log devices

Use the disk replication system facilities to perform the following operations:

- Materialize the mirror log devices with a snapshot of the primary log devices
- Configure the disk replication system to mirror (synchronously replicate) all changes on the primary log devices to the mirror log devices

See the documentation provided by your disk replication system vendor (or device vendor) for information about configuring the disk replication system and mirror log devices.

Set up Mirror Replication Agent connection parameters for Replication Server

Complete all the tasks described in "Setting Up a new Mirror Activator system," in Chapter 2 of the *Mirror Activator Administration Guide* — except the following:

- Creating the Replication Server user login name
- Setting up the Mirror Replication Agent configuration parameters for the Replication Server connection

When connecting to the Replication Server, the Mirror Replication Agent can use the login name that was created for the primary database Replication Agent thread.

Note You must have a system administrator or database owner user role in the primary ASE to perform this procedure.

❖ Finding the Replication Server login name for the Replication Agent thread

1. Log in to the primary database with a system administrator or database owner user role.
2. View the current values of the Replication Agent thread configuration parameters in the primary database:

   ```
   use pdb
   sp_config_rep_agent pdb
   ```

   where *pdb* is the name of the primary database.

Make a note of the current values returned for the following Replication Agent thread parameters:

- rs username – Replication Server user login for the Replication Agent thread.
- connect dataserver – primary data server name in the Replication Server database connection.

- connect database – primary database name in the Replication Server database connection.

Note The password for the Replication Server user login is not displayed with the other Replication Agent thread parameters. Consult the system administrator or System Security Officer for the Replication Server to obtain the password that the Mirror Replication Agent must use.

❖ Setting up connection parameters for the Replication Server

1 Log in to the Mirror Replication Agent administration port, and verify that the Mirror Replication Agent instance is in Admin state.

   a Use the following command to verify that the Mirror Replication Agent instance is in Admin state:

   ```
   ra_status
   ```

   b If the instance is not in Admin state, use the following command to put it in Admin state:

   ```
   suspend
   ```

2 Specify the Replication Server host name:

```
ra_config rs_hostname, rs_host
```

where *rs_host* is the network name of the Replication Server host machine.

3 Specify the Replication Server port number:

```
ra_config rs_port_number, NNN
```

where *NNN* is the number of the network port where Replication Server listens for connections.

4 Specify the Replication Server user login name for the Mirror Replication Agent instance:

```
ra_config rs_username, ma_rs_user
```

where *ma_rs_user* is the value of the Replication Agent thread rs_username parameter.

5 Specify the user login password for the Mirror Replication Agent instance:

```
ra_config rs_password, ma_rs_pwd
```

where *ma_rs_pwd* is the password you received from the system administrator.

6 Specify the Replication Server character set:

```
rs_charset
```

where rs_charset matches the character set used by Replication Server and is found in the configuration (*.cfg*) file.

7 Specify the primary data server name for the Replication Server primary database connection:

```
ra_config rs_source_ds, pds
```

where *pds* is the value of the Replication Agent thread connect dataserver parameter.

8 Specify the primary database name for the Replication Server primary database connection:

```
ra_config rs_source_db, pdb
```

where *pdb* is the value of the Replication Agent thread connect database parameter.

After you set up the Mirror Replication Agent connection configuration parameters, use the Mirror Replication Agent test_connection RS command to test connectivity between the Mirror Replication Agent and the Replication Server. See the *Mirror Activator Administration Guide*, Chapter 3, "Administering Mirror Replication Agent."

Stop and disable the Replication Agent thread in the primary database

In the Mirror Activator system, the Mirror Replication Agent must control the secondary truncation point in the primary database. This requires you to stop and disable the Replication Agent thread in the primary database when you convert an existing warm standby application to a Mirror Activator system.

Warning! You must use the preserve secondary truncpt option when you execute sp_config_rep_agent to disable the Replication Agent thread. If you do not preserve the secondary truncation point in the primary database, you must rematerialize the standby database before you resume replication to prevent data loss.

❖ Stopping and disabling the Replication Agent thread

1 Log in to the primary database with a system administrator user role.

2 Stop the Replication Agent thread in the primary database:

```
use pdb
sp_stop_rep_agent pdb
```

where *pdb* is the name of the primary database.

3 Disable the Replication Agent thread in the primary database:

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

where *pdb* is the name of the primary database.

Disabling the ASE Replication Agent thread allows the Mirror Replication Agent to reserve the logscan context in the primary database.

Initialize the primary database

You must initialize the primary database using the Mirror Replication Agent pdb_init command. Initializing the primary database does the following:

- Verifies that the primary database configuration is correct for the Mirror Activator system
- Marks the primary database for replication (equivalent to executing sp_reptostandby in the primary database)

Note After you initialize the primary database, you must not allow any DDL operations in the primary database before it is quiesced (the next setup task).

❖ Initializing the primary database

1 Log in to the Mirror Replication Agent administration port.

Warning! Do not use the move_truncpt option of the pdb_init command when you initialize the primary database. If you do not preserve the secondary truncation point in the primary database, you must rematerialize the standby database before you resume replication to prevent data loss.

2 Initialize the primary database:

```
pdb_init
```

Quiesce the primary database

Quiesce the primary database to suspend update activities until the Mirror Replication Agent is initialized.

Note A system administrator user role in the primary ASE must exist to perform this procedure.

❖ **Quiescing the primary database**

1 Log in to the primary database with a system administrator user role.

2 Quiesce the primary database to suspend update activities:

```
quiesce database MA_setup hold pdb
```

where:

- *MA_setup* is a user-defined tag that identifies the database.
- *pdb* is the name of the primary database.

Initialize the Mirror Replication Agent

Initialize the Mirror Replication Agent instance to populate the Replication Agent System Database (RASD) with the information it needs about the primary database schema and transaction log devices.

Note This procedure requires the primary database to be quiesced.

❖ **Initializing the Mirror Replication Agent instance**

1 Log in to the Mirror Replication Agent administration port.

2 Initialize the Mirror Replication Agent instance:

```
ra_init
```

You may need to alter the log device paths returned by the primary data server during Mirror Replication Agent initialization, so that the Mirror Replication Agent can access the mirror log devices.

To determine if you need to alter any default log device path, compare the path returned by the primary data server for each primary log device with the path for the corresponding mirror log device:

- Use the Mirror Replication Agent ra_helpdevice command to view the log device paths returned by the primary data server during initialization.
- If necessary, use the Mirror Replication Agent ra_devicepath command to alter the default log device path to point to the corresponding mirror log device.

For information about the ra_devicepath and ra_helpdevice commands, see the *Mirror Replication Agent Reference Manual*.

Resume update activity in the primary database

After the Mirror Replication Agent initialization is complete, release the quiesce hold to resume update activity in the primary database.

Do not release the quiesce hold on the primary database until the Mirror Replication Agent is initialized, with correct paths defined for all mirror log devices.

Note A system administrator user role in the primary ASE must exist to perform this procedure.

❖ Resuming update activity on the primary database

1. Log in to the primary database with a system administrator user role.
2. Release the quiesce hold on the primary database:

   ```
   quiesce database MA_setup release
   ```

   where *MA_setup* is a user-defined tag that identifies the suspended database.

Resume the Mirror Replication Agent

You must resume the Mirror Replication Agent instance to put it in Replicating state, so that it can read the mirror log devices and send replicated transactions to the Replication Server.

❖ Resuming the Mirror Replication Agent

1. Log in to the Mirror Replication Agent administration port.
2. Start replication in the Mirror Replication Agent:

   ```
   resume
   ```

3 Verify that the Mirror Replication Agent instance is in Replicating state:

```
ra_status
```

If the Mirror Replication Agent instance is not in Replicating state after you invoke the resume command, see the Mirror Activator Administration Guide, Chapter 4, "Troubleshooting Mirror Replication Agent."

Materializing databases in ASE 12.5.1 or later

This section describes two materialization procedures for Replication Server Heterogeneous Replication Options databases in ASE version 12.5.1 or later:

- Materializing the standby database (required when the Replication Server Heterogeneous Replication Options system is set up)
- Rematerializing the primary database for failback

Both of these procedures use the snapshot materialization technique.

The materialization procedures in this section use the ASE mount command. Using mount simplifies the materialization procedure by allowing you to "create" devices at the target site, using the disk replication system's snapshot (or point-in-time copy) feature, and then mount those devices in the target ASE. This feature eliminates initializing the devices, creating an empty database, and shutting down and restarting the server.

To materialize a database in ASE version 12.5.1 or later, use the procedures in this section.

Materializing the standby database in ASE 12.5.1 or later

Materializing the standby database is one of the tasks required to set up the Mirror Activator system. Therefore, the following Mirror Activator system setup tasks (which are not strictly materialization tasks) must be performed during the standby database materialization procedure:

- Materialize the mirror log devices at the standby site, and set up the disk replication system for synchronous replication to the mirror log devices.
- Initialize the Mirror Replication Agent.

The snapshot materialization procedure mentions these setup tasks, but it does not describe them in detail. See the *Mirror Activator Administration Guide*, Chapter 2, “Setting Up and Configuring Mirror Replication Agent.”

Note Before you materialize a standby database, create the Replication Server database objects in the primary database, and then initialize the primary database using the Mirror Replication Agent pdb_init command. See the *Mirror Activator Administration Guide*, Chapter 2, “Setting Up and Configuring Mirror Replication Agent.”

Table 2-3 provides a checklist of the snapshot materialization tasks for a standby database in ASE version 12.5.1 or later. This checklist assumes that the standby ASE is already installed and configured identically to the primary ASE.

Table 2-3: Materializing a standby database in ASE 12.5.1 or later

Task	Description
1	In the standby ASE, create the same server logins and roles that are defined in the primary ASE.
2	Quiesce the primary database to suspend update activity and generate a manifest file for the primary database.
3	Use the disk replication system to copy a snapshot of all primary database data and log devices to the standby site, on devices accessible to the standby ASE. While the primary database is suspended during Replication Server Heterogeneous Replication Options system setup, you also need to: • Copy a snapshot of the primary database log devices to the mirror log devices, and configure synchronous replication from the primary log devices to the mirror log devices • Initialize the Mirror Replication Agent
4	Resume update activity in the primary database after all procedures in step 3 are complete.
5	In the standby ASE, mount the standby database devices (created in step 3) and bring the standby database online.

❖ Materializing a standby database in ASE 12.5.1 or later

1 In the standby ASE, create all server logins and roles defined in the primary ASE.

The most efficient way to complete this task is to use an external copy utility (such as bcp) to copy the contents of the following tables from the primary ASE master database to the standby ASE master database:

- sysloginroles
- syslogins
- sysroles
- syssrvroles

See the *ASE Utility Guide* for information about using the bcp utility.

2 Quiesce the primary database to suspend all update activity, and generate a manifest file for the primary database.

Log in to the primary ASE with a system administrator user role, and execute the following command:

```
quiesce database MA_setup hold pdb
for external dump to pdb_manifest
```

where:

- *MA_setup* is a user-defined tag that identifies the database.
- *pdb* is the name of the primary database.
- *pdb_manifest* is the name of the manifest file.

The standby ASE uses the manifest file to mount the devices created by the disk replication system in the following step.

3 Use the disk replication system facilities to do the following:

- Capture a snapshot (or point-in-time) image of all primary database data and log devices
- Transfer the snapshot to the standby devices at the standby site

The standby devices must be accessible to the standby ASE, for use as database devices.

While the primary database is suspended during Replication Server Heterogeneous Replication Options system setup, you must also:

- Transfer the snapshot of the primary database log devices to the mirror log devices, and configure the disk replication system for synchronous replication from the primary log devices to the mirror log devices
- Initialize the Mirror Replication Agent, using the ra_init command

  See the *Mirror Activator Administration Guide,* Chapter 2, “Setting Up and Configuring Mirror Replication Agent.”

See the documentation provided by your disk replication system vendor for more information about the procedures in this step.

4 Resume update activity in the primary database after all procedures in step 3 are complete.

Note Initialize the Mirror Replication Agent before you resume update activity in the primary database.

Log in to the primary ASE with a system administrator user role, and execute the following command:

```
quiesce database MA_setup release
```

where *MA_setup* is a user-defined tag that identifies the suspended primary database.

5 Mount the standby devices in the standby ASE to recover the standby database, and then bring it online.

a Log in to the standby ASE with a system administrator user role, and execute the following command:

```
mount database all from pdb_manifest
with listonly
```

where *pdb_manifest* is the manifest file created by the quiesce command at the primary database.

The mount command with listonly option returns the device paths specified at the primary ASE for all primary database data and log devices.

If necessary, invoke the mount command to remap the device paths to the standby devices in the standby ASE:

```
mount database all from pdb_manifest
using "sdb_path" = "pdb_data"
```

where:

- *pdb_manifest* is the manifest file created by the quiesce command at the primary database.
- *sdb_path* is the path to the standby database data device.
- *pdb_data* is the device name of the primary database data device specified in the primary ASE.

When you invoke mount, ASE performs all required supporting activities, including adding database devices and activating them, creating the catalog entries for the new database, and recovering the database.

b After the standby ASE completes the mount processing, bring the standby database online:

```
online database sdb
```

where *sdb* is the name of the standby database.

Note The names of the standby database and primary database must be the same.

Rematerializing the primary database for failback in ASE 12.5.1 or later

Normally, the primary database is the source of all data and transactions replicated in the Replication Server Heterogeneous Replication Options system. Rematerializing the primary database is required only as part of a failback procedure, to restore normal system operations after a failover.

After a failover event, the standby database becomes the “active” database in the system, and the primary database must be rematerialized from the standby database to restore the normal operating condition, and resume replication from the primary database to the standby database.

Note When you rematerialize a primary database, the primary database is the target, and the standby database is the source in the materialization procedure.

Table 2-4 provides a checklist of the snapshot rematerialization tasks for a primary (target) database in ASE version 12.5.1 or later. This checklist assumes the following:

- The primary (target) ASE is already installed and configured identically to the standby (source) ASE.
- The primary (target) database exists in the primary (target) ASE, and its database options and devices are configured identically to the standby (source) database.

- All server logins defined in the standby (source) ASE exist in the primary (target) ASE, with identical suid values and names, and all server roles defined in the standby (source) ASE exist in the primary (target) ASE.

Table 2-4: Rematerializing a primary database in ASE 12.5.1 or later

Task	Description
1	Quiesce the standby (source) database to suspend all update activity and generate a manifest file for the standby (source) database. The standby (source) database remains suspended during failback, until after the materialization procedure is complete for the primary (target) database.
2	Use the disk replication system to copy a snapshot of all standby (source) database data and log devices to the primary (target) database devices.
3	In the primary (target) ASE, mount the primary (target) database devices (created in step 3) and bring the primary (target) database online.

After you complete the primary database rematerialization, you must perform additional tasks to complete the failback procedure. See the *Mirror Activator Administration Guide*.

❖ Rematerializing a primary database in ASE 12.5.1 or later

1. Quiesce the standby (source) database to suspend all update activity, and generate a manifest file for the standby (source) database.

   Log in to the standby (source) ASE with a system administrator user role, and execute the following command:

   ```
   quiesce database MA_setup hold sdb
   for external dump to sdb_manifest
   ```

   where:

   - *MA_setup* is a user-defined tag that identifies the database.
   - *sdb* is the name of the standby (source) database.
   - *sdb_manifest* is the name of the manifest file.

   The primary (target) ASE uses the manifest file to mount the devices created by the disk replication system in the following step.

2. Use the disk replication system facilities to do the following:

   - Capture a snapshot (or point-in-time) image of all standby (source) database data and log devices
   - Transfer the snapshot to the primary (target) devices at the primary (target) site

While the standby (source) database is suspended during failback, you must also:

- Transfer the snapshot of the standby (source) database log devices to the mirror log devices
- Configure the disk replication system for synchronous replication from the primary (target) log devices to the mirror log devices (to prepare for normal system operation after failback)

See the documentation provided by your disk replication system vendor for more information about the procedures in this step.

3 Mount the primary (target) devices in the primary (target) ASE to recover the primary (target) database, and then bring it online.

a Log in to the primary (target) ASE with a system administrator user role, and execute the following command:

```
mount database all from sdb_manifest
with listonly
```

where *sdb_manifest* is the manifest file created by the quiesce command at the standby (source) database.

The mount command with listonly option returns the device paths specified at the standby (source) ASE for all standby (source) database data and log devices.

If necessary, invoke the mount command to “remap” the device paths to the primary (target) devices in the primary (target) ASE. For example:

```
mount database all from sdb_manifest
using "pdb_path" = "sdb_data"
```

where:

- *sdb_manifest* is the manifest file created by the quiesce command at the standby (source) database.
- *pdb_path* is the path to the primary (target) database data device.
- *sdb_data* is the device name of the standby (source) database data device specified in the standby (source) ASE.

When you invoke mount, ASE performs all required supporting activities, including adding database devices and activating them, creating the catalog entries for the new database, and recovering the database.

b After the primary (target) ASE completes the mount processing, use the following command to bring the primary (target) database online:

```
online database pdb
```

where *pdb* is the name of the primary (target) database.

The names of the primary database and standby database must be the same.

Datatype support

All ASE datatypes are supported by Mirror Replication Agent. The following is additional information for two of the datatypes, encrypted columns and computed columns:

- Encrypted columns – the ability to encrypt most columns as they are stored on disk. Keys and some indexing may not be encrypted. The logged data is ciphertext (encrypted), and transmitted to Replication Server as ciphertext. An option to insert data already encrypted has been added, enabling the data to be transmitted in an image form to the standby database.
- Computed columns – defined by an expression, whether from regular columns in the same row, functions, arithmetic operators, or path names. Computed columns are different from function based indexes in the following ways:
    - A computed column provides a shorthand for an expression and indexability.
    - Computed columns can be either deterministic or nondeterministic, while function-based indexes must be deterministic. "Deterministic" means that if the input values in an expression are the same, the return values must also be the same.
    - Computed columns can be materialized or not materialized. Columns that are materialized are preevaluated and stored in the table when base columns are inserted or updated. Any subsequent access to a materialized column does not require reevaluation; its preevaluated result is accessed.
    - Computed columns that are not materialized are called virtual columns with the value evaluated each time the column is accessed. A nondeterministic expression for a virtual column may result in different values for each access.

Materialized computed columns must be replicated as there is no method to determine if the expression is deterministic or nondeterministic.

Note A table-level replication definition for encrypted columns must be provided, even if database-level replication or warm standby is used.

Support for Transact-SQL statement replication

Mirror Replication Agent supports SQL statement replication for ASE version 15.0.3 and later. Sybase recommends that you use SQL statement replication when:

- DML statements affect a large number of rows on replicated tables.
- You have difficulty altering the underlying application to enable stored procedure replication.

Performance issues with log-based replication

Mirror Replication Agent uses log-based replication. Modifications performed on replicated tables are logged in the database transaction log. ASE generates a log record for each modification to each affected row; a single DML statement may result in ASE generating multiple log records. Depending on the type of DML statement, the ASE may log one "before" image and one "after" image for every affected row. The Sybase Mirror Replication Agent reads the log and forwards it to the Replication Server. The Replication Server identifies the DML operation (insert, delete, update, insert, select, or stored procedure execution) and generates the corresponding SQL statement for every operation.

Log-based replication has these inherent issues:

- When a single DML statement affects multiple rows, Replication Server applies multiple DML statements on the standby site, not just the single original DML statement. For instance, if table t is replicated:

```
1> delete tbl where c < 4
2> go
(3 rows affected)
```

The delete statement logs three records in the transaction log, one for each of the rows deleted. These log records are used for database recovery and replication. Mirror Replication Agent sends the information pertaining to the three log records to the Replication Server, which converts the information back into three delete statements:

```
delete t where c = 1
delete t where c = 2
delete t where c = 3
```

- ASE cannot perform optimizations on the standby site that result in asymmetric loading of resources on the standby database.
- Processing large numbers of statements affecting multiple rows increases latency in the system.
- ASE only partially logs information about select into; therefore, the replication system cannot successfully replicate the DML command.

There are two different approaches to address all of these issues:

- Stored procedure replication
- SQL statement replication

Stored procedure replication

You may use stored procedure replication to encapsulate complex DML operations or those affecting a large number of rows. Stored procedure replication improves performance by replicating only the call to the stored procedure and ignoring modifications to individual rows. Network traffic is decreased and Replication Server needs less processing to apply the stored procedure at the standby site.

In warm standby configurations that replicate DDL, select into operations cannot be replicated as they are minimally logged. Stored procedure replication cannot be used because of transaction management restrictions inherent to replication processing and to the select into command.

Additionally, some third-party applications cannot be easily modified to support replication of stored procedures. Consequently, even though stored procedure replication improves Replication Server performance, it cannot be used in all circumstances.

How Replication Server topologies affect SQL statement replication

Like traditional replication, SQL statement replication is log-based; the information needed to replicate SQL statements (executed in the primary databases) is stored in the transaction log. The log reader, the Sybase Mirror Replication Agent, or other applications read the transaction log to notify Replication Server about modifications to a replicated table.

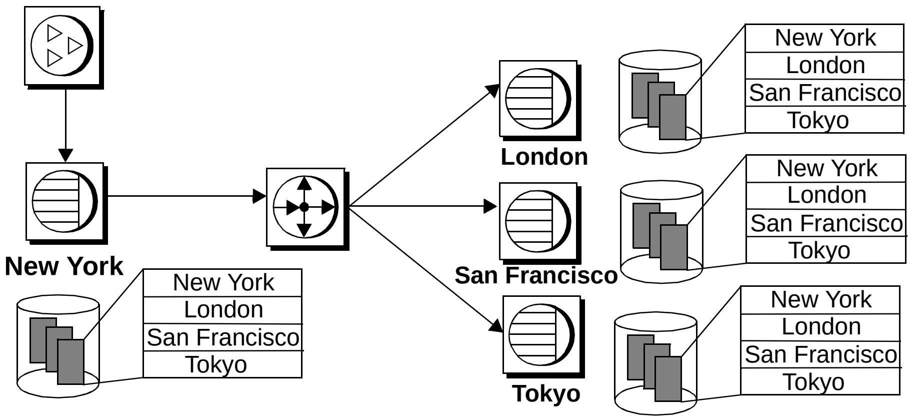
Replication Server supports a wide range of topologies, including "basic primary copy" models that may include several Replication Servers, warm standby configurations, and multi site availability (MSA) configurations. To use SQL statement replication, you must take into account the underlying Replication Server topology.

In simple MSA or warm standby configurations, source and destination data are identical, and a DML statement executed on the primary table affects the same data set on the standby table.

Note SQL statement replication applies only to DML statements.

Figure 2-1 shows a Replication Server topology with a single primary database in New York. Tables are replicated to three other sites: London, Tokyo, and San Francisco. All tables are fully replicated.

Figure 2-1: Basic primary copy model: identical data in standby sites



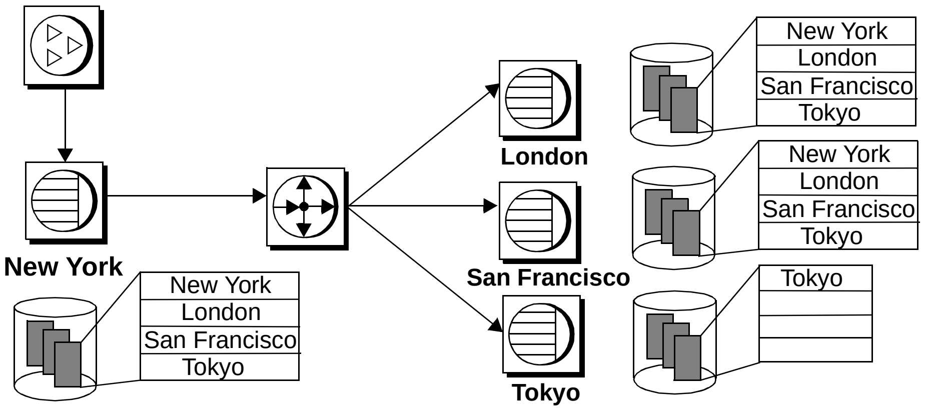
If a client connected to New York executes:

```
delete t1 where a >5
```

If this command is executed at Tokyo, London, and San Francisco, the same data set is affected at all the replicated sites, as data is identical in all the sites. In this case, all replicated sites can be configured to use SQL statement replication.

Figure 2-2 represents a system wherein the replicated site Tokyo subscribes only to a subset of data where the site is equal to "Tokyo."

Figure 2-2: Basic Primary Copy model: nonidentical data in standby sites



Consider the following statement executed at the New York site:

```
delete t1 where a>5
```

Replication Servers can execute the same statement in London and San Francisco, but not in Tokyo, as this site subscribes only to a subset of data. If SQL statement replication is used in this case, some replicated databases, like the Tokyo site, receive individual log record modifications from the primary transaction log, based on traditional replication. Other replicated databases, like the London site, receive the SQL statement.

Different sets of data on the primary and standby tables may also be affected when the primary and standby databases have different object schema, or the user executes a DML statement using a join with another table. In these situations, different data is affected on the primary and replicate. The table used for the join cannot be marked for replication, or values in that table may be partial or different from the primary database.

You must activate SQL statement replication in the ASE that holds primary data, and in the Replication Server. Once you enable SQL statement replication on the primary ASE, ASE logs additional information in the transaction log for each executed DML statement for which SQL statement replication was activated. The Mirror Replication Agent or other log readers deliver individual log record modifications and information for SQL statement replication to the Replication Server.

Note The Sybase Mirror Replication Agent sends SQL statement replication information for Replication Server 15.2 and later.

ASE does not allow SQL statement replication when the statement may affect a different data set when applied on the standby site.

Exceptions to using SQL statement replication

A DML statement matching one or more conditions as listed below cannot use SQL statement replication. In these cases, traditional replication is used:

- The statement refers to views, temporary tables, or tables in other databases.

  ```
  insert tbl select * from #tmp_info
  where column = 'remove'
  ```

- The user executes the statement with set rowcount option set to a value greater than zero.

  ```
  set rowcount 1
  update customers
  set information = 'reviewed'
  where information = 'pending'
  ```

- The statement uses the top n clause in select or select into statements, a Java function, or a SQL user-defined function (UDF):

  ```
  delete top 5
  from customers
  ```

```
where information = 'obsolete'
```

- The base table includes encrypted columns, and the statement references one of those columns in a set or where clause.
- The statement references system catalogs or fake tables such as “deleted” or “inserted.” In this example, the delete executed by the trigger does not use SQL statement replication because it is using the fake table deleted:

```
create trigger customers_trg on customers for delete
as
delete customers_hist
from customers_hist, deleted
where deleted.custID = customers_hist.custID
go
delete customers where  state = 'MA'
go
```

- The statement is an insert statement that generates a new identity or timestamp value.
- The statement is an update statement that changes a timestamp or identity value.
- The statement is an update statement that assigns a value to a local variable. For example:

```
update t set @a = @a + 2, c = @a where c > 1
```

- The statement makes references to materialized computed columns.
- The statement is a select into statement that affects a standby table with encrypted columns.
- The statement is an insert select or select into using a union clause:

```
select c1, c2 from tbl2
union
select cc1, cc2 from tbl3
```

- The statement is an update, insert select, or select into on a table with text/image columns.
- The statement is a query that uses built-in functions:

  If the built-in function statement can be resolved to a constant value, the query is replicated as a SQL statement. For example:

```
update tbl set value = convert(int, "15")
```

  However, the following query is not replicated using SQL statement replication:

```
update tbl set value = convert(int, column5)
```

In warm standby topologies, queries containing the following built-in functions can be replicated using SQL statement replication even if the built-in function cannot be resolved to a constant value:

abs	cot	ltrim	sqrt
acos	datalength	patindex	str
ascii	degrees	power	strtobin
asin	exp	replicate	stuff
atan	floor	reverse	substring
atn2	hextoint	right	tan
bintostr	inttohex	round	to_unichar
ceiling	len	rtrim	upper
char	log	sign	
convert	log10	soundex	
cos	lower	space	

Changes to replication configuration

You can enable SQL statement replication at the database, table, or session level. Session settings override both table and database settings. Table settings override database settings.

Several stored procedures and commands support this feature.

Database level

sp_setrepdbmode and sp_repstandby support SQL statement replication.

sp_setrepdbmode

sp_setrepdbmode enables SQL statement replication at the database level for a specific DML operation.

DML operations are designated as:

- U – update
- D – delete
- I – insert select
- S – select into

For example, to replicate delete statements as SQL statements and also enable replication of select into, enter:

```
sp_setrepdbmode pdb, 'DS', 'on'
```

When an user executes a delete on a table in database pdb, ASE logs additional information for SQL statement replication. The Mirror Replication Agent sends both individual log records, and the information needed by the Replication Server, to build the SQL statement.

You can set SQL statement replication at the database level only when the database has been marked for replication by setting sp_setreptostandby to ALL or L1.

sp_reptostandby

sp_reptostandby displays the SQL statement replication status at the database level. For example:

```
sp_reptostandby pdb
go
The replication status for database 'pdb' is 'ALL'.
The replication mode for database 'pdb' is 'off'.
```

Table level

Use sp_setrepdefmode to configure SQL statement replication at the table level. Table-level settings override database-level settings.

sp_setrepdefmode

sp_setrepdefmode includes options to:

- Enable or disable SQL statement replication for specific DML operations
- Configure the threshold that must be reached to activate SQL statement replication

DML operations are designated as:

- U – update
- D – delete
- I – insert select

For example, to enable SQL statement replication for update, delete, and insert select operations on table t, use:

```
sp_setrepdefmode t, 'UDI', 'on'
go
```

When a user executes deletes, updates, or insert select DML statements on table t, ASE logs additional information for SQL statement replication. The Replication Agent reads the log and sends both individual log records and the information needed by Replication Server to build the SQL statement.

The threshold parameter defines the minimum number of rows that a DML statement must affect, to activate SQL statement replication. The default threshold is 50 rows, which means that ASE automatically uses SQL statement replication if the DML statement affects at least 51 rows.

For example, to set the threshold to 100, use:

```
sp_setreptable t, true
go
sp_setrepdefmode t, 'UD', 'on'
go
sp_setrepdefmode t, 'threshold','100'
go
```

In the above example, update and delete statements executed on table t use SQL statement replication if the statement affects at least 101 rows.

Note You cannot configure a select into operation at the table level because the target table does not yet exist.

Session level

Use session option set repmode to set replication mode to SQL statement replication. You can specify session-level settings either during login by using a login trigger, or at the beginning of a batch. Session settings override both database-level and object-level settings.

Use set repmode on to enable SQL statement replication for the DML operation specified, for the duration of the session. Use set repmode off to remove all SQL statement replication settings at the session level.

For example, to replicate only select into and delete as SQL statements for the duration of the session, use:

```
set repmode on 'DS'
```

The set options are active for the duration of the session. Options that you set inside a stored procedure are reverted to the default values when the stored procedure finishes.

Note When you set options inside a login trigger, the option settings are maintained after the trigger has finished executing.

Executing set repmode on enables SQL statement replication only if session-level option set replication on is set. This example does not enable SQL statement replication:

```
set replication off
go
set repmode on 'S'
go
```

This example enables SQL statement replication:

```
sp_reptostandby pdb, 'ALL'
go
set repmode on 'S'
go
```

Scope of SQL statement replication

This section discusses how SQL statement replication applies to DML statements in batch processing, triggers, and stored procedures.

Batch processing

SQL statement replication is applied to any DML statement that is executed in a batch, provided that:

- The configuration allows SQL statement replication.
- The DML statement does not conform to any of the conditions in "Exceptions to using SQL statement replication" on page 71.

In the example below, while executing the batch statement with delete and insert, only the first statement uses SQL statement replication. table2 uses traditional replication as it is not configured to use SQL statement replication:

```
create table table1 (c int, d char(5))
go
create table table2 (c int, d char(5))
go
insert table1 values (1, 'ABCDE')
go 100
sp_setreptable table1, true
go
sp_setreptable table2, true
go
sp_setrepdefmode table1, 'UDI', 'on'
```

```
go
delete table1 where c=1
insert table2 select * from table1
go
```

Stored procedures

The replication status of a stored procedure determines if DML statements within it are replicated as statements:

- If a stored procedure is not marked for replication, a DML statement within it is replicated as a statement, provided that:
  - The configuration allows SQL statement replication.
  - The DML statement does not conform to any of the conditions in "Exceptions to using SQL statement replication" on page 71.
- If a stored procedure is marked for replication, only the call to it is replicated, not the individual statements that make up the stored procedure.

Triggers

ASE uses SQL statement replication for DML statements within triggers provided that:

- The configuration allows SQL statement replication.
- The DML statement does not conform to any of the conditions in "Exceptions to using SQL statement replication" on page 71.

In the example below, when a delete statement is executed on table1, it is replicated using traditional replication. The delete executed on table2 via the trigger is replicated using SQL statement replication as the table is configured for SQL statement replication and the delete meets the conditions to be replicated as a statement:

```
create table table1 (c int, d char(5))
go
create table table2 (c int, d char(5))
go
sp_setreptable table1, true
go
sp_setreptable table2, true
go
insert table1 values (1,'one')
```

```
go
insert table2 values (2,'two')
go 100
sp_setrepdefmode table2, 'udi', 'on'
go
create trigger del_table1 on table1
for delete
as
begin
delete table2
end
go
delete table1 where c=1
go
```

Recompilation of stored procedures and triggers

Stored procedures and triggers are automatically recompiled if SQL replication settings have changed from off to on between two successive executions of the stored procedure or trigger.

SQL statement replication setting at compile time	SQL statement replication setting at runtime	Automatically recompile stored procedure or trigger
Off	On	Yes
On	Off	No

Cross-database transactions

A single transaction can affect tables from different databases. Modifications to tables located in a different database are logged in the databases that hold the tables. The Sybase Mirror Replication Agent configured for the database sends the Replication Server information stored in its transaction log.

In this example, `db1` and `db2` are replicated databases with configured Sybase Mirror Replication Agents. Database `db1` is configured to use SQL statement replication:

```
use db2
go
begin tran
go
delete t1 where c between 1 and 10000000
delete db1..t1 where c between 1 and 1000000
commit tran
```

```
go
```

The second delete (on database db1) uses SQL statement replication, whereas the first delete (on database db2) uses traditional replication. The Sybase Mirror Replication Agent running on db1 replicates the statement.

Issues resolved by SQL statement replication

This section includes two scenarios where data cannot be replicated using traditional replication methods. In both cases, SQL statement replication provides a way to replicate data successfully.

Replicating *select into* in warm standby configurations

select into creates a new table based on the columns specified in the select list and the rows chosen in the where clause. This operation is minimally logged for recovery purposes, and cannot be replicated using traditional replication.

select into can be replicated in warm standby configurations by using SQL statement replication. To configure SQL statement replication at the database level, use:

```
sp_setrepdbmode pdb, 'S', 'on'
go
```

Once the option is active at the database level, all select into operations in database pdb are replicated using SQL statement replication. See "Exceptions to using SQL statement replication" on page 71 to verify that the query can be replicated using SQL statement replication. If only a subset of select into must be replicated, use set repmode instead.

Replicating deferred updates on primary keys

Updates on tables that have a unique column index are not supported by traditional replication, and the Replication Server reports errors. For example, table t has a unique index on column c, with values: 1, 2, 3, 4, and 5. A single update statement is applied to the table:

```
update t set c = c+1
```

Using traditional replication, this statement results in:

```
update t set c = 2 where c = 1
update t set c = 3 where c = 2
update t set c = 4 where c = 3
update t set c = 5 where c = 4
update t set c = 6 where c = 5
```

The first update attempts to insert a value of c=2 into the table; however, this value already exists in the table. Replication Server displays error 2601—an attempt to insert a duplicate key.

You can use SQL statement replication to address this issue. If the table has a unique index, and SQL statement replication is configured for update statements, the ASE replicates the update using SQL statement replication.

Monitoring tables

SQL statement replication uses these monitoring tables:

- monSQLRepActivity – provides statistics on DML statements that are replicated using SQL statement replication. monSQLRepActivity helps to identify areas where SQL statement replication improves performance. Data obtained over a period of time can distinguish specific DML statements on specific objects that benefit from SQL statement replication.
- monSQLRepMisses – maintains statistics on DML statements that cannot be replicated using SQL statement replication.

Downgrades

To downgrade ASE to a version earlier than 15.0.2 ESD #3, or Replication Server to a version earlier than 15.2, follow the procedure below.

Downgrading ASE

You can downgrade ASE to an earlier version while there still are transaction records related to SQL statement replication in the log.

If you downgrade to a version earlier than 15.0.2 ESD #3, Sybase recommends that you use the standard documented procedure to downgrade an ASE with replicated databases, including draining the transaction log. See the *ASE Installation Guide*.

ASE 15.0.3 provides the following downgrade support for Sybase Mirror Replication Agents version 15.0.2 ESD #3 and later:

- Sybase Mirror Replication Agents continue to replicate data even if the log contains information for SQL statement replication.
- When a Sybase Mirror Replication Agent reads a transaction containing SQL statement replication, it sends atomic modifications for that statement and ignores information related to SQL statement replication.

Downgrading Replication Server

You can downgrade a Replication Server to a version earlier than 15.2. The Sybase Mirror Replication Agent controls the amount and type of information sent to Replication Server based on the Log Transfer Language (LTL) version negotiated when the connection is established.

For Replication Servers earlier than 15.2, Sybase Mirror Replication Agent does not send information for SQL statement replication, and proceeds with standard replication.

APPENDIX A

Upgrading Mirror Replication Agent

Upgrading Mirror Replication Agent for Oracle

Using any of the upgrade procedures described in this section, the new Mirror Replication Agent for Oracle 15.2 instances will have the same configuration as previously existing instances, including instance names, administrative user IDs and passwords, and administrative port numbers.

Note Mirror Replication Agent for Oracle 15.2 does not support downgrading Mirror Replication Agent for Oracle 15.2 to an earlier log-based version (15.0 or 15.1).

Upgrading a log-based Mirror Replication Agent (version 15.0 or 15.1)

This section describes how to upgrade Mirror Replication Agent for Oracle 15.0 or 15.1 to 15.2.

❖ **Upgrading a log-based replication version 15.0 or 15.1 to 15.2**

1 For each existing Mirror Replication Agent for Oracle instance, Sybase recommends that you first back up the RASD, as described in the version 15.2 *Mirror Activator Administration Guide*. Back up the complete existing Mirror Replication Agent instance directory.

2 Install the Mirror Replication Agent 15.2 software as described in "Installing the Mirror Replication Agent software" in the version 15.2 *Mirror Replication Agent Installation Guide*. Sybase recommends that you install Mirror Replication Agent 15.2 into the same *SYBASE* directory as the earlier version of Mirror Replication Agent.

3 Download and install the Oracle JDBC driver, and set the CLASSPATH environment variable, as described in the version 15.2 *Mirror Replication Agent Installation Guide*. If the CLASSPATH contains another Oracle JDBC driver, remove it. Only the Oracle JDBC driver required by Mirror Replication Agent 15.2 should be in the CLASSPATH.

4 Create the 15.2 version of all valid existing Mirror Replication Agent instances.

Note This step creates new Mirror Replication Agent 15.2 instances for all valid existing instances of the earlier version of Mirror Replication Agent, regardless of whether the existing instances are for ASE or Oracle. If you do not want to run a newly created instance on this host, simply delete the new instance directory.

---

a On UNIX, set the SYBASE environment variables by changing to the *SYBASE* directory in which Mirror Replication Agent 15.2 is installed and sourcing the *SYBASE* script:

- For C Shell: `source SYBASE.csh`
- For Bourne or Korn shell: `. SYBASE.sh`

b Change to the Mirror Replication Agent 15.2 *bin* directory:

- On UNIX:

```
cd $SYBASE/MA-15_2/bin
```

- On Windows:

```
cd %SYBASE%\MA-15_2\bin
```

c Create new versions of all valid existing instances:

```
ma_admin -u src_directory
```

Here, *src_directory* is the full path name of the earlier version's Mirror Replication Agent installation directory. This is the source directory. For example:

```
ma_admin -u d:\sybase\MA-15_1
```

For information about instances that did not successfully upgrade, see the administration logs (*…/MA-15_2/admin_logs*). After you correct the problem, re-run this command. This command does not affect those Mirror Replication Agent instances that have already been successfully upgraded.

5. If necessary, set the RA_JAVA_DFLT_CHARSET environment variable in the Mirror Replication Agent 15.2 *RUN_instance* script to the name of the Java character set that is equivalent to the one being used at the primary database. See the version 15.2 *Mirror Activator Administration Guide*.

6. If necessary, override the default maximum amount of memory available to the JRE by setting the RA_JAVA_MAX_MEM environment variable in the Mirror Replication Agent 15.2 *RUN_instance* script. Mirror Replication Agent 15.2 does not set the RA_JAVA_MAX_MEM environment variable in the executable or run scripts, which allows the JVM to use its default for the maximum heap size. See the *Mirror Activator Administration Guide*.

7. In the primary Oracle database, grant the previously existing pds_username user any additional required privileges. See "Mirror Replication Agent permissions" on page 3.

8. To prevent any loss of replicated data, deny users (other than the previously existing Mirror Replication Agent pds_username user) any further access to the primary Oracle instance.

9. Log in to the previously existing Mirror Replication Agent instance, verify that it is in *Replicating* state, and allow replication to finish. To verify that replication has completed:

   a. Periodically issue the ra_statistics command, watching until all of the following statistics are zero (0):

      Input queue size
      Output queue size

   b. When all of these values are zero, note the Last QID Sent from the last set of statistics.

   c. Issue the ra_locator update command so that Mirror Replication Agent retrieves the truncation point from Replication Server.

   d. Wait, then issue the ra_locator command again and compare the displayed locator with that of the Last QID Sent. If they are different, wait and repeat this step.

   e. Quiesce the Mirror Replication Agent instance by issuing the quiesce command.
   f. Shut down the replication instance by issuing the shutdown command.

10. Start and log in to the Mirror Replication Agent 15.2 instance and migrate the Mirror Replication Agent metadata by issuing the ra_migrate command.
11. Allow all users to access the primary Oracle.
12. Log in to the RSSD, and set the Replication Server locator to zero:

    ```
    rs_zeroltm source_ds, source_db
    ```

    Here, *source_ds* matches the previous Mirror Replication Agent instance values for rs_source_ds, and *source_db* matches the previous Mirror Replication Agent instance values for rs_source_db.

    Note This step is required because the format of the QID has changed in version 15.2, requiring the previous value held by Replication Server to be replaced. The rs_source_ds and rs_source_db values are migrated from the earlier version of Mirror Replication Agent and do not need to be changed.

13. In the Mirror Replication Agent 15.2 instance, do the following:
    - To have automatic archiving turned off, set pdb_include_archives to false. To have automatic archiving turned on, set pdb_include_archives to true, set pdb_archive_path to the directory containing the archive logs, and set pdb_archive_remove to false. See "Redo and archive log setup" on page 6.
    - Resume replication by issuing the resume command.

Migrating Mirror Replication Agent 15.2 when upgrading Oracle 10g to 11g

Mirror Replication Agent for Oracle migration to support upgrading Oracle 10g to Oracle 11g is similar to upgrading Mirror Replication Agent for Oracle 15.0 or 15.1 to Mirror Replication Agent 15.2.

Note Quiesce the Mirror Replication Agent before upgrading Oracle 10g to Oracle 11g. The replication environment must have completed processing of all transactions before upgrading Oracle because the Mirror Replication Agent moves the truncation point to the end of the log during Mirror Replication Agent migration.

❖ **Migrating from Oracle 10g to Oracle 11g**

1 Follow the steps that Oracle provides in its documentation for upgrading from Oracle 10g to Oracle 11g.

2 After upgrading Oracle, restart the Mirror Replication Agent and issue the ra_migrate command.

3 As with the log-based Mirror Replication Agent upgrade process, you may need to reconfigure the Mirror Replication Agent for Oracle instance to read archive logs depending on the configuration in Oracle. This may change following the Oracle upgrade.

If you are upgrading from log-based Mirror Replication Agent and upgrading Oracle 10g to Oracle 11g at the same time, migrate Mirror Replication Agent 15.2 only once.

Upgrading Mirror Replication Agent for ASE

This section describes how to upgrade Mirror Replication Agent for ASE.

❖ **Upgrading from Mirror Replication Agent for ASE 15.1**

1 Sybase recommends that you back up the existing Mirror Replication Agent instances directory containing the instance configuration file. In addition, for Mirror Replication Agent for ASE, back up the Mirror Replication Agent System Database (RASD).

2 Shut down all Mirror Replication Agent version 15.1 instances.

3. Use the ma_admin utility script from the Mirror Replication Agent 15.2 installation *bin* directory to upgrade all the verifiable Mirror Replication Agent version 15.1 instances. Execute the ma_admin utility script with the *-u* option:

   ```
   ma_admin -u <src_directory>
   ```

   where *src_directory* is the full path name to the Mirror Replication Agent version 15.1 installation directory. For example:

   - For UNIX:

```
/sybase15/MA-15_2/bin/ma_admin.sh -u /sybase/MA-15_1
```

   - For Windows:

```
d:\sybase15\MA-15_2\bin\ma_admin -u d:\sybase\MA-15_1
```

   This command upgrades all valid Mirror Replication Agent instances.

   For information about instances that did not upgrade successfully, see the administration logs (*…/MA-15_2/admin_logs*). After you correct the problem, re-run this command. This command does not affect those Mirror Replication Agent instances that have already been successfully upgraded.

4. Start Mirror Replication Agent version 15.2.
5. Log in to each Mirror Replication Agent instance and run the ra_migrate command.

   Note For additional information and a manual procedure for Sybase ASE 15.2 migration, see the release bulletin for Mirror Replication Agent 15.2.

6. Resume replication.

Glossary

This glossary describes terms used in this book.

ASE	The brand name for Sybase relational database management system (RDBMS) software products. • ASE manages multiple, large relational databases for high-volume online transaction processing (OLTP) systems and client applications. • ASE IQ manages multiple, large relational databases with special indexing algorithms to support high-speed, high-volume business intelligence, decision support, and reporting client applications. • SQL Anywhere (formerly Adaptive Server Anywhere) manages relational databases with a small DBMS footprint, which is ideal for embedded applications and mobile device applications. See also **DBMS** and **RDBMS**.
atomic materialization	A materialization method that copies subscription data from a primary database to a standby database in a single, atomic operation. No changes to primary data are allowed until the subscription data is captured at the primary database. See also **bulk materialization** and **nonatomic materialization**.
BCP utility	A bulk copy transfer utility that provides the ability to load multiple rows of data into a table in a target database. See also **bulk copy**.
bulk copy	An Open Client interface for the high-speed transfer of data between a database table and program variables. Bulk copying provides an alternative to using SQL insert and select commands to transfer data.
bulk materialization	A materialization method whereby subscription data in a standby database is initialized outside of the replication system. You can use bulk materialization for subscriptions to table replication definitions or function replication definitions. See also **atomic materialization** and **nonatomic materialization**.

client	In client/server systems, the part of the system that sends requests to servers and processes the results of those requests. See also **client application**.
client application	Software that is responsible for the user interface, including menus, data entry screens, and report formats. See also **client**.
commit	An instruction to the DBMS to make permanent the changes requested in a transaction. See also **transaction**. Contrast with **rollback**.
data client	A client application that provides access to data by connecting to a data server. See also **client**, **client application**, and **data server**.
data distribution	A method of locating (or placing) discrete parts of a single set of data in multiple systems or at multiple sites. Data distribution is distinct from data replication, although a data replication system can be used to implement or support data distribution. Contrast with **data replication**.
data replication	The process of copying data to remote locations, and then keeping the replicated data synchronized with the primary data. Data replication is distinct from data distribution. Replicated data is stored copies of data at one or more remote sites throughout a system, and it is not necessarily distributed data. Contrast with **data distribution**. See also **disk replication** and **transaction replication**.
data server	A server that provides the functionality necessary to maintain the physical representation of a table in a database. Data servers are usually database servers, but they can also be any data repository with the interface and functionality a data client requires. See also **client**, **client application**, and **data client**.
database	A collection of data with a specific structure (or schema) for accepting, storing, and providing data for users. See also **data server**, **DBMS**, and **RDBMS**.
database connection	A connection that allows Replication Server to manage the database and distribute transactions to the database. Each database in a replication system can have only one database connection in Replication Server. See also **Replication Server** and **route**.
datatype	A keyword that identifies the characteristics of stored information on a computer. Some common datatypes are: char, int, smallint, date, time, numeric, and float. Different data servers support different datatypes.
DBMS	An abbreviation for database management system, which is a computer-based system for defining, creating, manipulating, controlling, managing, and using databases. The DBMS can include the user interface for using the database, or it can be a standalone data server system. Compare with **RDBMS**.

disaster recovery	A method or process used to restore the critical business functions interrupted by a catastrophic event. A disaster recovery (or business continuity) plan defines the resources and procedures required for an organization to recover from a disaster, based on specified recovery objectives.
failback	A procedure that restores the normal user and client access to a primary database, after a failover procedure switched access from the primary database to a standby database. See also **failover**.
failover	A procedure that switches user and client access from a primary database to a standby database, particularly in the event of a failure that interrupts operations at the primary database, or access to the primary database. Failover is an important fault-tolerance feature for systems that require high availability. See also **failback**.
function	A Replication Server object that represents a data server operation such as insert, delete, or begin transaction. Replication Server distributes operations to standby databases as functions. See also **function string**.
function string	A string that Replication Server uses to map a function and its parameters to a data server API. Function strings allow Replication Server to support heterogeneous replication, in which the primary and standby databases are different types, with different SQL extensions and different command features. See also **function**.
gateway	Connectivity software that allows two or more computer systems with different network architectures to communicate.
inbound queue	A stable queue managed by Replication Server to spool messages received from a Mirror Replication Agent. See also **outbound queue** and **stable queue**.
interfaces file	A file containing information that Sybase Open Client and Open Server™ applications need to establish connections to other Open Client and Open Server applications. See also **Open Client** and **Open Server**.
isql	An Interactive SQL client application that can connect and communicate with any Sybase Open Server application, including ASE, Mirror Replication Agent, and Replication Server. See also **Open Client** and **Open Server**.
Java	An object-oriented programming language developed by Sun Microsystems. A platform-independent, "write once, run anywhere" programming language.
Java VM	The Java Virtual Machine. The Java VM (or JVM) is the part of the Java Runtime Environment (JRE) that is responsible for interpreting Java byte codes. See also **Java** and **JRE**.

JDBC	An abbreviation for Java Database Connectivity, the standard communication protocol for connectivity between Java clients and data servers. See also **data server** and **Java**.
JRE	An abbreviation for Java Runtime Environment, which consists of the Java Virtual Machine (Java VM or JVM), the Java Core Classes, and supporting files. The JRE must be installed on a machine to run Java applications, such as the Mirror Replication Agent. See also **Java VM**.
LAN	An abbreviation for "local area network," a computer network located on the user's premises and covering a limited geographical area (usually a single site). Communication within a local area network is not subject to external regulations; however, communication across the LAN boundary can be subject to some form of regulation. Contrast with **WAN**.
latency	In transaction replication, the time it takes to replicate a transaction from a primary database to a standby database. Specifically, latency is the time elapsed between committing an original transaction in the primary database and committing the replicated transaction in the standby database. In disk replication, latency is the time elapsed between a disk write operation that changes a block or page on a primary device and the disk write operation that changes the replicated block or page on a mirror (or standby) device. See also **disk replication** and **transaction replication**.
LOB	An abbreviation for large object, a type of data element that is associated with a column that contains extremely large quantities of data.
Log Reader	An internal component of the Mirror Replication Agent that interacts with the primary database and mirror log devices to capture transactions for replication. See also **Log Transfer Interface** and **Log Transfer Manager**.
Log Transfer Interface	An internal component of the Mirror Replication Agent that interacts with Replication Server to forward transactions for distribution to a standby database. See also **Log Reader** and **Log Transfer Manager**.
Log Transfer Manager	An internal component of the Mirror Replication Agent that interacts with the other Mirror Replication Agent internal components to control and coordinate Mirror Replication Agent operations. See also **Log Reader** and **Log Transfer Interface**.
maintenance user	A special user login name in the standby database that Replication Server uses to apply replicated transactions to the database. See also **Replication Server**.

materialization	The process of copying the data from a primary database to a standby database, initializing the standby database so that the system can begin replicating transactions. See also **atomic materialization**, **bulk materialization**, and **nonatomic materialization**.
nonatomic materialization	A materialization method that copies subscription data without a lock on the primary database. Changes to primary data are allowed during data transfer, which may cause temporary inconsistencies between the primary and standby databases. Contrast with **atomic materialization**. See also **bulk materialization**.
ODBC	An abbreviation for Open Database Connectivity, an industry-standard communication protocol for clients connecting to data servers. See also **JDBC**.
Open Client	A Sybase product that provides customer applications, third-party products, and other Sybase products with the interfaces needed to communicate with Open Server applications. See also **Open Server**.
Open Client application	An application that uses Sybase Open Client libraries to implement Open Client communication protocols. See also **Open Client** and **Open Server**.
Open Server	A Sybase product that provides the tools and interfaces required to create a custom server. See also **Open Client**.
Open Server application	A server application that uses Sybase Open Server libraries to implement Open Server communication protocols. See also **Open Client** and **Open Server**.
outbound queue	A stable queue managed by Replication Server to spool messages to a standby database. See also **inbound queue** and **stable queue**.
primary data	The version of a set of data that is the source used for replication. Primary data is stored and managed by the primary database. See also **Mirror Replication Agent**, **primary database**, and **Replication Server**.
primary database	The database that contains the data to be replicated to another database (the standby database) through a replication system. The primary database is the database that is the source of replicated data in a replication system. Sometimes called the active database. Contrast with **standby database**. See also **primary data**.
primary key	The column or columns whose data uniquely identify each row in a table.
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 also **primary database** and **standby site**.

primary table	A table used as a source for replication. Primary tables are defined in the primary database schema. See also **primary data** and **primary database**.
primary transaction	A transaction that is committed in the primary database and recorded in the primary database transaction log. See also **primary database**, **replicated transaction**, and **transaction log**.
quiesce	To cause a system to go into a state in which further data changes are not allowed. See also **quiescent**.
quiescent	In a replication system, a state in which all updates have been propagated to their destinations. Some Mirror Replication Agent and Replication Server commands require that you first quiesce the replication system. In a database, a state in which all data updates are suspended so that transactions cannot change any data and the data and log devices are stable. This term is interchangeable with quiesced and in quiesce. See also **quiesce**.
RASD	An abbreviation for Mirror Replication Agent System Database. Information in the RASD is used by the primary database to recognize database structure or schema objects in the transaction log.
RCL	An abbreviation for replication Command Language, the command language used to manage Replication Server.
RDBMS	An abbreviation for relational database management system, an application that manages and controls relational databases. Compare with **DBMS**. See also **relational database**.
relational database	A collection of data in which data is viewed as being stored in tables, which consist of columns (data items) and rows (units of information). Relational databases can be accessed by SQL requests. See also **SQL**.
replicated data	A set of data that is replicated from a primary database to a standby database by a replication system. See also **primary database**, **replication system**, and **standby database**.
replicated transaction	A primary transaction that is replicated from a primary database to a standby database by a transaction replication system. See also **primary database**, **primary transaction**, **standby database**, and **transaction replication**.
Mirror Replication Agent	An application that reads a primary database transaction log to acquire information about data-changing transactions in the primary database, processes the log information, and then sends it to a Replication Server for distribution to a standby database. See also **primary database** and **Replication Server**.

replication definition	A description of a table or stored procedure in a primary database, for which subscriptions can be created. The replication definition, maintained by Replication Server, includes information about the columns to be replicated and the location of the primary table or stored procedure. See also **Replication Server** and **subscription**.
Replication Server	The Sybase software product that provides the infrastructure for a robust transaction replication system. See also **Mirror Replication Agent**.
RSSD	An abbreviation for Replication Server System Database, which manages replication system information for a Replication Server. See also **Replication Server**.
replication system	A data processing system that replicates data from one location to another. Data can be replicated between separate systems at a single site, or from one or more local systems to one or more remote systems. See also **disk replication** and **transaction replication**.
rollback	An instruction to a database to back out of the changes requested in a unit of work (called a transaction). Contrast with **commit**. See also **transaction**.
route	A one-way message stream from a primary Replication Server to a replicate Replication Server. Routes carry data-changing commands (including those for RSSDs) and replicated functions (database procedures) between separate Replication Servers. See also **Replication Server**.
SQL	An abbreviation for Structured Query Language, a nonprocedural programming language used to process data in a relational database. ANSI SQL is an industry standard. See also **transaction**.
stable queue	A disk device-based, store-and-forward queue managed by Replication Server. Messages written into the stable queue remain there until they can be delivered to the appropriate process or standby database. Replication Server provides a stable queue for both incoming messages (the inbound queue) and outgoing messages (the outbound queue). See also **database connection**, **Replication Server**, and **route**.
standby data	The data managed by a standby database, which is the destination (or target) of a replication system. See also **data replication** and **standby database**.
standby database	A database that contains data replicated from another database (the primary database) through a replication system. The standby database is the database that receives replicated data in a replication system. Sometimes called the standby database. Contrast with **primary database**. See also **standby data**.

standby site	The location or facility at which standby data servers and standby databases are deployed to support disaster recovery, and normal business operations during scheduled downtime at the primary site. Sometimes called the alternate site or replicate site. Contrast with **primary site**. See also **standby database**.
subscription	A request for Replication Server to maintain a replicated copy of a table, or a set of rows from a table, in a standby database at a specified location. See also **replication definition** and **Replication Server**.
table	In a relational DBMS, a two-dimensional array of data or a named data object that contains a specific number of unordered rows composed of a group of columns that are specific for the table. See also **database**.
transaction	A unit of work in a database that can include zero, one, or many operations (including insert, update, and delete operations), and that is either applied or rejected as a whole. Each SQL statement that modifies data can be treated as a separate transaction, if the database is so configured. See also **SQL**.
transaction log	Generally, the log of transactions that affect the data managed by a data server. Mirror Replication Agent reads the transaction log to identify and acquire the transactions to be replicated from the primary database. See also **Mirror Replication Agent**, **primary database**, and **Replication Server**.
transaction replication	A data replication method that copies data-changing operations from a primary database transaction log to a standby database. See also **data replication** and **disk replication**.
transactional consistency	A condition in which all transactions in the primary database are applied in the standby database, in the same order that they were applied in the primary database.
WAN	An abbreviation for “wide area network,” a system of local-area networks (LANs) connected together with data communication lines. Contrast with **LAN**.

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