



Sun StorEdge™ Data Replicator Software With Oracle Databases Usage Guide

For Sun StorEdge 6920 Systems

Sun Microsystems, Inc.
www.sun.com

Part No. 819-3328-10 (v1)
November 2005, Revision A

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Overview

This document provides guidelines for using the Sun StorEdge™ Data Replication software in conjunction with Oracle® databases.

This chapter describes the Sun StorEdge Data Replicator software, discusses considerations in planning for its implementation, and explores a variety of its uses. This chapter contains the following sections:

- “About Sun StorEdge Data Replicator Software” on page 1
- “Sun StorEdge Data Replicator Features” on page 2
- “How Sun StorEdge Data Replicator Software Works” on page 3
- “Example Uses of Sun StorEdge Data Replicator Software” on page 9
- “Using Sun StorEdge Data Replicator Software With Oracle Software” on page 10

About Sun StorEdge Data Replicator Software

Sun StorEdge Data Replicator software is designed to enable you to replicate data in synchronous or asynchronous mode to local campus, metro, or remote data centers to protect critical data. The replication network can be either TCP/IP or Fibre Channel (FC) over public or private telecommunications infrastructures. This gives you the capability to replicate between sites located throughout the world and enables data to be written transparently to both primary or secondary sites either simultaneously or with a managed delay.

The Sun StorEdge Data Replicator software is a volume-level replication tool that protects your data. You can use this software to replicate disk volumes between physically separate primary and secondary Sun StorEdge 6920 systems in real time. The software is active while your applications, such as Oracle databases, access the data volumes, and it continuously replicates the data to the remote site.

As part of a disaster recovery and business continuance plan, the software enables you to keep up-to-date copies of critical applications at remote sites. You can also rehearse your data recovery strategy to fail applications over to remote sites. Later, you can update the remote site with any changes that occurred on the production data set during the rehearsal, as well as restore any data that was changed on the remote site as part of the rehearsal.

To help ensure that Oracle databases and Sun StorEdge Data Replicator software perform together as expected, Oracle provides a suite of tests, under the Oracle Storage Compatibility Program (OSCP). These tests are used to validate the compatibility of mirroring software solutions with Oracle databases. These tests were performed according to the Oracle approved scenarios with the Sun StorEdge Data Replicator software.

Sun StorEdge Data Replicator Features

The Sun StorEdge Data Replicator software has a number of features, listed in TABLE 1-1.

TABLE 1-1 Sun StorEdge Data Replicator Features and Functions

Feature	Functions
Enterprise-wide data protection	<ul style="list-style-type: none"> • Supports data center, campus, metro area network (MAN), and wide area network (WAN) replication.
Synchronous and asynchronous replication modes	<ul style="list-style-type: none"> • Synchronous mode provides zero data loss remote replication. • Asynchronous mode enables economical and long distance remote replication. • Both modes support both IP and FC links.
Write-order consistency across volumes	<ul style="list-style-type: none"> • Preserves write transaction order across remote volumes. • Protects against data corruption. • Enables remote volumes to be immediately used as restartable volumes in the event of a primary site failure.

TABLE 1-1 Sun StorEdge Data Replicator Features and Functions (Continued)

Feature	Functions
Fast start	<ul style="list-style-type: none">• Allows initialization of volume groups at the remote site by loading of data on the systems from previously shipped tape storage.• Enables configuration of large volumes at the remote site with inexpensive tape rather than requiring a full remote volume initialization over the replication network.
Legacy volume replication	<ul style="list-style-type: none">• Allows data from legacy heterogeneous storage to be replicated to comparable legacy volumes at remote sites.
Role reversal	<ul style="list-style-type: none">• Allows a secondary site to be assigned as primary.
Scripting interface	<ul style="list-style-type: none">• Enables a remote scripting client to be used to automate tasks.• Enables cron jobs to be used to replicate data between primary and secondary sites at night or during times of reduced utilization.
Multi-site support	<ul style="list-style-type: none">• Allows up to four simultaneous Ethernet or eight simultaneous FC replications to one or more Sun StorEdge 6920 systems with different replication sets. This enables one system to act as a secondary, or repository, for multiple primary systems.

How Sun StorEdge Data Replicator Software Works

The Sun StorEdge Data Replicator software replicates data from a primary volume to a secondary volume. The association between the primary and secondary volumes, and a corresponding replication bitmap at each site, make up a replication set. After the volumes in a replication set have been initially synchronized, the software ensures that the primary and secondary volumes contain the same data on an ongoing basis.

Note – Third-party applications can continue to access the primary volume while it is replicating, but not the secondary volume.

When replicating data, the software preserves write order consistency. That is, the software ensures that write operations to the secondary volume occur in the same order as the write operations to the primary volume. This ensures that the data on the secondary volume is consistent with data on the primary volume and does not compromise an attempt to recover the data if a disaster occurs at the primary peer.

Note – For the purposes of this document, a primary peer is one of a pair of physically separate Sun StorEdge 6920 systems on which the primary replication set resides. The primary peer copies user data to its counterpart, which is the remote, secondary peer. The terms *primary site* and *secondary site* are used to describe both the computer system and storage system at the physical primary and secondary sites. Peers can change roles through role reversal, such that the secondary site can be configured as the primary peer.

If you need to ensure write order consistency across multiple volumes, such as for an application that builds its database on multiple volumes, you can place multiple replication sets into a consistency group. A consistency group enables you to manage several replication sets as one. By using a consistency group, the software maintains write ordering for volumes in a group to ensure that the data on all secondary volumes is a consistent copy of the corresponding primary volumes.

The software transports data between the two Sun StorEdge 6920 systems by means of synchronous replication or asynchronous replication, using either an FC connection or a Gigabit Ethernet network link (replication link).

Note – The system does not provide built-in authentication or encryption for data traveling outside of your data center over a long-distance replication link. It is assumed that customers implementing remote replication strategies using multiple Sun StorEdge 6920 systems will replicate data over secure leased lines or use edge devices to provide encryption and authentication. For help setting up appropriate security, contact Sun Professional Services.

If there is a break in the network or if the secondary peer is unavailable, the software automatically switches to suspended mode, in which it ceases replication and tracks changes to the primary peer in the replication bitmap. When communication is re-established, the software uses the replication bitmap to resynchronize the volumes and returns to replicating the data.

The software can also restore data from a secondary volume to a primary volume by reversing the roles of the primary and secondary peers. Role reversal is a failover technique in which a primary peer failure causes the secondary peer to assume the role of the primary peer. The application software accesses the secondary volume directly until you can correct the failure at the primary peer.

About Replication Sets

A replication set includes the following:

- A volume residing on a Sun StorEdge 6920 system and a reference to a volume residing on another, physically separate Sun StorEdge 6920 system. One system is the primary peer, which copies the data, and the other system is the secondary peer, which is the recipient of the data.
- A replication bitmap for logging purposes.
- The communication mode between both systems.
- The role that the peer plays within the replication set, either as a primary or as a secondary peer.

The system administrator at each site must create and configure a replication set on each system. The replication set definition for the secondary peer must be equivalent to that of the replication set for the primary peer.

You can update the secondary volumes synchronously in real time or asynchronously using a store-and-forward technique. Typically, a primary volume is first explicitly copied to a designated secondary volume to establish matching contents. As applications write to the primary volume, the data replication software copies the changes from the primary volume to the secondary volume, keeping the two images consistent.

The replication set also includes the following:

- A replication bitmap volume on each system.

The replication bitmap tracks write operations and differences between the volumes. The primary volume's bitmap records write actions issued at the primary peer. The secondary peer's replication set also includes a replication bitmap in case you initiate a role reversal and the secondary peer becomes the primary peer. The replication bitmap defines the differences between the primary and secondary peers. This enables the software to resynchronize only the blocks that have changed since the last synchronization.
- If you choose asynchronous mode replication, an asynchronous queue is associated with each peer.

If the primary volume becomes unavailable, the secondary volume can assume the role of primary volume. This role reversal allows applications to continue their operations by using the newly designated primary volume. When the former primary volume is again available, you must synchronize it with the more recent data on the other volume to restore the functions of the replication set pair.

For more information on the operations you can perform on volumes, restrictions, other factors, and replication set properties, see the *Sun StorEdge 6920 System Administrator Guide for the Browser Interface Management Software*.

About Consistency Groups

To ensure write order consistency across multiple volumes, you can group multiple replication sets into a consistency group. A consistency group is a collection of replication sets that have the same group name, primary and secondary roles, and replication mode. Mixed groups, in which replication modes are asynchronous for one replication set and synchronous for another replication set, are not allowed.

Note – As with replication sets, the system administrator at each site must each create and configure a consistency group for the respective peers. The consistency group for the secondary peer must complement the consistency group for the primary peer.

When you perform an operation on a consistency group, the operation applies to all the replication sets, and consequently their volumes, in the consistency group. If you make a change to a consistency group, the change occurs on every replication set in a consistency group; if an operation fails on a single replication set in the consistency group, it fails on every replication set in the consistency group.

Note – Volume snapshot operations are the exception. You must create a snapshot of each replication set individually.

When you configure a consistency group, the system preserves write ordering among the volumes in the replication sets. Because you control the replication sets as a single unit, data replication operations are executed on every member of the consistency group. Write operations to the secondary volume occur in the same order as the write operations to the primary volume. By using a consistency group, the software maintains write ordering among volumes in a group to ensure that the data on each secondary volume is a consistent copy of the corresponding primary volume.

For more information on restrictions and other factors, see the *Sun StorEdge 6920 System Administrator Guide for the Browser Interface Management Software*.

About Replication Links

A replication link is a logical and physical connection between two Sun StorEdge 6920 systems that allows for data replication. A replication link transports data between the primary and secondary peers. This link transfers data as well as replication control commands. You can use both FC and Gigabit Ethernet ports for data replication. You must enable the same types of ports on both systems to establish the replication link.

Note – You can configure only two replication links at a time, and the replication links must both be on either FC ports or Gigabit Ethernet ports. You cannot mix port types.

For more information on replication links, see the *Sun StorEdge 6920 System Administrator Guide for the Browser Interface Management Software*.

About Replication Modes

The replication mode is a user-selectable property that defines the communication mode for a replication set. The software supports two modes of data replication:

- **Synchronous mode**

In synchronous mode replication, a write operation to the primary volume is not confirmed as complete until the remote volume has been updated. Synchronous replication forces the software to wait until the primary peer receives an acknowledgment of the receipt of the data from the secondary volume before returning to the application.

- **Asynchronous mode**

In asynchronous mode replication, data is written to the primary volume and to a local asynchronous queue. A write operation is confirmed as complete before the remote volume has been updated. Later, write operations that have accumulated in the asynchronous queue are forwarded in sequence to the remote peer. Asynchronous replication enables the data replication software to return to the peer as soon as the write operation has been completed on the primary volume and has been placed on a per-volume queue for the secondary peer. The secondary peer receives the queued requests in the order in which they were written. After the write operation has been completed at the secondary peer, notification is sent to the primary peer.

The asynchronous queue exists to absorb bursts of application writes. You can select how the asynchronous queue operates when it becomes full and causes application writes to wait for room in the queue:

- **Blocking mode** – If the asynchronous queue fills, all writes to the primary volume and replication writes to the secondary volume are delayed until the queue drains enough to allow for a write to occur. Blocking mode, which is the default option, ensures write ordering of the data to the secondary peer. If the asynchronous queue fills with the blocking option set, response time to the application might be affected. Write operations to the secondary volume must be acknowledged before being removed from the queue on the primary peer, so they can prevent, or block, further write operations to the queue until space is available.

- **Suspended mode** – If the asynchronous queue fills, the software discontinues data replication and no longer records writes in the queue. Instead, the software records data block changes in the replication bitmap. The application's writes are not blocked, but write ordering is lost when the software is in suspended mode. However, the application sees no significant degradation in response time. To resume replication, you must first synchronize the secondary volume with the primary volume.

Consider the following when you choose asynchronous mode replication:

- All the volumes in a consistency group share a single asynchronous queue.
- If you choose the suspend option, when the queue is full, the software switches to suspended mode. Write ordering is not preserved. However, application write operations are not impacted because of a full queue.
- If you choose the block option, and the queue becomes full, writes are blocked until the queue drains. The software maintains write ordering. However, application write operations are impacted.
- The minimum size of an asynchronous queue for a consistency group is 16 Mbytes.
- You must choose the proper queue size for your environment. If the asynchronous queue fills, subsequent write operations must wait to be placed in the queue. As a result, the application response time increases. To help improve the response time for the application, increase the asynchronous queue size based on its usage.

If you need to extend the size of the asynchronous queue, follow these steps:

- a. Place the replication set or consistency group into suspended mode.
 - b. Go to the replication set or consistency group Details page and use the pull-down menu to change the asynchronous queue size.
 - c. Initiate a synchronize operation for the replication set or consistency group to synchronize both peers and resume replication.
- You can limit when the queue is considered full by the number of queued disk blocks or length of time an entry is in the queue. To set asynchronous queue parameters, use the Create Replication Set wizard or make changes on the replication set or consistency group Details page.
 - Asynchronous mode accommodates bursts of write activity in which the write rate exceeds the replication link's bandwidth. The asynchronous queue must be sufficient in size to handle bursts of write traffic associated with the application peak write periods. A large queue can handle prolonged bursts of write activity, but this activity causes the secondary peer to become further out of synchronization with the primary peer.
 - If you add a replication set that is configured for asynchronous replication to a consistency group, that replication set's own queue is deleted.

- Because of the nature of an asynchronous queue, the secondary volume will always be somewhat out of date with the primary volume. How far out of date the secondary volume is compared with the primary volume depends on how much data there is in the asynchronous queue at the time, as well as on the latency of the link.

You can change the replication mode at any time during the life of a replication set. However, you must first place the replication set in suspended mode. If the replication set is a member of a consistency group, you must place the consistency group in suspended mode.

Note – If a replication set is a member of a consistency group, you cannot change the replication mode of the replication set. The replication set's attributes must match those of the consistency group.

Example Uses of Sun StorEdge Data Replicator Software

Sun StorEdge Data Replicator software enables you to improve business operations by replicating data sets to a remote and physically separate location. Below are two examples of how Sun StorEdge Data Replicator Software can be used to add value to your operations:

- **Business and data continuance** – Use remote replication to make a secondary site available as a primary site in the event of a disaster or unplanned outage at the primary site. Both synchronous and asynchronous replication can be used, selected by the distance between the replication sites and the amount of data loss that can be sustained in the event of an outage.
- **Content distribution** – Use remote replication to duplicate applications and data from a central core site to one or many remote sites for the purpose of updating information repositories or databases at those sites. An example could be product price lists that are distributed on a daily basis from a central corporate site to regional sites.

Using Sun StorEdge Data Replicator Software With Oracle Software

You can use the Oracle secondary (or standby) database for disaster recovery purposes. The secondary database is maintained by application of the archive redo logs generated at the primary database to the secondary database. With Oracle software, the database can automatically ship archive logs from the primary to the secondary and can apply the archive logs. However, the standby database cannot guarantee no loss of committed transactions; the current online log file information is lost in the standby database. In other words, if a disaster happens at the primary site, and you fail over to the secondary database, the secondary database may not contain all of the committed transactions.

Storage systems, such as the Sun StorEdge 6920 system, that can remotely replicate data offer two additional options for disaster recovery:

- **Remote replication of online logs for the Oracle secondary database** – If a disaster occurs at the primary site, you can use the replicated online redo logs to recover changes in the current logs.
- **Remote replication of the entire database, including data files and log files** – If a disaster occurs at the primary site, you can quickly fail over to the secondary site.

Depending on the mode of replication, both options can provide for either no loss of committed data (synchronous mode) or reduced loss of committed data (asynchronous mode).

When selecting a disaster recovery strategy, you need to choose between replicating either the entire database or just the online logs. The following factors may affect your decision:

- **Performance** – Replicating the entire database typically has a larger performance impact on the primary database, especially as the distance between the primary and secondary sites increases. This factor alone may lead you to choose to replicate only the online logs if you need to replicate over long distances, such as hundreds or thousands of miles.
- **Availability** – Replicating online logs provides better availability characteristics. If you replicate the entire database, any corruption on the primary database is propagated to the secondary database, whether the corruption is caused by the database, operating systems, storage systems, or users. The standby database can protect you from a wide variety of these failures by checking for consistency during redo application. The standby database can also be run with a delay to protect the database from user errors.

- **Failover time** – Failover is faster when you replicate the entire database because failover needs to wait only for crash recovery to be complete at the secondary site. When online logs are replicated, failover needs to wait for all logs not yet archived to be applied.

Overall, Oracle recommends replicating online logs as a better disaster recovery strategy in almost all situations.

Replicating Online Logs

When replicating online logs, the Sun StorEdge Data Replicator software replicates the log files from the primary peer to the secondary peer, as shown in FIGURE 1-1. If a disaster occurs at the primary site or a network failure occurs, the replicated online redo logs can be used to recover the secondary database to the last committed transaction. With synchronous mode, potential data loss can be reduced in the event of a disaster. With asynchronous mode, data loss might occur in the event of a disaster. If you replicate the online logs using asynchronous mode, you must put all of the online logs in a consistency group in order to preserve write ordering. The advantages of only replicating online logs are reduced cost and improved performance.

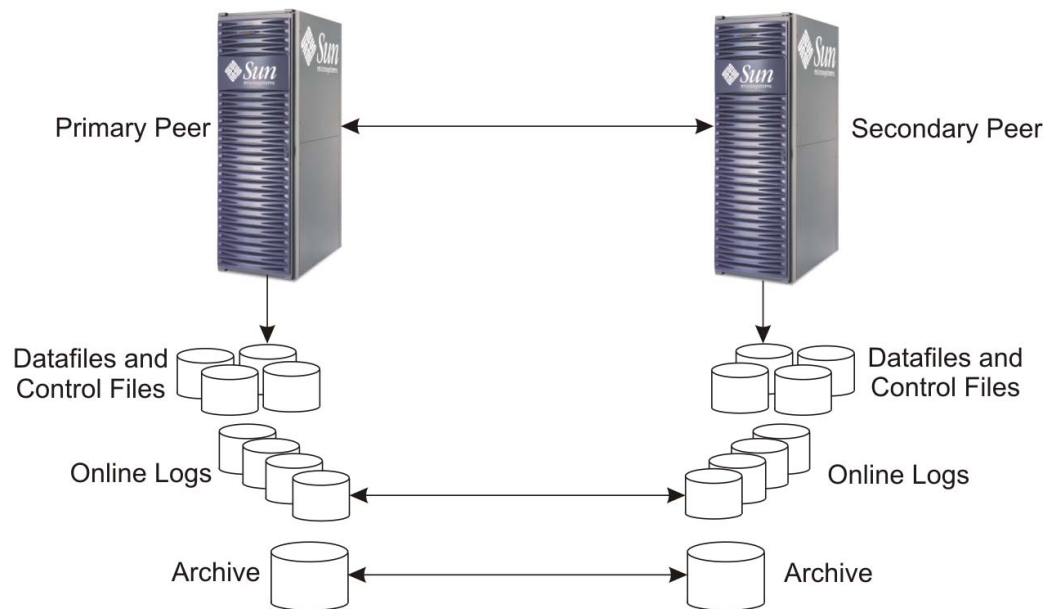


FIGURE 1-1 Replicating Online Logs for the Oracle Standby Database

Replicating the Entire Database

Using Sun StorEdge Data Replicator software, you can define multiple replication sets, each containing information such as index, data, rollback, and log files. If a disaster occurs at the primary site, you can accomplish the failover operation to the secondary site quickly to minimize the crash recovery time.

Note – If you place replication sets in a consistency group, all replication sets must have the same replication mode.

With synchronous mode, potential data loss can be reduced in the event of a disaster. With asynchronous mode, it is possible for some data to be lost. The advantage of replicating the entire database, as illustrated in FIGURE 1-2, is that the failover operation is relatively straightforward. The disadvantages are performance degradation, costliness of operation, and the propagation of any primary data corruption to the secondary volumes.

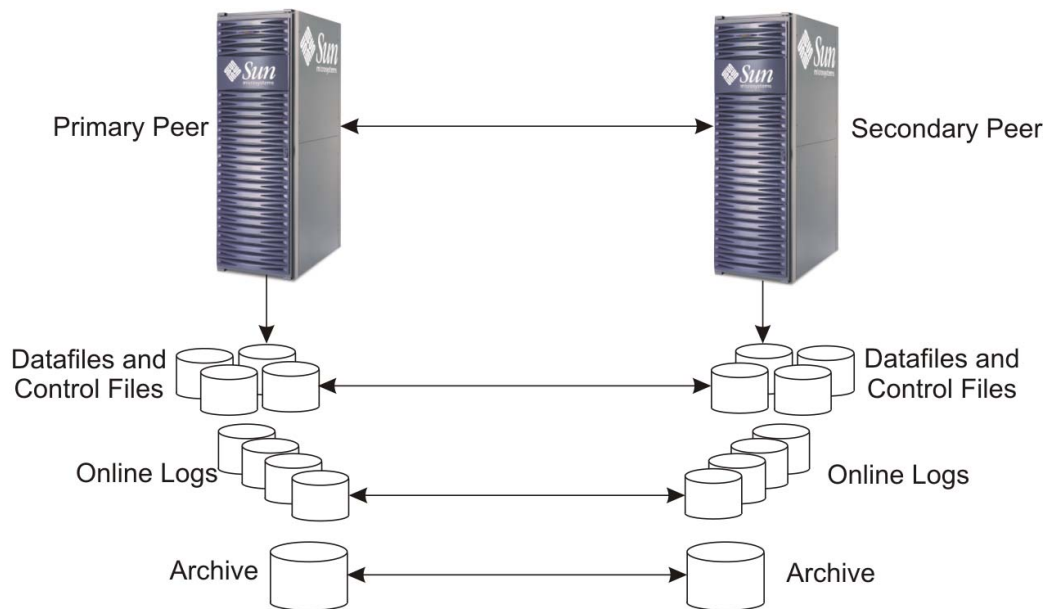


FIGURE 1-2 Replicating the Entire Oracle Database

Requirements, Planning, and Installation

This chapter describes system requirements and installation procedures for Sun StorEdge Data Replicator software and Oracle software, and it provides information on creating replicated volumes and replicating data. This chapter contains the following sections:

- “System Requirements” on page 13
 - “Configuring the Sun StorEdge Data Replicator Software” on page 14
 - “Installing Oracle” on page 22
 - “Replicating Data” on page 27
-

System Requirements

The following table lists the hardware and software requirements for running both the Sun StorEdge Data Replicator and Oracle database software.

Hardware	Sun StorEdge 6920 system
Software	Solaris™ 8 (update 4 or higher), Solaris 9, or Solaris 10 Operating Systems
For CLI interface	Remote scripting command-line interface (CLI)
For browser interface	One of the following: <ul style="list-style-type: none">• Mozilla 1.4 and above• Firefox 1.0• Microsoft Internet Explorer version 5.5 and above• Mozilla™ 1.4 and above

For further information, refer to the *Sun StorEdge 6920 System Release Notes*.

For additional information on the Sun StorEdge 6920 system, see the following documents, which are supplied with the software.

Description	Title	Part Number
Installation information	<i>Sun StorEdge 6920 System Getting Started Guide</i>	819-0117-nn
Release information	<i>Sun StorEdge 6920 System Release Notes</i>	819-4889-10
Man pages	sscs(1M)	N/A

Configuring the Sun StorEdge Data Replicator Software

To complete the configuration for remote replication, you must follow these general steps:

1. Determine the application replication requirements.
2. Register the feature licenses for Sun StorEdge Data Replicator software.
3. Configure both the primary and secondary volumes.
4. Record the World Wide Name (WWN) and IP addresses.
5. Enable the Fibre Channel (FC) or Gigabit Ethernet ports that you plan to use for replication on both the local and remote Sun StorEdge 6920 systems.
6. Use the Create Replication Set wizard to do one of the following:
 - Create a replication set or consistency group
 - Combine replication sets in a consistency group

You must make sure that the replication sets and consistency groups for both peers are configured identically.

The rest of this section describes each of these steps in detail.

Determining Application Replication Requirements

Before you start planning the remote replication configuration, you must fully understand your application requirements for consistency and the application recovery methods. First, you must decide which data needs to be replicated and the mode of replication to be used. A number of methods are available:

- Replication of volumes using a mix of synchronous and asynchronous modes according to the volumes' level of importance. This mode choice provides the most practical solution.
- Replication of all volumes in synchronous mode. This choice simplifies procedures because data at the primary and secondary sites is identical, apart from any data lost in transit during a failure. This method is reliable and can help reduce the risk of data loss. One disadvantage might be an increase in response time, especially for large data sets or long-distance replication.
- Replication of all volumes in asynchronous mode. This choice allows the possibility of lost transactions during system failures and might result in the database being inconsistent. The advantages are that it provides fast response and has the least impact on the response time of the primary application. The disadvantage is that there is a possibility of data loss at the secondary site after a primary site or network failure.

The database files can be grouped based on the requirements for their availability and the importance for the application recovery process. Suggested replication modes are shown in TABLE 2-1.

TABLE 2-1 Oracle File Entities and Suggested Replication Modes

Oracle File Entities	Access Method	Replication Mode
System tablespace and rollback tablespace	Raw volumes	Synchronous
Control files and archive logs	File system	Synchronous
Log files	Raw volumes	Synchronous
Data files	Raw volumes	Asynchronous
Index files	Raw volumes	Asynchronous
Temp files	Raw volumes	Asynchronous
Application binaries	File system	Not replicated

If the primary site becomes unavailable, the most important files required to bring the secondary site online in a consistent and up-to-date state are the system and rollback tablespace, the control files, and the archive logs. If consistent data, index,

and temporary volumes are available, it is possible to update the secondary database into a recent and consistent state. With the addition of log files, it is possible to completely update the database.

Registering the Feature Licenses for Sun StorEdge Data Replicator Software

Before you can use the Sun StorEdge Data Replicator software, you must obtain a feature license key and register feature licenses for each feature (synchronous and asynchronous) that you plan to use. The feature license grants you the right to use a specific amount of storage on a volume, and use that volume to replicate data to a remote site using synchronous or asynchronous communication. You must register a feature license on the local system and a separate feature license on the system at the remote site to which you plan to replicate volumes.

▼ To Add a Feature License Key and Register a Feature

1. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Administration > Licensing.**

The Feature License Summary page is displayed.

2. **Click Add.**

The Add Feature License page is displayed.

3. **In the Key field, enter the feature license key for the feature that you want to register.**

4. **Click OK.**

The feature is registered for use.

5. **Refer to the Feature License Summary page to see the total licensed storage amount and the number of licenses for the feature.**

Configuring Both the Primary and Secondary Volumes

Configure both the primary and secondary volumes as you would any other volumes, and make sure that they have identical configurations. The capacity of the volumes must be precisely the same. You must consider a number of factors and make a number of decisions before creating volumes. For more information on planning volumes, see the *Sun StorEdge 6920 System Administration Guide for the Browser Interface Management Software*.

To determine the volumes to be replicated using the remote replication software, you must balance remote accessibility and recoverability against capacity usage and I/O response time. Typically, for the Oracle database, you can include the following volumes in the remote replication configuration:

- For data that is constantly changing:
 - Online logs
 - Control files
 - Data files (typically multivolume)
 - Index files (typically multivolume)
 - Rollback segments (typically multivolume)
 - Archived logs
- For data that seldom changes or can be reconstructed:
 - Static tablespace data files
 - Temporary tablespace data files

Do not include the following as remote replication volumes:

- Spool files
- Paging volumes
- Oracle binary
- Other binary volumes

Create the following volumes on both the primary and secondary systems:

- A volume for the Oracle binary (not to be replicated)
- One or more volumes for the database data files
- A volume for online logs
- A volume for the archive logs, if replicating the entire database

For additional information on creating volumes and mapping initiators, refer to the *Sun StorEdge 6920 System Getting Started Guide*, the *Sun StorEdge 6920 System Administration Guide for the Browser Interface Management Software*, or the `SSCS(1M)` man page.

▼ To Create a Volume

1. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Volumes.**

The Volume Summary page is displayed.

2. **Click New.**

The New Volume wizard is displayed.

3. Follow the steps in the wizard.

Click the Help tab in the wizard for more information.

Recording the WWNs and IP Addresses

Before you can create replication sets and consistency groups, you must know the WWN of the Sun StorEdge 6920 systems, the WWN of the volumes, and the IP addresses of the local and remote ports. This section tells you how to obtain that information.

▼ To Display the WWN of Sun StorEdge 6920 Systems

The following steps must be performed on both the primary and secondary systems.

1. In the system's browser interface, click the Sun StorEdge 6920 Configuration Service > Physical Storage > Ports.

The Port Summary page is displayed.

2. Select the check box for the port for which you want to display information.

The Port Details page is displayed.

3. Go the Additional Information.

Click an item to see its Summary page.

Record the WWN of both the local and remote Sun StorEdge 6920 systems ports that you will use for replication.

▼ To Display Information About the Volumes

The following steps must be performed on both the primary and secondary systems.

1. In the system's browser interface, click the Sun StorEdge 6920 Configuration Service > Logical Storage > Volumes.

The Volume Summary page is displayed.

2. Select the check box for the volume for which you want to display information.

The Volume Details page is displayed.

3. Go the Additional Information.

Click an item to see its Summary page.

Record the WWN of the local and remote volumes that will make up the replication set.

▼ To Display Information About Gigabit Ethernet Ports

The following steps must be performed on both the primary and secondary systems.

1. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Physical Storage > Ports.**

The Port Summary page is displayed.

2. **Select the Gigabit Ethernet port for which you want to see information.**

The Gigabit Ethernet Port Details page is displayed.

3. **Go to Additional Information and click any item for more information associated with the selected port.**

The Summary page for the selected item is displayed.

Record the IP addresses of both the local and remote ports.

Enabling the FC or Gigabit Ethernet Ports

You can configure only two replication links at a time, and the replication links must both be on either FC ports or Gigabit Ethernet ports. You cannot mix port types.

If you use FC ports for data replication, you need not perform any other configuration tasks. However, you must configure any FC switches that you use to make the connection to the remote site for long-distance operations, and you must apply zone practices.

See the FC switch vendor's documentation for information about operating over long distances.

If you use Gigabit Ethernet ports, you must explicitly configure the ports to create the replication link.

▼ To Enable a FC or Gigabit Ethernet Port for Data Replication

The following steps must be performed on both the primary and secondary systems.

1. **In the system's browser interface, click the Sun StorEdge 6920 Configuration Service > Physical Storage > Ports.**

The Port Summary page is displayed.

2. **Click a port name.**

The Fibre Channel Port Details or Gigabit Ethernet Port Details page is displayed, depending on the type of port you select.

- 3. If the port is an FC port, click OK to confirm that you want to enable the port for replication.**

The port's replication status is displayed as Enabled.

- 4. If the port is a Gigabit Ethernet port, click Configure Replicating.**

The Configure Gigabit Ethernet Port Replication wizard is displayed.

- 5. Complete the steps in the wizard.**

For more information on planning, adding, and deleting replication links, see the *Sun StorEdge 6920 System Administration Guide for the Browser Interface Management Software*.

Creating Replication Sets and Consistency Groups

You must consider a number of factors and make a number of decisions before creating a replication set or consistency group. For more information on planning a replication set or consistency group see the *Sun StorEdge 6920 System Administration Guide for the Browser Interface Management Software*.

▼ To Create a Replication Set or a Consistency Group

- 1. In the system's browser interface, click Sun StorEdge Configuration Service > Logical Storage > Volumes.**

The Volume Summary page is displayed.

- 2. Click the name of a volume you want to replication to the remote peer.**

The Volume Details page for the selected volume is displayed.

- 3. Click Replicate.**

The Create Replication Set wizard is displayed.

- 4. Follow the steps in the wizard.**

Click the Help tab in the wizard for more information.

Combining Replication Sets in a Consistency Group

If you have already created a number of replication sets and then determined that you want to place them in a consistency group, do so as outlined in the following sample procedure. In this example, Replication Set A and Replication Set B are existing independent replication sets.

▼ To Combine Replication Sets in a Consistency Group

Follow these steps on both the primary and secondary peers.

1. **Create a temporary volume, or identify an unused volume in the same storage domain as Replication Sets A and B.**
2. **Determine the WWN of the remote peer.**
This information is on the Details page for either replication set.
3. **Select a temporary or unused volume from which to create Replication Set C, and launch the Create Replication Set wizard from the Details page for that volume.**
Creating Replication Set C is just a means to create a consistency group. You will delete this set later.
4. **Do the following in the Create Replication Set wizard:**
 - a. **Select a temporary or unused volume from which to create the replication set.**
 - b. **In the Replication Peer WWN field, type the WWN of the remote system.**
 - c. **In the Remote Volume WWN field, type all zeros. Then click Next.**
 - d. **Select the Create New Consistency Group option, and provide a name and description for Consistency Group G. Click Next.**
 - e. **Specify the replication properties and replication bitmap as prompted, confirm your selections, and click Finish.**

Note – It is not necessary to create complementary replication sets on the remote peer at this time.

5. **On the Details page for Replication Set A, click Add to Group to add the replication set to Consistency Group G.**
6. **On the Details page for Replication Set B, click Add to Group to add the replication set to Consistency Group G.**
7. **On the Details page for Replication Set C, click Delete to remove the replication set from Consistency Group G.**

Replication Set A and Replication Set B are no longer independent are now part of a consistency group.

Installing Oracle

The following information, which is provided as an overview of installing the Oracle binaries, uses Oracle 9i as an example. Your installation is likely to vary. See the *Oracle Installation Guide* for further installation details. You must perform these steps on both the primary and secondary systems, except where differences are noted.

Oracle Installation Considerations

Before you install the Oracle binaries, you should be aware of the following:

- You can use the path `/oracle/9.x.x` (where `x` is a version number) as the `ORACLE_HOME` environment variable. The software then creates various directories under `$ORACLE_HOME`. The `/bin` directory contains all binaries, and the `/rdbms/admin` directory contains all utility SQL files.
- The installation software automatically creates a default database named `starter`. You must assign a four-character `ORACLE_SID` system identifier (SID) name to the database.
- When the installation is complete, you can use the `dbassist` utility to create numerous Oracle databases on the server. The number of databases per server is restricted by resource availability.

▼ To Prepare for Oracle Installation

You must perform the following steps before you install the Oracle binaries.

1. **Add the following entries to the `/etc/system` file by using a text editor:**

```
set semsys:seminfo_semmni=100
set semsys:seminfo_semmns=256
set semsys:seminfo_semmns1=256
set shmsys:shminfo_shmmax=4294967295
set shmsys:shminfo_shmmmin=1
set shmsys:shminfo_shmmni=100
set shmsys:shminfo_shmseg=10
```

2. **Create the directory `/opt/bin`.**
3. **Create the group `oinstall`.**

4. Create the user `oracle` and attach the `oinstall` group to `oracle`.
5. Have a mount point ready and make `oracle` the owner.
6. Reboot the server.

▼ To Install Oracle Binaries

1. Log in to the server as user `oracle`.
2. Insert the Oracle 9.x Universal Install CD into the CD-ROM drive.
3. Accept the Oracle 9i Server Installation option and follow the instructions.

Distributing Data for Optimal Performance

You must decide whether you want to replicate the full database or only the online redo logs. From a performance perspective, it is recommended that you perform online redo logs replication and use the standby database at the secondary site.

Replicating Online Log Files

This choice assumes that the secondary site hosts the standby database. If the online redo files are multiplexed, use synchronous mode on all of the replication sets and consistency groups. If asynchronous mode is used, data loss might occur during disaster failover operations.

Replicating the Entire Database

You can also replicate the entire Oracle database, including data files, online log files, and control files. You can replicate the entire database either synchronously or asynchronously. Use separate volumes for redo logs, system data files, data, index, rollback segments, and archive logs. Although using synchronous mode for all of the volumes helps make failover operations easier, it has an impact on performance at the primary site.

Whether you use synchronous or asynchronous replication, replicate all data files, log files, and control files. You must include all log members, if logs are multiplexed. You can include just one control file, if the control file is also multiplexed. `Init.ora` files are not replicated.

If you use asynchronous replication, you must put the data files, online log files, and control files in the same consistency group to preserve write ordering. If you use asynchronous replication, you have two options for the archive logs:

- Not replicating archive logs. With this option, old backups might become invalid after failover.
- Replicating the archive logs in the same consistency group used to replicate data files, log files, and control files to preserve write ordering.

If you use synchronous replication, you also have two options for the archive logs:

- Not replicating archive logs. With this option, old backups might become invalid after failover.
- Replicating the archive logs synchronously. In this case, you can continue to use old backups.

Sample Oracle Configuration Files

You can use the Oracle configuration files shown in this section for both online log replication and entire database replication. All files are located in the `$ORACLE_HOME/network/admin` directory.

Any text in *italics* is a variable that you must supply:

- *Site-X-hostname* – Name of the host, where X is the primary or secondary site
- *sid* – System identifier
- *domain-name* – Domain for the primary site host

Primary Site

File listener.ora

```
LISTENER =
  (DESCRIPTION_LIST =
    (DESCRIPTION =
      (ADDRESS_LIST =
        (ADDRESS = (PROTOCOL = IPC) (KEY = sid) )
      )
      (ADDRESS_LIST =
        (ADDRESS = (PROTOCOL = TCP) (HOST = Site-primary-hostname) (PORT = 1521))
      )
    )
  )

SID_LIST_LISTENER =
  (SID_LIST =
    (SID_DESC =
      (GLOBAL_DBNAME = sid.domain name)
      (ORACLE_HOME = /oral/oracle/product/9.x.x)
      (SID_NAME = sid)
    )
  )
```

File tnsnames.ora

```
sid.domain name =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = TCP) (HOST = Site-primary-hostname) (PORT = 1521))
    )
    (CONNECT_DATA =
      (SERVICE_NAME = sid.domain name)
    )
  )

sid.domain name =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = TCP) (HOST = Site-secondary-hostname) (PORT = 1521))
    )
    (CONNECT_DATA =
      (SID = sid)
    )
  )
```

File sqlnet.ora

```
NAMES.DEFAULT_DOMAIN = domain name
automatic_ipc=off
```

Secondary Site

file listener.ora

```
LISTENER =
  (DESCRIPTION_LIST =
    (DESCRIPTION =
      (ADDRESS_LIST =
        (ADDRESS = (PROTOCOL = TCP) (HOST = Site-secondary-hostname) (PORT = 1521))
      )
    )
  )

SID_LIST_LISTENER =
  (SID_LIST =
    (SID_DESC =
      (GLOBAL_DBNAME = sid.domain name)
      (ORACLE_HOME = /ora1/oracle/product/9.x.x)
      (SID_NAME = sid)
    )
  )
```


File tnsnames.ora

```
sid.domain name =
(DESCRIPTION =
(AADDRESS_LIST =
(AADDRESS = (PROTOCOL = TCP) (HOST = Site-secondary-hostname) (PORT = 1521)
)
(CONNECT_DATA =
(SERVICE_NAME = sid.domain name)
)
)

sid.domain name =
(DESCRIPTION =
(AADDRESS_LIST =
(AADDRESS = (PROTOCOL = TCP) (HOST = Site-primary-hostname) (PORT = 1521)
)
(CONNECT_DATA =
(SID_NAME = sid.domain-name)
)
)
```

File sqlnet.ora

```
NAMES.DEFAULT_DOMAIN = domain name
automatic_ipc=off
```

Replicating Data

After you have the replication software configured and the database installed and configured at both the primary and secondary sites, you can begin replicating data. You have two choices for performing the initial replication of the secondary peer:

- You can replicate the secondary peer from the primary peer over the IP or FC network.
- If you want to minimize data replication I/O traffic when you set up a copy of the data on the remote peer, you can synchronize data using a backup tape.

Both procedures are detailed in this section.

▼ To Replicate Data From the Primary Volume to a Secondary Volume

1. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**

The Replication Set Summary page is displayed.

2. **Select the replication set or a consistency group that you want to replicate on the remote peer.**

The Replication Set Details or Consistency Group Details page is displayed.

3. **If you want to synchronize the data on the volumes for both peers, follow these steps:**

- a. **Click Resume.**

The system displays the Resume Replication window.

- b. **Select the type of synchronization you want:**

- If you want to copy known differences rather than the entire volume, select Normal synchronization.
- If you want to initiate a full volume-to-volume copy operation, select Full synchronization.

- c. **Click OK.**

4. **If you want to place the replication set or consistency group into suspended mode, click Suspend.**

The system displays the Suspend Replication window.

5. **If you want to suspend replication and track changes between volumes into the replication bitmap, click Normal.**

Note – If the replication set is in suspended mode, the Normal option is unavailable.

6. **Click OK.**

7. **To resume replication, click Resume.**

▼ To Synchronize Data Using a Backup Tape

- 1. In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**
The Replication Set Summary page is displayed.
- 2. Select a replication set or a consistency group that you want to replicate to a remote peer.**
The Replication Set Details or Consistency Group Details page is displayed.
- 3. Make sure that you have the autosynchronization option disabled so that you can start the synchronization operation manually when you have the backup tape ready.**
- 4. Click Suspend and select Fast Start.**
- 5. Have the system administrator for the secondary peer load the backup tape of the primary volume onto the secondary peer.**
- 6. Click OK.**
- 7. To resume replication, click Resume.**

Using Sun StorEdge Data Replicator Software With Oracle Software

This chapter provides details on how to use Sun StorEdge Replicator software with Oracle software for disaster recovery. It contains the following sections:

- “Determining Failover Procedures” on page 31
 - “About Link Failures” on page 32
 - “Failing Over to the Secondary Site When Using a Standby Database” on page 34
 - “Failing Over to the Secondary Site When Replicating the Entire Database” on page 51
 - “Switching Back After Failover When Replicating the Entire Database” on page 52
-

Determining Failover Procedures

As part of your disaster recovery plan, you should determine when to fail over to the secondary site and the procedures for doing so. If you switch to the secondary site, you have to perform steps both in switching to it and in switching back to the primary site later. Document the time it takes for each step and related factors so that when a failure occurs, you can determine the best approach for the current scenario.

Calculate the normal time needed to do the following:

- Reboot the server
- Fail over to the secondary site, which requires you to do the following:
 - Shut down the databases at both sites (if running)
 - Reverse the roles of the primary and secondary peers
 - Mount the necessary file systems

- Start the application (if only replicating online logs) or start, recover, and roll forward the application (if replicating the entire database)
 - Switch users from the primary site to the secondary site
 - Switch back to the primary site, which requires you to do the following:
 - Resume replication from the secondary site (now the primary peer, after the role reversal step from above) to the primary site (now the secondary peer) to synchronize the two sites
 - Shut down the application on the secondary site
 - Unmount any file systems on the secondary site
 - Reverse the roles of the secondary and primary sites to their original states and resume replication
 - Mount the necessary files systems
 - Start the application (if only replicating online logs) or start, recover, and roll forward the application (if replicating the entire database)
 - Switch users from the secondary site to the primary site to resume user operations on the primary site
-

About Link Failures

The Sun StorEdge Data Replicator software automatically retries temporary transmission errors for both synchronous and asynchronous modes. If the transmission errors occur for a long period of time in asynchronous mode, the transmitted data continues to be queued, even though it is not sent to the secondary peer. When the asynchronous disk queue fills up (or has reached a high watermark that you have specified), a user-specified option determines whether the queue goes into blocking mode or suspended mode. Redundant links between peers are recommended to enable the system to transparently fail over to a working link if one of the links fails.

If appropriate for your environment, you can enable the autosynchronization option. Autosynchronization is an alternative to manual synchronization. The autosynchronization option supports both replication sets and consistency groups. If you enable the autosynchronization option on the primary peer, the software synchronizes the volumes on both peers and resumes replication as soon as possible. For example, if a network link fails and causes the software to cease replication, synchronization occurs when the link is re-established.

If autosynchronization is enabled, the software attempts to synchronize the secondary volume with the primary volume if the replication set or consistency group is placed in suspended mode because of a link failure or system shutdown.

The software does not perform an autosynchronization operation if the replication set or consistency group was placed in suspended mode through either of the following methods:

- You manually set the replication set or consistency group to suspended mode.
- The asynchronous queue exceeded its limits while the replication link was active.

If a network failure continues and you are using synchronous replication and do not have autosynchronization enabled, you must resynchronize as described in the following procedure.

▼ To Resynchronize the Secondary Site From the Primary Site

1. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**

The Replication Set Summary page is displayed.

2. **Select the replication set or a consistency group that you want to resynchronize on the remote peer.**

The Replication Set Details page or Consistency Group Details pages is displayed.

3. **If you want to synchronize the data on the volumes for both peers, follow these steps:**

- a. **Click Resume.**

The system displays the Resume Replication window.

- b. **Select the type of synchronization you want:**

- If you want to copy known differences rather than the entire volume, select Normal synchronization.
- If you want to initiate a full volume-to-volume copy operation, select Full synchronization.

- c. **Click OK.**

Failing Over to the Secondary Site When Using a Standby Database

If you are using an Oracle standby database and only replicating online logs, you need to construct a `create control file` script on the primary site and copy it to the secondary database site. In addition, whenever you change online redo log structures or datafile structures, you need to construct a new script and copy it to the secondary site.

If the primary site is not accessible, business users must connect to the alternative secondary site to continue operations. Use the following procedures to use the secondary site:

1. Shut down the databases.
2. Fail over to the secondary site.

After you perform these steps, the secondary site is the failover site.

▼ To Construct a Create Control File Script

1. Issue the following Oracle command to construct a `create control file` script:

```
SQL> alter database backup control file to trace
```

▼ To Shut Down the Databases

1. At the primary and secondary sites, shut down the production database (if it is running) by using one of the following Oracle commands:

```
SQL> shutdown immediate  
SQL> shutdown abort
```


▼ To Fail Over to the Secondary Site

1. At the secondary site, suspend replication into normal mode so that changes can be applied to the primary site later.
 - a. In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.
The Replication Set Summary page is displayed.
 - b. Select the replication set or a consistency group that you want to suspend.
The Replication Set Details page or Consistency Group Details pages is displayed.
 - c. To place the replication set or consistency group into suspended mode, click Suspend, select Normal, and click OK.
2. If you are replicating a file system, such as the online redo logs, run the `fsck(1M)` command for the replicated volumes and then mount them as follows:

```
# fsck replicated-volume  
# mount mount-point
```

3. Activate the standby database as follows:
 - a. Prepare a new `init.ora` file for activating the standby database as the primary. This `init.ora` file should use a different location for the control file.
 - b. Modify the `create control file` script so that all data files point to the data files of the standby database, and all log files point to replicated online logs. Make sure that the `create control file` command uses the `noresetlogs` option.
 - c. Start the database in the `nomount` state.

```
SQL> startup pfile=path/init.ora nomount
```

- d. Mount the standby database.

```
SQL> alter database mount standby database
```

- e. Recover the database. If the recovery asks for more logs, supply the correct logs for recovery.

```
SQL> alter database recover automatic standby database
```

f. Open the database as the production database.

```
SQL> alter database open
```

Switching Back After Failover When Replicating Online Logs

After failover, there are two categories of methods for switching back to the primary site if you are replicating online logs, as opposed to the entire database:

- **Reversing roles** – Continue to run the production database at the secondary site, and start to maintain a standby database at the primary site.
- **Falling back directly** – Fall back to run the production database at the primary site.

The following sections describe these procedures:

- “Reversing Roles by Copying Files” on page 36
- “Reversing Roles Using Tape Backup and Copying Logs From the Secondary Site” on page 38
- “Reversing Roles Via Recovery” on page 40
- “Falling Back Directly Using a Database Copy” on page 42
- “Falling Back Directly Using a Restored Backup” on page 45
- “Falling Back Directly Using Recovery” on page 48

Reversing Roles by Copying Files

If the replication set at the primary peer is damaged or has questionable data integrity, you can copy all of the files from the secondary peer to the primary peer by reversing roles and performing a full synchronization. This procedure assumes that you have failed over to the secondary site using the steps in “To Fail Over to the Secondary Site” on page 35.

▼ To Reverse Roles

1. **At the secondary site, shut down the database (if it is running) by using one of the following Oracle commands:**

```
SQL> shutdown immediate
SQL> shutdown abort
```

2. **Unmount the volumes if necessary.**
3. **Follow these steps first on the secondary and then on the primary site:**
 - a. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**
The Replication Set Summary page is displayed.
 - b. **Select the replication set or consistency group whose role you want to change.**
The Replication Set Details or Consistency Group Details page is displayed.
 - c. **Click Suspend, select Normal, and click OK to place the replication set or consistency group into suspended mode.**
 - d. **In the Role Properties section of the Details page, select the new role from the Role menu for the replication set or consistency group.**
 - e. **Click Save.**

When you have completed these steps on the secondary site, it is now the primary peer and provides the original data. When you have completed these steps on the primary site, it is ready to receive data.

▼ To Copy Files From the Secondary to the Primary Site

1. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**
The Replication Set Summary page is displayed.
2. **Select the replication set or consistency group you want to replicate.**
The Replication Set Details or Consistency Group Details page is displayed.
3. **Click Resume.**
The system displays the Resume Replication window.
4. **Select Full synchronization.**
5. **Click OK.**

▼ To Create the Standby Database on the Primary Site

1. On the primary site, create an `init.ora` file for the new standby database to be created.
2. On the secondary site, issue the following Oracle command:

```
SQL> alter database create standby controlfile
```

3. Copy the standby control file from the secondary site to the primary site.
4. Use the `name convert init.ora` parameter or `rename` command to point the database to the correct data file and log files.
5. Mount and recover the standby database.

Reversing Roles Using Tape Backup and Copying Logs From the Secondary Site

With this procedure, you do not need to copy files across the network in the process of restoring a local full backup at the primary site. Instead, you must restore a local full backup and recover the database at the primary site. This procedure assumes you have failed over to the secondary site using the steps in “To Fail Over to the Secondary Site” on page 35

This process includes the following tasks:

1. Restoring the backup at the primary site
2. Reversing roles
3. Copying the log files from the secondary to the primary site
4. Creating a standby database at the primary site

The rest of this section describes each of these tasks.

▼ To Restore the Backup at the Primary Site

- **Restore the full backup of the database.**

Make sure that you use a backup that was taken before the disaster, particularly if logs were replicated asynchronously or if the replication was suspended at the time of the disaster. In these cases, the backup must have been taken before the primary database generated the last archive log replicated to the standby site. When in doubt, always use an older full backup.

▼ To Reverse Roles

1. **At the secondary site, shut down the database by using one of the following Oracle commands:**

```
SQL> shutdown immediate
SQL> shutdown abort
```

2. **Unmount the volumes if necessary.**
3. **Follow these steps first on the secondary and then on the primary site:**
 - a. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**
The Replication Set Summary page is displayed.
 - a. **Select the replication set or consistency group whose role you want to change.**
The Replication Set Details or Consistency Group Details page is displayed.
 - b. **Click Suspend, select Normal, and click OK to place the replication set or consistency group into suspended mode.**
 - c. **In the Role Properties section of the Details page, select the new role from the Role menu for the replication set or consistency group.**
 - d. **Click Save.**

When you have completed these steps on the secondary site, it is the primary peer and provides the original data. When you have completed these steps on the primary site, it is ready to receive data.

▼ To Copy Files From the Secondary to the Primary Site

1. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**
The Replication Set Summary page is displayed.
2. **Select the replication set or consistency group you want to replicate.**
The Replication Set Details or Consistency Group Details page is displayed.
3. **Click Resume.**
The system displays the Resume Replication window.
4. **Select Full synchronization.**
5. **Click OK.**

▼ To Create a Standby Database on the Primary Site

1. On the primary site, create an `init.ora` file for the new standby database to be created.
2. On the secondary site, issue the following Oracle command:

```
SQL> alter database create standby controlfile
```

3. Copy the standby control file from the secondary site to the primary site.
4. Use the `name convert init.ora` parameter or `rename` command to point the database to the correct data file and log files.
5. Mount and recover the standby database.

Reversing Roles Via Recovery

An alternative method of reversing roles requires neither copying the database across the network nor restoring backups. However, you can only use it under the following three conditions:

- The online logs are replicated using synchronous mode.
- Replication was not suspended when the disaster occurred.
- No one started the database at the primary site after the disaster.

This procedure assumes you have failed over to the secondary site using the steps in “To Fail Over to the Secondary Site” on page 35.

This process includes the following tasks:

1. Preparing to create a standby database at the primary site
2. Reversing roles
3. Performing a full synchronization of the logs to the primary site
4. Creating a standby database at the primary site and recovering the standby database

The rest of this section describes each of these tasks.

▼ To Prepare to Create a Standby Database

1. On the secondary site, create the standby database control file by issuing the following Oracle command:

```
SQL> alter database create standby controlfile
```

2. On the primary site, make sure the database is shut down.
3. Make sure that, after failover, no one has either opened the database or mounted the database and performed any recovery. You can check the `alter` file to see whether these operations have occurred.
4. Copy the standby database control file from the secondary site.
5. Create a new `init.ora` file for the standby database to be created.

▼ To Reverse Roles

1. At the secondary site, shut down the database by using one of the following Oracle commands:

```
SQL> shutdown immediate  
SQL> shutdown abort
```

2. Unmount the volumes if necessary.
3. Follow these steps first on the secondary and then on the primary site:
 - a. In the system's browser interface, click **Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets**.
The Replication Set Summary page is displayed.
 - b. Select the replication set or consistency group whose role you want to change.
The Replication Set Details or Consistency Group Details page is displayed.
 - c. Click **Suspend**, select **Normal**, and click **OK** to place the replication set or consistency group into suspended mode.
 - d. In the **Role Properties** section of the **Details** page, select the new role from the **Role** menu for the replication set or consistency group.

e. **Click Save.**

When you have completed these steps on the secondary site, it is the primary peer and provides the original data. When you have completed these steps on the secondary site, it is ready to receive data.

▼ **To Copy Logs From the Secondary to the Primary Site**

1. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**

The Replication Set Summary page is displayed.

2. **Select the replication set or consistency group you want to replicate.**

The Replication Set Details or Consistency Group Details page is displayed.

3. **Click Resume.**

The system displays the Resume Replication window.

4. **Select Full synchronization.**

5. **Click OK.**

▼ **To Create and Recover a Standby Database on the Primary Site**

1. **Use the name `convert init.ora` parameter or `alter database rename file` command in Oracle to point the database to the correct data files.**
2. **Mount and recover the database, using only the archived logs that you copied using full synchronization from the secondary site.**

Falling Back Directly Using a Database Copy

This procedure involves copying the database from the secondary to the primary site and assumes you have failed over to the secondary site using the steps in "To Fail Over to the Secondary Site" on page 35.

This process includes the following tasks:

1. Making a backup of the database at the secondary site and copying it to the primary site
2. Reversing roles
3. Performing a full synchronization of the logs to the primary site
4. Reversing roles again

5. Falling back and recovering the database

The rest of this section describes each of these tasks.

▼ To Make a Backup of the Database

1. **On the secondary site, make a cold or hot full backup of the database.**
2. **Copy the full backup from the secondary site to the primary site. Overwrite the old production datafiles on the primary site.**

▼ To Reverse Roles

1. **On the secondary site, shut down the database by using one of the following Oracle commands:**

```
SQL> shutdown immediate
SQL> shutdown abort
```

2. **Unmount the volumes if necessary.**
3. **Follow these steps first on the secondary and then on the primary site:**
 - a. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**
The Replication Set Summary page is displayed.
 - b. **Select the replication set or consistency group whose role you want to change.**
The Replication Set Details or Consistency Group Details page is displayed.
 - c. **Click Suspend, select Normal, and click OK to place the replication set or consistency group into suspended mode.**
 - d. **In the Role Properties section of the Details page, select the new role from the Role menu for the replication set or consistency group.**
 - e. **Click Save.**

When you have completed these steps on the secondary site, it is the primary peer and provides the original data. When you have completed these steps on the secondary site, it is ready to receive data.

▼ To Copy Logs From the Secondary to the Primary Site

1. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**
The Replication Set Summary page is displayed.

2. **Select the replication set or consistency group you want to replicate. These should be the sets or groups where the online logs and archive logs reside.**

The Replication Set Details or Consistency Group Details page is displayed.

3. **Click Resume.**

The system displays the Resume Replication window.

4. **Select Full synchronization.**

5. **Click OK.**

▼ To Reverse Roles Again

- **Follow the procedures in “To Reverse Roles” on page 43 above to return the primary site to its original role as the provider of data to the secondary site.**

▼ To Fall Back and Recover the Database

1. **Copy the current control file from the secondary site to the primary site. Overwrite the old production control files on the primary sites.**
2. **Start up the database in mount mode using the original production `init.ora` file.**

```
SQL> startup pfile=path/init.sid.ora mount
```

3. **Query the `v$datafile` and `v$logfile` to make sure they point to the correct data files and log files. Rename those files to the correct location if necessary.**
4. **Recover the database, supplying only the archive logs that were synchronized from the secondary site.**

```
SQL> alter database recover
```

5. **Open the database.**

```
SQL> alter database open
```

Falling Back Directly Using a Restored Backup

An alternative method for falling back directly to the primary site involves restoring a backup on the primary peer and recovering the database all the way to the current state. This is useful when the database is large and would therefore take too long to copy over the network.

This procedure assumes you have failed over to the secondary site using the steps in “To Fail Over to the Secondary Site” on page 35, and that you back up the control file on the primary site using the Oracle command `alter database backup controlfile to location`.

This process includes the following tasks:

1. Restoring the backup at the primary site
2. Reversing roles
3. Performing a full synchronization of the archive logs to the primary site
4. Recovering the primary site
5. Performing a full synchronization of the online logs and new archive logs to the primary site
6. Reversing roles again
7. Falling back and recovering the database

The rest of this section describes each of these tasks.

▼ To Restore the Backup at the Primary Site

- **Restore the full backup of the database at the primary site.**

Make sure that you use a backup that was taken before the disaster occurred, particularly if logs were replicated asynchronously or if the replication was suspended at the time of the disaster. In these cases, the backup must have been taken before the primary database generated the last archive log replicated to the standby site. When in doubt, always use an older full backup.

▼ To Reverse Roles

1. **On the secondary site, shut down the database (if it is running) by using one of the following Oracle commands:**

```
SQL> shutdown immediate
SQL> shutdown abort
```

2. **Unmount the volumes if necessary.**
3. **Follow these steps first on the secondary and then on the primary site:**
 - a. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**
The Replication Set Summary page is displayed.
 - b. **Select the replication set or consistency group whose role you want to change.**
The Replication Set Details or Consistency Group Details page is displayed.
 - c. **Click Suspend, select Normal, and click OK to place the replication set or consistency group into suspended mode.**
 - d. **In the Role Properties section of the Details page, select the new role from the Role menu for the replication set or consistency group.**
 - e. **Click Save.**
When you have completed these steps on the secondary site, it is the primary peer and provides the original data. When you have completed these steps on the secondary site, it is ready to receive data.

▼ **To Copy Archive Logs From the Secondary to the Primary Site**

1. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**
The Replication Set Summary page is displayed.
2. **Select the replication set where the archive logs reside.**
The Replication Set Details page is displayed.
3. **Click Resume.**
The system displays the Resume Replication window.
4. **Select Full synchronization.**
5. **Click OK.**

▼ **To Recover the Primary Site**

1. **Restore the backup control file.**
2. **Start up the database in mount mode using the original production `init.ora` file.**

```
SQL> startup pfile=path/init.sid.ora mount
```

3. Issue the following Oracle command to recover the database:

```
SQL> recover database using backup controlfile until cancel
```

Recover the database until it has applied all the archive logs synchronized from the secondary site.

4. After the recovery is completed, shut down the database by using one of the following Oracle commands:

```
SQL> shutdown immediate  
SQL> shutdown abort
```

▼ **To Copy Online and New Archive Logs From the Secondary to the Primary Site**

1. In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.

The Replication Set Summary page is displayed.

2. Follow these steps for each replication set in which the online logs and any new archive logs reside:

a. Select the replication set you want to replicate.

The Replication Set Details or Consistency Group Details page is displayed.

b. Click Resume.

The system displays the Resume Replication window.

c. Select Full synchronization.

d. Click OK.

▼ **To Reverse Roles Again**

- **Follow the procedures in “To Reverse Roles” on page 45 to return the primary site to its original role as the provider of data to the secondary site.**

▼ **To Fall Back and Recover the Database**

1. Copy the `create control file` script from the secondary site.

Edit it if necessary so that it points to the correct data files and control files.

2. Start up the database in `nomount` mode using the original production `init.ora` file.

```
SQL> startup pfile=path/init.sid.ora nomount
```

3. Create the control file.
4. Issue the following Oracle command to recover the database and supply archive logs if necessary:

```
SQL> recover database
```

5. Open the database.

```
SQL> alter database open
```

Falling Back Directly Using Recovery

This procedure for direct fallback requires neither copying the database across the network nor restoring backups. However, you can use it only under the following three conditions:

- The online logs are replicated using synchronous mode.
- Replication was not suspended when the disaster occurred.
- No one started the database at the primary site after the disaster.

This procedure assumes you have failed over to the secondary site using the steps in “To Fail Over to the Secondary Site” on page 35.

This process includes the following tasks:

1. Generating a create control file
2. Reversing roles
3. Performing a full synchronization of the online and archive logs to the primary site
4. Reversing roles again
5. Falling back and recovering the database

The rest of this section describes each of these tasks.

▼ To Generate a Create Control File

1. On the secondary site, issue the following Oracle command:

```
SQL> alter database backup control file to trace
```

2. On the secondary and primary sites, shut down the database by using one of the following Oracle commands:

```
SQL> shutdown immediate  
SQL> shutdown abort
```

3. Make sure that, after failover, no one has either opened the database or mounted the database and performed any recovery. You can check the `alter` file to see whether these operations have occurred.

▼ To Reverse Roles

1. On the secondary site, shut down the database (if it is running) by using one of the following Oracle commands:

```
SQL> shutdown immediate  
SQL> shutdown abort
```

2. Unmount the volumes if necessary.
3. Follow these steps first on the secondary and then on the primary site:
 - a. In the system's browser interface, click **Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets**.
The Replication Set Summary page is displayed.
 - b. Select the replication set or consistency group whose role you want to change.
The Replication Set Details or Consistency Group Details page is displayed.
 - c. Click **Suspend**, select **Normal**, and click **OK** to place the replication set or consistency group into suspended mode.
 - d. In the **Role Properties** section of the **Details** page, select the new role from the **Role** menu for the replication set or consistency group.

e. Click Save.

When you have completed these steps on the secondary site, it is the primary peer and provides the original data. When you have completed these steps on the secondary site, it is ready to receive data.

▼ **To Copy Online and Archive Logs From the Secondary to the Primary Site**

- 1. In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**

The Replication Set Summary page is displayed.

- 2. Follow these steps for each replication set in which the online logs and any new archive logs reside:**

- a. Select the replication set you want to replicate.**

The Replication Set Details or Consistency Group Details page is displayed.

- b. Click Resume.**

The system displays the Resume Replication window.

- c. Select Full synchronization.**

- d. Click OK.**

▼ **To Reverse Roles Again**

- **Follow the procedures in “To Reverse Roles” on page 45 to return the primary site to its original role as the provider of data to the secondary site.**

▼ **To Fall Back and Recover the Database**

- 1. Copy the `create control file` script from the secondary site to the primary site.**

Edit it if necessary so that it points to the correct data files and log files. Make sure the script uses the `noresetlogs` option.

- 2. Start up the database in `nomount` mode using the original production `init.ora` file.**

```
SQL> startup pfile=path/init.sid.ora nomount
```

- 3. Create the control file.**

4. Issue the following Oracle command to recover the database and use only the archive logs synchronized from the secondary site:

```
SQL> recover database
```

5. Open the database.

```
SQL> alter database open
```

Failing Over to the Secondary Site When Replicating the Entire Database

If the primary site is not accessible, business users must connect to the alternative secondary site to continue operations. Use the following procedures to use the secondary site:

1. Shut down the databases.
2. Fail over to the secondary site.

After you perform these steps, the secondary site is the failover site.

▼ To Shut Down the Databases

1. At the primary and secondary sites, shut down the production database (if it is running) by using one of the following Oracle commands:

```
SQL> shutdown immediate  
SQL> shutdown abort
```

▼ To Fail Over to the Secondary Site

1. At the secondary site, suspend replication into normal mode so that changes can be applied to the primary site later.

- a. In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.
The Replication Set Summary page is displayed.
 - b. Select the replication set or a consistency group that you want to suspend.
The Replication Set Details page or Consistency Group Details pages is displayed.
 - c. To place the replication set or consistency group into suspended mode, click Suspend, select Normal, and click OK.
2. If you are replicating a file system, such as the online redo logs, run the `fsck(1M)` command for the replicated volumes and then mount them as follows:

```
# fsck replicated-volume  
# mount mount-point
```

3. Recover the database at the secondary site and open it as a production database as follows:
 - a. Start the database in `mount` mode.

```
SQL> startup pfile=path/initsid.ora mount
```

- b. Open the database as the production database.

```
SQL> alter database open
```

Switching Back After Failover When Replicating the Entire Database

The following procedures apply to configurations in which the entire database is replicated from the primary to the secondary site. See “Distributing Data for Optimal Performance” on page 23 for more information on synchronous and asynchronous options.

After the primary site is repaired, you can fall back to the primary site in either of the following ways:

- **Direct fallback** – Copy the database from the secondary site to the primary site and use the primary site as the production site.

- **Reverse role** – Establish the primary site as the secondary database and continue to run the production database at the secondary site.

Both methods require copying the database from the secondary site to the primary site.

The following sections describe these procedures:

- “Failing Over From the Primary to the Secondary Site” on page 53
- “Falling Back Directly Using a Database Copy” on page 54
- “Reversing Roles Using a Database Copy” on page 55

Failing Over From the Primary to the Secondary Site

If a disaster occurs at the primary site, follow the procedures in “Failing Over to the Secondary Site When Replicating the Entire Database” on page 51 to fail over to the secondary site.

If the database was replicated synchronously and replication was enabled at the time of the disaster, then no committed data is lost after failover. If the database was replicated asynchronously, or if replication was suspended at the time of the disaster, it is possible that some committed data is lost after failover.

If the archive logs are not replicated, take a full backup after failover and discard any old archive logs. If the archive logs are replicated, you must be very careful when using past archive logs. There are two cases to consider:

- Both the database and the archive logs are replicated synchronously. You must always maintain one current production database, and always use archive logs generated on the production database.
- Both the database and the archive logs are replicated asynchronously, within the same consistency group. You must again always maintain one current production database, and always use archive logs generated by the production database. In addition, you should avoid copying archive logs between primary and secondary sites, and only use archived logs from the consistency group.

If replication is suspended at the time of the disaster, the secondary database may not be valid. Crash recovery may fail if you try to open an invalid secondary database. Even if crash recovery appears to succeed, the invalid secondary database may display data corruption later. Thus, never open an invalid secondary database. If you are not sure whether the secondary database is invalid, assume that it is not valid until it is synchronized with the primary peer.

Falling Back Directly Using a Database Copy

The tasks in this process are the same for synchronous and asynchronous replication:

1. Reversing roles
2. Copying all of the data files, log files, and control files to the primary site using either full synchronization or normal synchronization (to copy only known differences)
3. Mounting the database on the primary site
4. Reversing roles again
5. Opening the database on the primary site

The rest of this section describes each of these tasks.

▼ To Reverse Roles

1. **On the secondary site, shut down the database (if it is running) by using one of the following Oracle commands:**

```
SQL> shutdown immediate
SQL> shutdown abort
```

2. **Unmount the volumes if necessary.**
3. **Follow these steps first on the secondary and then on the primary site:**
 - a. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**
The Replication Set Summary page is displayed.
 - b. **Select the replication set or consistency group whose role you want to change.**
The Replication Set Details or Consistency Group Details page is displayed.
 - c. **Click Suspend, select Normal, and click OK to place the replication set or consistency group into suspended mode.**
 - d. **In the Role Properties section of the Details page, select the new role from the Role menu for the replication set or consistency group.**
 - e. **Click Save.**

When you have completed these steps on the secondary site, it is the primary peer and provides the original data. When you have completed these steps on the secondary site, it is ready to receive data.

▼ To Copy Data Files, Log Files, and Control Files to the Primary Site

1. **In the system's browser interface, click Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets.**

The Replication Set Summary page is displayed.

2. **Follow these steps for each replication set or consistency group in which the data files, log files, and control files reside:**

- a. **Select the replication set or consistency group you want to replicate.**

The Replication Set Details or Consistency Group Details page is displayed.

- b. **Click Resume.**

The system displays the Resume Replication window.

- c. **Select either Full or Normal synchronization.**

Full will copy all of the files back to the primary site. Normal will copy only known changes between the two back to the primary site.

- d. **Click OK.**

▼ To Mount the Database on the Primary Site

- **If necessary, mount the database on the primary site and rename data files and log files to the correct file path.**

▼ To Reverse Roles Again

- **Follow the procedures in “To Reverse Roles” on page 54 to return the primary site to its original role as the provider of data to the secondary site.**

▼ To Open the Database

- **Open the database as the production database on the primary site using the following Oracle command:**

```
SQL> alter database open
```

Reversing Roles Using a Database Copy

The tasks in this process are the same for synchronous and asynchronous replication:

1. Reversing roles

2. Copying all of the data files, log files, and control files to the primary site using either full synchronization or normal synchronization (to copy only known differences)
3. Starting up the database again on the secondary site, which has now become the production site

▼ To Reverse Roles

1. On the secondary site, shut down the database (if it is running) by using one of the following Oracle commands:

```
SQL> shutdown immediate
SQL> shutdown abort
```

2. Unmount the volumes if necessary.
3. Follow these steps first on the secondary and then on the primary site:
 - a. In the system's browser interface, click **Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets**.
The Replication Set Summary page is displayed.
 - b. Select the replication set or consistency group whose role you want to change.
The Replication Set Details or Consistency Group Details page is displayed.
 - c. Click **Suspend**, select **Normal**, and click **OK** to place the replication set or consistency group into suspended mode.
 - d. In the **Role Properties** section of the **Details** page, select the new role from the **Role** menu for the replication set or consistency group.
 - e. Click **Save**.
When you have completed these steps on the secondary site, it is the primary peer and provides the original data. When you have completed these steps on the secondary site, it is ready to receive data.

▼ To Copy Data Files, Log Files, and Control Files to the Primary Site

1. Click the **Sun StorEdge 6920 Configuration Service > Logical Storage > Replication Sets**.
The Replication Set Summary page is displayed.
2. Follow these steps for each replication set or consistency group in which the data files, log files, and control files reside:

- a. **Select the replication set or consistency group you want to replicate.**

The Replication Set Details page is displayed.

- b. **Click Resume.**

The system displays the Resume Replication window.

- c. **Select either Full or Normal synchronization.**

Full will copy all of the files back to the primary site. Normal will copy only known changes between the two back to the primary site.

- d. **Click OK.**

▼ To Open the Database

- **Open the database as the production database on the secondary site using the following Oracle command:**

```
SQL> alter database open
```


Glossary

Definitions obtained from the Storage Networking Industry Association (SNIA) Dictionary are indicated with “(SNIA)” at the end. For the complete SNIA Dictionary, go to www.snia.org/education/dictionary.

- asynchronous queue** In the context of data replication, a queue used to store writes that are to be replicated to the remote site. After the writes have been put into the queue, the writes are acknowledged to the application and then forwarded to the remote site as network capabilities permit. The asynchronous queue is a persistent queue, so in the event of a disaster at the primary site, the data in the asynchronous queue is not lost.
- asynchronous replication** A form of data replication in which application write operations are written to the primary site and to the asynchronous queue on the primary site. The asynchronous queue forwards queued writes to the secondary site as network capabilities permit. The write operations to the primary site are confirmed, regardless of when, or whether, they are replicated successfully to the secondary site. Deferring the secondary copy removes long-distance propagation delays from the I/O response time. See also synchronous replication.
- autosynchronization** An option enabled at the primary site that attempts to synchronize replication sets or consistency groups whenever a link is established. With autosynchronization, synchronization continues even if there are link errors, for example.
- consistency group** A collection of replication sets grouped together to ensure write order consistency across all the replication sets' primary volumes. An operation on a consistency group applies to all the replication sets within the consistency group, and consequently their volumes.
- data replication** A disaster recovery and business continuance method in which a primary volume at the local site and a secondary volume at a remote site contain the same data on an ongoing basis, thereby protecting user data.

- Fast Start operation** An option of the suspend operation and the procedure in which a method such as a backup tape is used to copy data from the primary volume to the secondary volume. This procedure is used to avoid the initial step in which you send the primary volume's data over the physical link. For example, network bandwidth might justify a Fast Start procedure. See also resume operation and suspend operation.
- FC** See Fibre Channel (FC).
- FC port** See Fibre Channel (FC) port.
- FC switch** See Fibre Channel (FC) switch.
- Fibre Channel (FC)** A set of standards for a serial I/O bus capable of transferring data between two ports at up to 100 MBytes/second, with standards proposals to go to higher speeds. Fibre Channel supports point to point, arbitrated loop, and switched topologies. Fibre Channel was completely developed through industry cooperation, unlike SCSI, which was developed by a vendor and submitted for standardization after the fact. (SNIA)
- Fibre Channel (FC) port** A port on the I/O panel that connects data hosts, external storage, or internal storage to the Sun StorEdge 6920 system. See also host port and storage port.
- Fibre Channel (FC) switch** A networking device that can send packets directly to a port associated with a given network address in a Fibre Channel storage area network (SAN). Fibre Channel switches can be used to expand the number of data host or external storage device connections. Each switch is managed by its own management software.
- full synchronization** A resume operation in which a complete volume-to-volume copy occurs. Unlike a normal resume operation, in which a copy of differences between the primary and secondary volumes occurs, a full synchronize operation copies the entire contents of the volume. The system performs a full synchronize operation the first time you resume data replication on a replication set. See resume operation and synchronization.
- initiator** A system component that initiates an I/O operation over a Fibre Channel (FC) network. If allowed by FC fabric zoning rules, each host connection within the FC network has the ability to initiate transactions with the storage array. Each host in the FC network represents a separate initiator, so if a host is connected to the system through two host bus adapters (HBAs), the system identifies two different initiators (similar to multi-homed, Ethernet-based hosts). In contrast, when multipathing is used in round-robin mode, multiple HBAs are grouped together, and the multipathing software identifies the group of HBAs as a single initiator.

legacy volume	An entire logical unit number (LUN) on an external storage array that you can use in specific ways as if it were a local volume, while preserving the user data on that external storage array. You can apply the system's data services to a legacy volume; however, you cannot extend a legacy volume.
OSCP	Oracle Storage Compatibility Program. A program that is designed to test the compatibility of storage vendor technologies by providing a test kit with which the integrity of the Oracle database can be validated with snapshot copies.
primary peer	One of a pair of physically separate systems on which the primary replication set resides. The primary peer copies user data to its counterpart, which is the remote, secondary peer.
primary volume	The volume that contains the original user data that the primary peer replicates to the secondary peer.
remote scripting CLI client	A command-line interface (CLI) that enables you to manage the system from a remote management host. The client communicates with the management software through a secure out-of-band interface, HTTPS, and provides the same control and monitoring capability as the browser interface. The client must be installed on a host that has network access to the system.
replication	See data replication.
replication bitmap	The bitmap that tracks changes to the primary volume. Writes issued to the primary peer are noted in the replication bitmap. The replication set at the secondary peer also includes a replication bitmap that tracks changes if a role reversal assigns the secondary volume the role of primary.
replication link	A logical connection associated with a Gigabit Ethernet port that transports data and replication control commands between primary and secondary sites. The Gigabit Ethernet ports at both sites must be enabled for data replication and be configured with the remote site's IP information.
replication peer	One of a pair of complementary components that are on physically separate systems. For example, user data is copied to a remote system, which is the counterpart, or remote peer, of the system on which that user data resides.
replication set	A local volume paired with reference to a single remote volume on a remote peer. A replication set works in conjunction with an identically configured replication set on the remote peer to provide an instance of replication. The local volume within a replication set is associated with a replication bitmap and, depending on the set's attributes, with an asynchronous queue.
resume operation	In the context of data replication, a synchronization operation to establish an identical copy of the primary volume's user data on the secondary volume. The data is synchronized when replication occurs. Synchronization can be initiated by either the user or the system. See also autosynchronization, suspend operation, and synchronization.

reverse synchronization	See role reversal.
role reversal	In the context of data replication, a procedure in which the secondary host is assigned the role of primary host within an established replication set, and the primary volume is updated with the contents of the secondary volume. Role reversal is a failover technique used when the primary site fails and for disaster rehearsal.
secondary peer	One of a pair of physically separate systems on which the secondary replication set resides. The secondary peer is the recipient of user data from its counterpart, which is the primary peer.
secondary volume	The remote counterpart of the primary volume. The secondary volume is the replicated copy of the primary volume. You can map or create a volume snapshot of a secondary volume. You cannot read from or write to a secondary volume unless it is in scoreboard mode or you change its role to primary.
suspend operation	In the context of data replication, an operation in which replication set or consistency group activity is temporarily stopped, and an internal bitmap tracks write operations to the volume rather than sending the write operations over the physical link to the secondary volume. This method tracks write operations that have not been remotely copied while access to the secondary peer is interrupted or impaired. The software uses this replication bitmap to reestablish data replication through an optimized update synchronization rather than through a complete volume-to-volume copy. See also Fast Start operation and resume operation.
synchronization	The act of aligning or making entries be equivalent at a specified point in time. (SNIA).
synchronous replication	A replication technique in which data must be committed to storage at both the primary site and the secondary site before a write to the primary volume is acknowledged. See also asynchronous replication.
thin-scripting client	See remote scripting CLI client.
volume	A logically contiguous range of storage blocks allocated from a single pool and presented by a disk array as a logical unit number (LUN). A volume can span the physical devices that constitute the array, or it can be wholly contained within a single physical disk, depending on its virtualization strategy, size, and the internal array configuration. The array controller makes these details transparent to applications running on the attached server system.
World Wide Name (WWN)	A unique identifier for a port, initiator, virtual disk, or volume, assigned by the system. The WWN of an object does not change throughout its lifetime and is never reused to name another object.

- write order consistency** Preservation of write ordering across all volumes in a consistency group or in replication sets.
- write ordering** The process by which write operations that are directed to the secondary volume occur in the same order as write operations to the primary volume.
- WWN** See World Wide Name (WWN).
- zone** A collection of Fibre Channel N_Ports and/or NL_Ports (that is, device ports) that are permitted to communicate with each other via the fabric. (SNIA)

