IBM TotalStorage DS4000 Storage Manager Version 9

Copy Services User's Guide

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IBM

Copy Services User's Guide

> **Note:**
>
> Before using this information and the product it supports, be sure to read the general information under "Notices" on page 181.

Contents

Figures

Tables

About this document

This document provides information about setting up, installing, configuring, and working with the three IBM® TotalStorage® DS4000 premium features that assist with copy services: FlashCopy®, VolumeCopy, and the Enhanced Remote Mirroring option (also referred to as Remote Mirror Option). These features are used with DS4000 IBM Storage Manager software. Use this guide to accomplish the following tasks:

- Determine the hardware and software that are required to install the copy services features
- Install, enable, and activate the IBM DS4000 FlashCopy feature
- Install, enable, and activate the IBM DS4000 VolumeCopy feature
- Install, enable, and activate the IBM DS4000 Enhanced Remote Mirroring option
- Troubleshoot hardware and software problems

Notes:

1. Depending on which version of Storage Manager you are using, the SMclient instructions in this document might vary slightly from the actual menu paths in the SMclient software GUI.

2. The VolumeCopy premium feature is only supported in DS4000 Storage Manager version 8.4 and higher.

3. Enhanced Remote Mirroring, Remote Mirror, and Remote Mirroring are used interchangeably throughout this document, the online client, and online help system to refer to remote mirroring functionality.

Who should read this document

This guide is intended for system administrators who are responsible for operating and maintaining storage systems, with an emphasis on disaster prevention and recovery.

Important: Before you install premium features, make sure that you have purchased the premium feature keys necessary for those features you want to install and consult the following documentation:

DS4000 Storage Manager readme file for your operating system
Read this text file first. Updated readme files contain important configuration information that supersedes the information in this document. To access the most recent DS4000 Storage Manager readme file for your operating system, complete the following steps.

1. Go to the following Web site:

   www-1.ibm.com/servers/storage/support/disk/

2. Click the link for your storage subsystem (for example, **DS4800**).

3. When the subsystem support page opens, click the **Download** tab, then click the **Storage Manager, firmware, HBA and tools (including readmes)** link.

4. When the download page opens, click the **Storage Mgr** tab. A table displays.

5. In the table, find the row that contains the listing for your operating system, then click on the corresponding **v9.1x** link under the **Current Versions and Readmes** column.

DS4000 Storage Manager installation and support guides

The following Storage Manager installation and support guides describe how to set up your host operating system for the DS4000 storage subsystem, how to install the DS4000 Storage Manager software, and how to configure storage:

- *IBM DS4000 Storage Manager Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux*
- *IBM DS4000 Storage Manager Installation and Support Guide for AIX, HP-UX, Solaris, and Linux on POWER*

You can download these documents from the following Web site:

www.ibm.com/shop/publications/order/

DS4000 installation task overview

Table 1 provides a sequential list of many installation and configuration tasks that are common to most DS4000 configurations. When you install and configure your DS4000 storage subsystem, refer to this table to find the documentation that explains how to complete each task.

See also: The *DS4000 Storage Server and Storage Expansion Enclosure Quick Start Guide* provides an excellent overview of the installation process.

Table 1. Where to find DS4000 installation and configuration procedures

	Installation task	Where to find information or procedures
1	Plan the installation	• DS4000 Storage Manager Concepts Guide
		• DS4000 Storage Manager Installation and Support Guide for AIX, HP-UX, Solaris and Linux on POWER
		• DS4000 Storage Manager Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux
		• DS4100 Storage Server Installation, User's, and Maintenance Guide
		• DS4300 Fibre Channel Storage Server Installation and User's Guide
		• DS4400 Fibre Channel Storage Server Installation and Support Guide
		• DS4500 Fibre Channel Storage Server Installation and Support Guide
		• DS4800 Storage Subsystem Installation, User's, and Maintenance Guide
2	Mount the DS4000 storage subsystem in the rack	• DS4800 Installation, User's, and Maintenance Guide
		• DS4400 and DS4500 Rack Mounting Instructions
		• DS4300 Rack Mounting Instructions
		• DS4100 Installation, User's and Maintenance Guide
3	Mount the DS4000 EXP storage expansion unit in the rack	• DS4000 EXP100 Storage Expansion Unit Installation, User's and Maintenance Guide
		• DS4000 EXP700 and EXP710 Storage Expansion Enclosures Installation, User's, and Maintenance Guide
		• FAStT EXP500 Installation and User's Guide

Table 1. Where to find DS4000 installation and configuration procedures (continued)

	Installation task	Where to find information or procedures
4	Route the storage expansion unit Fibre Channel cables	• DS4100 Fibre Channel Cabling Instructions • DS4300 Fibre Channel Cabling Instructions • DS4400 Fibre Channel Cabling Instructions • DS4500 Fibre Channel Cabling Instructions • DS4800 Installation, User's, and Maintenance Guide
5	Route the host server Fibre Channel cables	• DS4100 Fibre Channel Cabling Instructions • DS4300 Fibre Channel Cabling Instructions • DS4400 Fibre Channel Cabling Instructions • DS4500 Fibre Channel Cabling Instructions • DS4800 Installation, User's, and Maintenance Guide
6	Power up the subsystem	• DS4100 Storage Server Installation, User's, and Maintenance Guide • DS4300 Fibre Channel Storage Server Installation and User's Guide • DS4400 Fibre Channel Storage Server Installation and Support Guide • DS4500 Fibre Channel Storage Server Installation and Support Guide • DS4800 Storage Subsystem Installation, User's, and Maintenance Guide
7	Configure DS4000 network settings	• DS4100 Storage Server Installation, User's, and Maintenance Guide • DS4300 Fibre Channel Storage Server Installation and User's Guide • DS4400 Fibre Channel Storage Server Installation and Support Guide • DS4500 Fibre Channel Storage Server Installation and Support Guide • DS4800 Storage Subsystem Installation, User's, and Maintenance Guide
8	Zone the fabric switch (SAN-attached only)	• DS4000 Storage Manager Installation and Support Guide for AIX, HP-UX, Solaris and Linux on POWER • DS4000 Storage Manager Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux • DS4000 Storage Manager Copy Services Guide (describes switch zoning for the Remote Mirror Option) • See also the documentation provided by the switch manufacturer

Table 1. Where to find DS4000 installation and configuration procedures (continued)

	Installation task	Where to find information or procedures
9	Install DS4000 Storage Manager software on the management station	• DS4000 Storage Manager Installation and Support Guide for AIX, HP-UX, Solaris and Linux on POWER • DS4000 Storage Manager Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux • DS4000 Storage Manager online help (for post-installation tasks)
10	Install host software (failover drivers) on host server	
11	Start DS4000 Storage Manager	
12	Set the DS4000 Storage Manager clock	
13	Set the DS4000 Storage Manager host default type	
14	Verify DS4000 subsystem health	• DS4100 Storage Server Installation, User's, and Maintenance Guide • DS4300 Fibre Channel Storage Server Installation and User's Guide • DS4400 Fibre Channel Storage Server Installation and Support Guide • DS4500 Fibre Channel Storage Server Installation and Support Guide • DS4800 Storage Subsystem Installation, User's, and Maintenance Guide
15	Enable DS4000 Storage Manager premium feature keys	**Copy Services premium features** 　　DS4000 Storage Manager Copy Services Guide **FC/SATA Intermix premium feature** 　　DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview **Storage Partitioning (and general premium features information)** 　　• DS4000 Storage Manager Concepts Guide 　　• DS4000 Storage Manager Installation and Support Guide for AIX, HP-UX, Solaris and Linux on POWER 　　• DS4000 Storage Manager Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux
16	Configure arrays and logical drives	• DS4000 Storage Manager Installation and Support Guide for AIX, HP-UX, Solaris and Linux on POWER • DS4000 Storage Manager Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux • DS4000 Storage Manager online help
17	Configure host partitions	
18	Verify host access to DS4000 storage	

How this document is organized

Chapter 1, "Introduction," on page 1 provides information on how to enable, view, and disable the premium features.

Chapter 2, "Overview of FlashCopy," on page 13 provides information about the FlashCopy feature, how to enable the feature, plan, create, and reuse FlashCopy logical drives, and how to perform some common FlashCopy tasks.

Chapter 3, "Overview of VolumeCopy," on page 57 provides information about the VolumeCopy feature, how to use the Create Copy wizard and the Copy Manager to copy, backup, and restore data.

Chapter 4, "Managing VolumeCopy," on page 73 provides information to help you manage your VolumeCopies. It also provides information about how to re-copy, stop, or remove a VolumeCopy, modify the attributes of a logical drive, view the status of a VolumeCopy operation, and determine what logical drives are involved in a VolumeCopy operation.

Chapter 5, "Troubleshooting VolumeCopy," on page 85 provides information about troubleshooting some of the more common problems encountered when you use the VolumeCopy feature.

Chapter 6, "Overview of the Enhanced Remote Mirroring option," on page 91 provides an introduction to the Remote Mirror Option and describes the hardware and software requirements for using the Remote Mirror Option. It also provides information about configuration types, describes how the Remote Mirror Option interfaces with other premium features (such as Storage Partitioning and FlashCopy logical drives), and provides a hardware and software checklist to ensure that all the requirements are met before you install and configure your systems.

Note: Enhanced Remote Mirroring, Remote Mirror Option, and Remote Mirroring are used interchangeably to refer to the remote mirroring option functionality.

Chapter 7, "Installing hardware and software for the Enhanced Remote Mirroring option," on page 111 provides information about preparing the site and instructions for installing key hardware and software components to run the Remote Mirror Option.

Chapter 8, "Using the Enhanced Remote Mirroring option," on page 135 provides step-by-step instructions for enabling and activating the Remote Mirror Option, creating a mirror relationship, and maintaining a mirror relationship.

Chapter 9, "Disaster recovery," on page 147 provides a number of scenarios about how the Remote Mirror Option can help prevent data loss, and assist with the recovery of critical data if a disaster or unrecoverable error occurs.

Chapter 10, "Troubleshooting the Enhanced Remote Mirroring option," on page 155 provides information for troubleshooting hardware and software components, and describes the events that might be logged when using the Remote Mirror Option.

Appendix A, "Upgrading controller firmware," on page 169 describes the procedure that you must follow to upgrade controller firmware to ensure that the Remote Mirror Option works properly.

Appendix B, "Additional DS4000 documentation," on page 171 provides a bibliography of additional documentation.

"Notices" on page 181 provides product notices and trademark information.

Notices used in this document

This document contains the following notices designed to highlight key information:

- **Notes:** These notices provide important tips, guidance, or advice.
- **Important:** These notices provide information that might help you avoid inconvenient or problem situations.
- **Attention:** These notices indicate possible damage to programs, devices, or data. An attention notice is placed just before the instruction or situation in which damage could occur.

Getting information, help, and service

If you need help, service, or technical assistance or just want more information about IBM products, you will find a wide variety of sources available from IBM to assist you. This section contains information about where to go for additional information about IBM and IBM products, what to do if you experience a problem with your system, and whom to call for service, if it is necessary.

Before you call

Before you call, make sure that you take these steps to try to solve the problem yourself:

- Check all cables to make sure that they are connected.
- Check the power switches to make sure that the system is turned on.
- Use the troubleshooting information in your system documentation, and use the diagnostic tools that come with your system.
- Check for technical information, hints, tips, and new device drivers at the IBM support Web sites that are listed in this section.
- Use an IBM discussion forum on the IBM Web site to ask questions.

You can solve many problems without outside assistance by following the troubleshooting procedures that IBM provides in the online help or in the documents that are provided with your system and software. The information that comes with your system also describes the diagnostic tests that you can perform. Most servers, operating systems, and programs come with information that contains troubleshooting procedures and explanations of error messages and error codes. If you suspect a software problem, see the information for the operating system or program.

Using the documentation

Information about your IBM system and preinstalled software, if any, is available in the documents that come with your system. This includes printed books, online documents, readme files, and help files. See the troubleshooting information in your system documentation for instructions for using the diagnostic programs. The troubleshooting information or the diagnostic programs might tell you that you need additional or updated device drivers or other software.

Web sites

At the following Web sites, you can find the most up-to-date information about DS4000 storage subsystems and DS4000 Storage Manager, including documentation and the most recent software, firmware, and NVSRAM downloads.

DS4000 Fibre Channel storage subsystems
Find the latest information about all of the DS4000 storage subsystems:

http://www-1.ibm.com/servers/storage/disk/ds4000/

IBM TotalStorage products
Find information about all IBM TotalStorage products:

www.storage.ibm.com/

IBM product service information
Find service information for your IBM products, including supported options:

www.ibm.com/pc/support/

IBM @server
Find information about xSeries® and pSeries® eServers:

xSeries: www.ibm.com/eserver/xseries/

pSeries: www.ibm.com/servers/eserver/support/pseries/index.html

IBM IntelliStation®
Find information about IntelliStation:

www.ibm.com/pc/intellistation/

DS4000 technical support
Find DS4000 readme files, downloads, hints and tips, documentation, parts information, HBA and Fibre Channel support:

www-1.ibm.com/servers/storage/support/disk/

Premium feature activation
Enable a premium feature by using this online tool:

www-912.ibm.com/PremiumFeatures/jsp/keyInput.jsp

IBM publications center
Find IBM publications:

www.ibm.com/shop/publications/order/

If you click **Profile** from the support page, you can create a customized support page. The support page has many sources of information and ways for you to solve problems, including how to:
- Diagnose problems, using the IBM Online Assistant
- Download the latest device drivers and updates for your products
- View Frequently Asked Questions (FAQ)
- View hints and tips to help you solve problems
- Participate in IBM discussion forums
- Set up e-mail notification of technical updates about your products

For the latest information about operating system and HBA support, clustering support, storage area network (SAN) fabric support, and Storage Manager feature support, see the IBM TotalStorage DS4000 Interoperability Matrix at the following Web site:

www-1.ibm.com/servers/storage/disk/ds4000/interop-matrix.html

Software service and support

Through the IBM Support Line, for a fee, you can get telephone assistance with usage, configuration, and software problems with xSeries servers, IntelliStation workstations and appliances. For information about which products are supported by Support Line in your country or region, go to the following Web site:

www.ibm.com/services/sl/products/

For more information about Support Line and other IBM services, go to the following Web site:

www.ibm.com/services/

For support telephone numbers, go to the following Web site:

www.ibm.com/planetwide/

Hardware service and support

You can receive hardware service through IBM Integrated Technology Services or through your IBM reseller, if your reseller is authorized by IBM to provide warranty service.

For support telephone numbers, go to the following Web site:

www.ibm.com/planetwide/

In the U.S. and Canada, hardware service and support is available 24 hours a day, 7 days a week. In the U.K., these services are available Monday through Friday, from 9 a.m. to 6 p.m.

How to send your comments

Your feedback is important to help us provide the highest quality of information. If you have any comments about this document, you can submit them in one of the following ways.

E-mail

> Submit your comments by email to:
>
> starpubs@us.ibm.com
>
> Be sure to include the name and order number of the document and, if applicable, the specific location of the text that you are commenting on, such as a page number or table number.

Mail

> Fill out the Readers' Comments form (RCF) at the back of this document and return it by mail or give it to an IBM representative.

If the RCF has been removed, send your comments to:

International Business Machines Corporation
Information Development
Department GZW
9000 South Rita Road
Tucson, Arizona
USA
85744-0001

Be sure to include the name and order number of the document and, if applicable, the specific location of the text that you are commenting on, such as a page number or table number.

Chapter 1. Introduction

This chapter introduces three Storage Manager premium features that assist with copy services:

FlashCopy

> You use the FlashCopy feature to create and manage FlashCopy logical drives. A FlashCopy is the logical equivalent of a complete physical copy, but is created more quickly and requires less disk space. It is host addressable, so you can perform backups using FlashCopy while the base logical drive is online and user-accessible. When the backup completes, you can delete the FlashCopy logical drive or save it for reuse. See Chapter 2, "Overview of FlashCopy," on page 13 for more information.

VolumeCopy

> The VolumeCopy feature is a DS4000 Storage Subsystem controller firmware-based mechanism that you use to copy data from one logical drive (the *source* logical drive) to another logical drive (the *target* logical drive) in a single storage subsystem. Once defined, the combination of the source and target logical drives in a VolumeCopy relationship is referred to as a VolumeCopy logical drive pair. For more information on VolumeCopy functionality, see Chapter 3, "Overview of VolumeCopy," on page 57.

> The VolumeCopy feature can be used to perform the following tasks:
> - Copy data from arrays that use smaller capacity drives to arrays that use larger capacity drives
> - Back up data
> - Restore FlashCopy logical drive data to the base logical drive

> The VolumeCopy feature includes a Create Copy wizard that you use to create a logical drive copy, and a Copy Manager that you use to monitor logical drive pairs after they have been created.

> **Important:** During the VolumeCopy data transfer operation, any write requests to the source logical drive will be rejected. If the source logical drive is used in a production environment, the FlashCopy feature must be enabled and the FlashCopy of the logical drive must be specified as the VolumeCopy source logical drive instead of using the actual logical drive itself. This requirement is to prevent the logical drive from being inaccessible to the users.

Enhanced Remote Mirroring option

> Enhanced Remote Mirroring provides the ability to create remote logical drive mirror pairs with two new features: asynchronous write mode, and the write consistency group option. Asynchronous mirroring with the consistency group option is referred to as Global Mirroring, and asynchronous mirroring *without* the consistency group option is referred to as Global Copy. Mirroring that uses the existing synchronous write mode is now referred to as Metro Mirroring. For more information on remote mirroring, see Chapter 6, "Overview of the Enhanced Remote Mirroring option," on page 91.

Note: Enhanced Remote Mirroring, Remote Mirror, and Remote Mirroring are used interchangeably throughout this document, the online client, and online help system to refer to remote mirroring functionality.

1

Product updates

<table>
<tr><td>

Important

In order to keep your system up to date with the latest firmware and other product updates, use the information below to register and use the **My support** web site.

</td></tr>
</table>

Download the latest versions of the DS4000 Storage Manager host software, DS4000 storage server controller firmware, DS4000 drive expansion enclosure ESM firmware, and drive firmware at the time of the initial installation and when product updates become available.

To be notified of important product updates, you must first register at the IBM Support and Download Web site:

www-1.ibm.com/servers/storage/support/disk/index.html

In the **Additional Support** section of the Web page, click **My support**. On the next page, if you have not already done so, register to use the site by clicking **register now**.

Perform the following steps to receive product updates:

1. After you have registered, type your user ID and password to log into the site. The **My support** page opens.
2. Click **add products**. A pull-down menu displays.
3. In the pull-down menu, select **Storage**. Another pull-down menu displays.
4. In the new pull-down menu, and in the subsequent pull-down menus that display, select the following topics:
   - **Computer Storage**
   - **Disk Storage Systems**
   - **TotalStorage DS4000 Midrange Disk Systems & FAStT Stor Srvrs**

   Note: During this process a check list displays. Do not check any of the items in the check list until you complete the selections in the pull-down menus.
5. When you finish selecting the menu topics, place a check in the box for the machine type of your DS4000 series product, as well as any other attached DS4000 series product(s) for which you would like to receive information, then click **Add products**. The **My support** page opens again.
6. On the **My support** page, click the **Edit profile** tab, then click **Subscribe to email**. A pull-down menu displays.
7. In the pull-down menu, select **Storage**. A check list displays.
8. Place a check in each of the following boxes:
   a. **Please send these documents by weekly email**
   b. **Downloads and drivers**
   c. **Flashes**

   and any other topics that you may be interested in, and then click **Update**.
9. Click **Sign out** to log out of My Support.

FAStT product renaming

IBM has renamed some FAStT family products. Table 2 identifies each DS4000 product name with its corresponding previous FAStT product name. Note that this change of **product name only** indicates no change in functionality or warranty. All products listed below with new names are functionally-equivalent and fully-interoperable. Each DS4000 product retains full IBM service as outlined in service contracts issued for analogous FAStT products.

Table 2. Mapping of FAStT names to DS4000 Series names

Previous FAStT Product Name	Current DS4000 Product Name
IBM TotalStorage FAStT Storage Server	IBM TotalStorage DS4000
FAStT	DS4000
FAStT Family	DS4000 Mid-range Disk System
FAStT Storage Manager vX.Y (for example v9.10)	DS4000 Storage Manager vX.Y (for example v9.10)
FAStT100	DS4100
FAStT600	DS4300
FAStT600 with Turbo Feature	DS4300 Turbo
FAStT700	DS4400
FAStT900	DS4500
EXP700	DS4000 EXP700
EXP710	DS4000 EXP710
EXP100	DS4000 EXP100
FAStT FlashCopy	FlashCopy for DS4000
FAStT VolumeCopy	VolumeCopy for DS4000
FAStT Remote Mirror (RM)	Enhanced Remote Mirroring for DS4000
FAStT Synchronous Mirroring	Metro Mirroring for DS4000
	Global Copy for DS4000 (New Feature = Asynchronous Mirroring without Consistency Group)
	Global Mirroring for DS4000 (New Feature = Asynchronous Mirroring with Consistency Group)

Supported features

Table 3 indicates the support for FlashCopy, VolumeCopy, and the Enhanced Remote Mirror option on the DS4100, DS4300, DS4300 Turbo, DS4400, DS4500, and DS4800 Storage Subsystems.

This support matrix requires that the DS4000 Storage Subsystem controller firmware be at version 06.1x.xx.xx and the Storage Manager host software at version 9.15.

Table 3. DS4000 Storage Subsystem Copy Services feature support

Feature	DS4100 Base	DS4300 Base	DS4300 Turbo	DS4400	DS4500	DS4800
FlashCopy	Supported	Supported	Supported	Supported	Supported	Supported
• Maximum number of logical drives that can be defined (See note 2)	1024	1024	1024	2048	2048	2048
• Maximum total FlashCopy logical drives (See note 3)	512	512	512	1024	1024	1024
• Maximum FlashCopy logical drives per base RAID logical drive	4	4	4	4	4	4
VolumeCopy	Not supported	Not supported	Supported	Supported	Supported	Supported
• Maximum number of VolumeCopy target logical drives for a given source logical drive		1023	1023	2047	2047	2047
• Maximum copy pairs per array		1023	1023	2047	2047	2047
• Maximum running copies per array (See note 4)		8	8	8	8	8
Remote Mirror Option	Supported[1]	Not supported[1]	Supported	Supported	Supported	Supported

Table 3. DS4000 Storage Subsystem Copy Services feature support (continued)

Feature	DS4100 Base	DS4300 Base	DS4300 Turbo	DS4400	DS4500	DS4800
• Total Remote Mirror logical drives	32	N/A	32	64	64	64

Notes:

1. See the *IBM DS4000 Storage Manager Installation and User's Guide* for your host operating system for more information about Storage Manager controller firmware support for the various DS4000 Storage Subsystems.

2. Enhanced Remote Mirroring is not available for FAStT200, FAStT500, or DS4100 single-controller storage subsystems, or for DS4300 standard (base) and single-controller storage subsystems. Please contact IBM representatives or resellers for availability of such support in the future. (You can use FAStT500 Storage Subsystems with the previous synchronous-mode-only Remote Mirroring option.)

3. When using firmware version 5.xx.xx.xx and higher, the firmware reserves one logical drive for use by the system. For firmware version 05.2x.xx.xx and higher, the maximum number of logical drives includes the FlashCopy repository logical drives, the VolumeCopy target logical drive and the Remote Mirror logical drives in addition to the standard data logical drives. If the Remote Mirror Option is enabled, two logical drives are reserved for use by the system.

4. The total number of FlashCopy logical drives is limited to one half of the total number of logical drives.

5. Refers to logical drives in the copy-in-progress state.

6. DS4300 and DS4100 Single-Controller (SCU) storage subsystems are not supported with Storage Manager controller firmware version 6.1x.xx.xx, or with AIX host operating systems.

New features and enhancements

DS4000 Storage Manager 9.15 supports controller firmware versions 4.10.xx.xx

through 06.15.xx.xx.

Notes:

1. For more information about current Storage Manager controller firmware support for the various DS4000 storage subsystems, see the *IBM DS4000 Storage Manager Installation and User's Guide* for your host operating system.

2. For information about supported host operating systems and operating system requirements, see the Storage Manager readme file for your operating system. See section "Who should read this document" on page xi for instructions that describe how to find the readme files online.

FAStT product renaming

IBM is in the process of renaming some FAStT family products. For a reference guide that identifies each new DS4000 product name with its corresponding FAStT product name, see "FAStT product renaming" on page 3.

Controller firmware 6.14 and 6.15: New features

With controller firmware version **6.15.xx.xx**, the DS4800 storage subsystem utilizes all of the available data cache memory installed in each controller blade for I/O

caching. (With controller firmware version 06.14.xx.xx, the DS4800 uses only the first 1 GB of the installed data cache memory per controller for I/O caching.)

Controller firmware versions 6.14.xx.xx and 6.15.xx.xx support:

- DS4800 storage subsystem (only)
- All of the features listed in "Controller firmware 6.10: New features" and "Controller firmware 6.12: New features."

Controller firmware 6.12: New features

Controller firmware **6.12.xx.xx** and later versions all of the features listed in "Controller firmware 6.10: New features" in addition to the following new features:

DS4000 FC/SATA Intermix update: Premium Feature Key
> DS4000 Storage Manager 9.1x with controller firmware 06.12.xx.xx (and later) supports enabling of the DS4000 FC/SATA Intermix premium feature using a Premium Feature Key.
>
> For more information about using the Intermix premium feature, including configuration and set-up requirements, see the *IBM TotalStorage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview*.

New DS4000 Storage Manager installation option
> DS4000 Storage Manager 9.1x with controller firmware 06.12.xx.xx (and later) features an installation wizard that enables you to automatically install Storage Manager software packages on your host server.
>
> **Note:** Using the DS4000 Storage Manager installation wizard requires a system with a graphics card installed. You still have the option of installing the stand-alone host software packages manually. The packages are included with the installation CD.

Support for DS4100 standard (base) SATA Storage Subsystems
> Storage Manager 9.1x with controller firmware 06.12.xx.xx (and later) supports DS4100 Standard (Base) SATA Storage Subsystems.
>
> **Note:** The VolumeCopy, FC/SATA Intermix and Enhanced Remote Mirroring premium features are not supported at this time with the DS4100 Standard (Base) Storage Subsystem. Also, the DS4100 Standard (Base) Storage Subsystem is not supported on AIX host operating systems.

DS4000 Storage Manager usability enhancements
> DS4000 Storage Manager 9.12 and later versions feature the following usability enhancements:
> - Storage Partitioning wizard, which helps you easily create storage partitions
> - Task Assistant, which helps guide you through common enterprise and subsystem management tasks
> - Ability to extract SMART data for SATA drives

Controller firmware 6.10: New features

Controller firmware **6.10.xx.xx** and later versions support the following new features:

Enhanced Remote Mirroring
> In addition to Metro Mirroring, IBM DS4000 Storage Manager version 9.1x with controller firmware level 6.10.11.xx (and later) also supports Global

Copy and Global Mirroring Remote Mirror options. Please see the *IBM TotalStorage DS4000 Storage Manager Version 9 Copy Services User's Guide* for more information.

> **Note:** The terms "Enhanced Remote Mirror Option," "Metro/Global Remote Mirror Option," "Remote Mirror," "Remote Mirror Option," and "Remote Mirroring" are used interchangeably throughout this document, the SMclient, and the online help system to refer to remote mirroring functionality.

Parallel hard drive firmware download
You can now download drive firmware packages to multiple drives simultaneously, which minimizes downtime. In addition, all files that are associated with a firmware update are now bundled into a single firmware package. See the Subsystem Management window online help for drive firmware download procedures.

> **Notes:**
> 1. Drive firmware download is an offline management event. You must schedule downtime for the download because I/O to the storage subsystem is not allowed during the drive firmware download process.
> 2. Parallel hard drive firmware download is not the same thing as concurrent download.

Staged controller firmware download
You can now download the DS4000 controller firmware and NVSRAM to DS4300 Turbo and DS4500 Storage Subsystem for later activation. Depending on your firmware version, DS4000 Storage Subsystem model, and host operating system, the following options might be available:

- Controller firmware download only with immediate activation
- Controller firmware download with the option to activate the firmware at a later time

> **Note:** Staged controller firmware download is not supported on DS4400 Storage Subsystems.

Subsystem Management Window menu enhancements
Troubleshooting, recovery and maintenance tools are now under the Advanced heading in the Subsystem Management window. The following submenus are available:

- Maintenance
- Troubleshooting
- Recovery

Full command-line interface capability
All of the options that are available in SMclient are also available using either the script editor in the Enterprise Management window, or using your preferred command-line interface. For more information about using the command-line interface, see the Enterprise Management window online help.

Support for DS4300 standard (base) Fibre Channel Storage Subsystems
Storage Manager 9.1x with controller firmware 6.10.xx.xx (and later) supports DS4300 Standard (Base) Fibre Channel Storage Subsystems.

> **Note:** The VolumeCopy, FC/SATA Intermix and Enhanced Remote Mirroring premium features are not supported at this time with the

DS4300 Standard (Base) Storage Subsystem. Also, the DS4300 Standard (Base) Storage Subsystem is not supported on AIX host operating systems.

DS4000 FC/SATA Intermix premium feature
Storage Manager 9.1x with controller firmware 6.10.xx.xx (and later) supports the DS4000 FC/SATA Intermix premium feature. This premium feature supports the concurrent attachment of Fibre Channel and SATA storage expansion enclosures to a single DS4000 controller configuration.

With controller firmware 6.10.xx.xx and later versions, the FC/SATA Intermix premium feature is enabled using NVSRAM.

For more information about using the Intermix premium feature, including configuration and set-up requirements, see the *IBM TotalStorage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview*.

Support for DS4000 EXP710 storage expansion enclosures
Storage Manager 9.1x with controller firmware 6.10.xx.xx (and later) supports DS4000 EXP710 storage expansion enclosures.

Increased support for DS4000 EXP100 SATA storage expansion enclosures
DS4000 EXP100 SATA storage expansion enclosures are now supported on DS4400 Fibre Channel Storage Subsystems.

Also, the DS4100 storage subsystem now supports up to seven EXP100 SATA storage expansion enclosures.

DS4000 Storage Manager usability enhancements
DS4000 Storage Manager 9.10 and later versions feature the following usability enhancements:

- One-click collection of support data, drive diagnostic data, drive channel state management, controller 'service mode,' and the ability to save host topology information
- Improved media error handling for better reporting of unreadable sectors in the DS4000 Storage Subsystem event log, and persistent reporting of unreadable sectors

Enabling premium features

You must perform the following tasks to enable a premium feature on your storage subsystem:

- Obtain the feature enable identifier
- Generate the feature key file
- Enable the feature
- Verify that the premium feature is enabled

Before you begin, gather the following information:

- Your Feature Activation Code, which is printed on the IBM Premium entitlement card
- Your controller unit IBM serial number, which is printed on the label on the back of your DS4000 controller unit
- A 32 alphanumeric-character IBM DS4000 Storage Subsystem premium feature identifier string
- Review the instructions on the Premium Feature entitlement card for any special prerequisites or instructions.

To obtain the storage subsystem premium feature identifier string, ensure that your controller unit and storage expansion enclosures are connected, powered on, and managed using the SMclient. Continue with the next section.

Note: To check the status of an existing premium feature, select **Storage Subsystem → Premium Features → List** from the pull-down menu.

Obtaining the feature enable identifier

Each storage subsystem has its own unique feature enable identifier. This identifier ensures that a particular feature key file is applicable only to that storage subsystem. Complete the following steps to obtain the feature enable identifier:

1. Click **Start → Programs → Storage Manager 9 Client**. The Enterprise Management window opens.
2. In the Enterprise Management window, double-click the storage subsystem for which you want to enable the premium feature. The Subsystem Management window opens for the selected storage subsystem.
3. In the Subsystem Management window, click **Storage Subsystem → Premium Features → List**. The List Premium Features window opens and displays the feature enable identifier.
4. Record the feature enable identifier.
5. Close the List Premium Features window.

Generating the feature key file and enabling the premium feature

You can enable the premium feature by using the Premium Feature Activation tool that is located at the following Web site:

www-912.ibm.com/PremiumFeatures/jsp/keyInput.jsp

If a premium feature becomes disabled, you can access the Web site and repeat this process. For any additional assistance, contact your local IBM service provider. Make sure you have the information listed in "Enabling premium features" on page 8 available.

Viewing the status of premium features

Perform the following steps to see a list of those premium features that are enabled on your storage subsystem:

1. In the Subsystem Management window, click **Storage Subsystem → Premium Features → List**.

   The List Premium Features window opens (see Figure 1 on page 10).
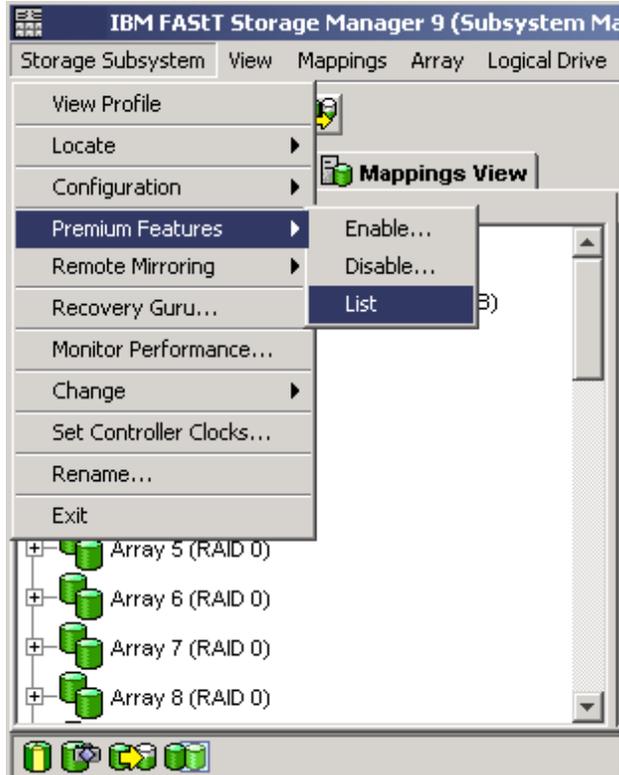
Figure 1. Listing premium features

The dialog lists the following items:

- The premium features that are enabled on the storage subsystem
- The feature enable identifier

2. Click **Close** to close the window.

Disabling premium features

In normal system operations, you do not need to disable the premium features. However, if you want to disable a premium feature, make sure that you have the key file or the IBM DS4000 premium feature entitlement card with the premium feature activation code for generating the key file. You need this key file to reenable the premium feature at a later time.

Perform the following steps to disable a premium feature on the storage subsystem:

1. In the Subsystem Management window, click **Storage Subsystem → Premium Features → Disable**.

   The Disable Premium Feature window opens, listing all the premium features that are enabled.

2. Select one item in the list, and click **OK**.

   A confirmation dialog displays that states that disabling a premium feature is not recommended.

3. Click **Yes**.

   The Working dialog displays while the feature is being disabled. When the feature has been disabled, the Working dialog closes.

Notes:

1. If you want to enable the premium feature in the future, you must reapply the Feature Key file for that feature.

2. You can disable the Remote Mirror Option without deactivating the feature. If the feature is disabled but activated, you can perform all mirroring operations on existing remote mirrors. However, when the feature is disabled you cannot create any new remote mirrors. For more information about activating the Remote Mirror Option, see "Enabling and activating the Remote Mirror Option" on page 129 or see "Using the Activate Remote Mirroring Wizard" in the Storage Manager online help.

Chapter 2. Overview of FlashCopy

You use FlashCopy to create and manage FlashCopy logical drives. A FlashCopy logical drive is a point-in-time image of a standard logical drive in your storage subsystem. The logical drive that is copied is called a *base logical drive*.

When you make a FlashCopy, the controller suspends write operations to the base logical drive for a few seconds while it creates a FlashCopy *repository logical drive*. This is a physical logical drive where FlashCopy metadata and copy-on-write data are stored.

Note: In order to ensure an accurate FlashCopy image of the base logical drive, you must follow the procedures that are described in "Prepare the host operating system" on page 27.

You can create up to four FlashCopies of a base logical drive, and then write data to the FlashCopy logical drives to perform testing and analysis. For example, before upgrading a database management system, you can use FlashCopy logical drives to test different configurations.

You can create FlashCopy logical drives for repeated reuse (frequent or nightly backups) or for one-time use (speculative change or upgrade testing).

This chapter describes the following procedures:
- "Enabling FlashCopy"
- "Planning a FlashCopy logical drive" on page 14
- "Creating a FlashCopy logical drive" on page 27
- "Reusing a FlashCopy logical drive" on page 40
- "Performing FlashCopy tasks" on page 45

You can perform these procedures using the SMclient GUI interface, or with the command-line interface (SMcli) and the script editor. For more information, click the **Help** tab in the Enterprise Management window, and then search for *SMcli* or *script editor*.

Notes:
1. FlashCopy is not supported on a DS4300 that is running firmware version 5.33.xx.xx.
2. Making a FlashCopy of a ″Dynamic Disk″ type of logical drive is not supported on Windows® operating systems.

Enabling FlashCopy

To enable FlashCopy, you must perform the following tasks in the following order:
1. Obtain the feature enable identifier. This procedure is described in detail in "Obtaining the feature enable identifier" on page 9.
2. Generate the feature key file and enable FlashCopy. This procedure is described in detail in "Generating the feature key file and enabling the premium feature" on page 9.

Before you begin, gather the following information:
- Your Feature Activation Code, which is printed on the IBM FlashCopy Premium entitlement card

- Your controller unit IBM serial number, which is printed on the label on the back of your DS4000 controller unit
- A 32 alphanumeric IBM DS4000 Storage Subsystem premium feature identifier string.

To obtain the storage subsystem premium feature identifier string, ensure that your controller unit and storage expansion enclosures are connected, powered on, and managed using the SMclient.

For information on how to view a list of those premium features that are enabled on your storage subsystem, see "Viewing the status of premium features" on page 9.

Planning a FlashCopy logical drive

Before you create a FlashCopy logical drive, make sure that you are familiar with the following concepts, which are described in this section:
- "Specifying FlashCopy repository logical drive failure settings"
- "Estimating FlashCopy repository logical drive capacity" on page 15
- "Estimating FlashCopy repository life" on page 17
- "Overview of the FlashCopy Logical Drive wizard" on page 18

Specifying FlashCopy repository logical drive failure settings

When you create a FlashCopy logical drive, you also create and define the parameters of a physical logical drive that is called the FlashCopy repository logical drive. The repository logical drive is where FlashCopy data and copy-on-write data are stored.

This section contains information that helps you choose the FlashCopy repository logical drive failure settings that you specify in the FlashCopy Logical Drive wizard.

You should read this section before you create a FlashCopy logical drive, so that you have a better understanding of the parameters when you set them initially.

For information about changing the properties of an existing FlashCopy repository logical drive, see "Changing FlashCopy repository logical drive properties" on page 47.

Repository capacity threshold warning level

When you create the FlashCopy repository logical drive, you specify its capacity threshold warning level.

The threshold warning is the only warning that is given before the FlashCopy repository logical drive becomes full, so do not ignore it. When you receive the `Threshold Exceeded` warning, you can perform one of the following two actions:
- Increase the capacity of the FlashCopy repository logical drive
- Increase the FlashCopy repository logical drive threshold capacity warning level

Important: Increasing the threshold capacity warning level reduces the amount of time that you have to perform the necessary tasks to prevent the FlashCopy repository logical drive from becoming full when you receive a *Threshold Exceeded* warning.

See "Specify Logical Drive Parameters panel" on page 20 for information about setting the capacity threshold warning level for the FlashCopy repository logical drive.

If you are not sure how high to set the threshold warning level, accept the default setting.

Repository full policy

When you create the FlashCopy repository logical drive, you can specify the action that you want the system to perform when the drive reaches its capacity and becomes full. You can choose from the following two options:

Fail FlashCopy logical drive
> When the FlashCopy repository logical drive becomes full, FlashCopy logical drive data is not recoverable and the FlashCopy cannot be accessed. In this case, the only possible action is to delete the FlashCopy logical drive or re-create the FlashCopy logical drive to create a new point-in-time image.
>
> This is the default option.

Fail writes to base logical drive
> When the FlashCopy repository logical drive becomes full, the FlashCopy logical drive data is still accessible. However, all write requests to the base logical drive are rejected until the FlashCopy repository logical drive capacity is increased. *This is not a recommended setting.*
>
> **Attention:** The *Fail writes to base logical drive* option is not supported on AIX®. Selecting this option might cause data loss on the base logical drive. If you are using AIX, select the *Fail FlashCopy logical drive* option, which is the default. Be sure to monitor the capacity of the FlashCopy repository logical drive, because you cannot access the FlashCopy if the repository logical drive becomes full.

For more information about increasing the storage capacity of an existing FlashCopy repository logical drive, see "Resizing a FlashCopy repository logical drive" on page 51.

Estimating FlashCopy repository logical drive capacity

If numerous I/O requests are written to the base logical drive, the FlashCopy repository logical drive can eventually exceed the base logical drive capacity if all the original data blocks are changed.

Note: Different operating systems might deal with data modifications, such as deleting, replacing, adding only, or deleting only, differently. For example, if you continuously delete and recreate a 10 MB file, the operating system might use only new disk blocks each time the file is created which causes the FlashCopy repository logical drive to become full with the original data. So, instead of generating the 10 MB worth of data in the FlashCopy repository logical drive, it might generate data up to the size of the base logical drive in the FlashCopy repository logical drive.

You can estimate the FlashCopy repository logical drive capacity by calculating the amount of expected management overhead and the space required for copy-on-write data.

Note: You should reestimate the FlashCopy repository logical drive capacity periodically. You can estimate the FlashCopy repository logical drive capacity by calculating the following figures:

- The amount of expected management overhead
- The space required for copy-on-write data
- The rate that the FlashCopy repository logical drive is filled up with the copy-on-write data

Considerations

The following information can help you to determine the appropriate capacity of the FlashCopy repository logical drive:

- The minimum capacity of a FlashCopy repository logical drive is 8 MB.
- The amount of write activity to the base logical drive that takes place after the FlashCopy logical drive has been created determines the size of a FlashCopy repository logical drive. As the amount of write activity to the base logical drive increases, the number of original data blocks that need to be copied from the base logical drive to the FlashCopy repository logical drive also increases.
- The longer a FlashCopy logical drive remains enabled, the higher the risk of the FlashCopy repository logical drive reaching its maximum capacity. For more information, see "Estimating FlashCopy repository life" on page 17.
- There is not necessarily a one-to-one correlation between the number of data blocks that change on the base logical drive and the amount of copy-on-write data that is stored on the FlashCopy repository logical drive. The controller might copy over a full set of 32 blocks for performance reasons, even if only one set of blocks has changed. Keep this in mind when determining the percentage of the capacity of the base logical drive that can be copied to the FlashCopy repository logical drive.

Calculating estimated repository capacity

The following formula should be used merely as a guide. When you estimate the FlashCopy repository logical drive capacity, keep in mind the information listed in "Considerations."

Note: When performing this calculation, you must convert the bytes to kilobytes, the kilobytes to megabytes, and the megabytes to gigabytes.

Use the following formula to calculate the amount of expected management overhead:

```
192 KB + (X / 2000)
```

where X is the capacity of the base logical drive in bytes.

Then, add this amount to the amount of space that is required for copy-on-write data. The result is the estimated FlashCopy repository logical drive capacity.

Sample calculation: On a base logical drive of 5 GB, 30% of the data blocks on the base logical drive are expected to change.

1. Calculate the amount of management overhead that is required.
   a. Convert the capacity of the base logical drive to bytes.
      ```
      5 GB = 5 368 709 120 bytes
      ```
   b. Divide the capacity of the base logical drive (in bytes) by 2000.
      ```
      5 368 709 120 / 2000 = 2 684 354.56 bytes
      ```

c. Convert the result from step 1b on page 16 (in bytes) to kilobytes (KB).

```
2 684 354.56 bytes = 2621.44 KB
```

d. Add 192 KB to the results from step 1c.

```
192 KB + 2621.44 KB = 2813.44 KB
```

e. Convert the result from step 1d to megabytes (MB), then to gigabytes (GB).

```
2813.44 KB = 2.75 MB = 0.002686 GB
```

Result: The amount of required management overhead is 0.002686 GB.

2. Determine the amount of space (in gigabytes) that is required for copy-on-write data, using the percentage of the base logical drive that is expected to change (30%).

```
30% of 5 GB = 1.5 GB
```

Result: The amount of space that is required for copy-on-write data is 1.5 GB.

3. Add the result from step 2 to the result from step 1e.

```
1.5 GB + 0.002686 GB = 1.502686 GB
```

Result: The estimated FlashCopy repository logical drive capacity is 1.502686 GB.

For more information on estimating the FlashCopy repository logical drive capacity, see "Learn About Estimating FlashCopy Repository Logical Drive Capacity" in the FlashCopy online help.

Estimating FlashCopy repository life

When you initially define the properties of the FlashCopy repository logical drive, keep in mind the kind of usage that is planned for the FlashCopy logical drive. Understanding how the FlashCopy logical drive will be used can help you to estimate the life expectancy of the FlashCopy repository logical drive.

After you have created the FlashCopy repository logical drive and some usage data is available, you can estimate its life expectancy using the following procedure as a guide. You can then change the properties of the FlashCopy repository logical drive, if necessary.

Note: The life expectancy of a FlashCopy repository logical drive should be re-estimated periodically.

1. Select the FlashCopy repository logical drive in the Logical/Physical view. Click **Logical Drive → Properties** and click the **Capacity** tab.
2. Record the creation timestamp day and time.
3. Record the capacity used (GB) and the available capacity (GB).
4. Determine the elapsed time (t) by subtracting the creation time from the current time, expressing the elapsed time in either minutes, hours, or days.
5. The total time (Tr) that the repository is available for copy-on-write data can now be estimated, based on the current usage. Multiply the elapsed time (t) by the available capacity (Ct), and then divide the resultant number by the capacity used (Cu).

Use the following formula:

```
Tr =(t *Ct)/Cu
```

Where:

Tr   Total time available

t   Elapsed time

Ct   Available capacity

Cu   Capacity used

Note: The total time available (Tr) indicates the total usage time for the FlashCopy repository logical drive.

Using the result of these calculations, you can decide whether to increase the capacity of the FlashCopy repository logical drive. If the repository capacity becomes 100% full during the expected lifetime of the FlashCopy, then you should increase the capacity of the FlashCopy repository logical drive.

For more information, see "Resizing a FlashCopy repository logical drive" on page 51.

Overview of the FlashCopy Logical Drive wizard

This section contains descriptions of the parameters that you specify on the following FlashCopy Logical Drive wizard panels:

- Introduction
- Allocate Capacity
- Specify Logical Drive Parameters
- Specify Array Parameters
- Specify Names
- Specify FlashCopy Repository Logical Drive Capacity
- Preview

Note: See the FlashCopy Logical Drive wizard online help for additional information.

Introduction panel

The Introduction panel, shown in Figure 2 on page 19, provides a definition of a FlashCopy logical drive and describes its physical components.
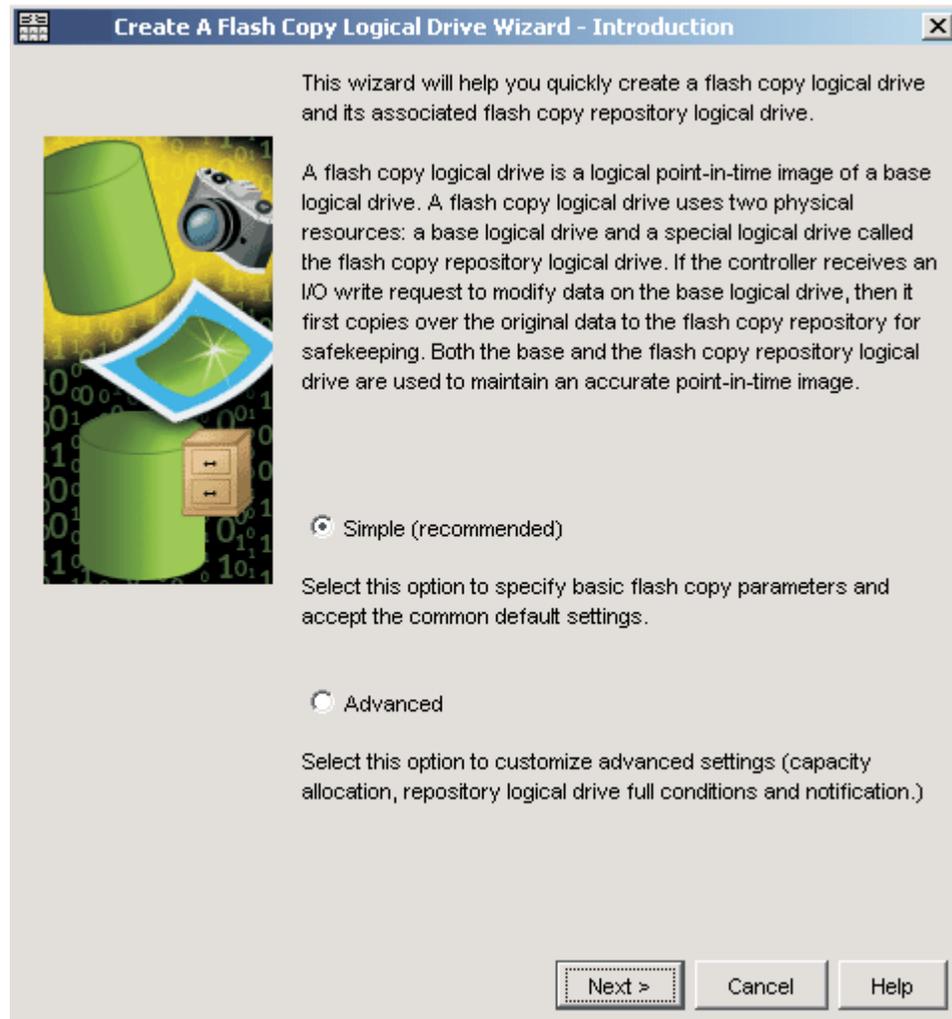
Figure 2. FlashCopy Logical Drive Wizard Introduction panel

On this panel you can select one of the following options:

Simple

> You can use this option if there is free capacity in the array in which the base logical drive is allocated and the free capacity is at least 8 MB plus 1% of the base logical drive capacity. Select this option to specify basic FlashCopy parameters with default settings for FlashCopy logical drive mappings.

Advanced

> You can use this option if you want to specify the following factors:
> - Where the FlashCopy repository logical drive will be created
> - All of the customizable FlashCopy settings

Allocate Capacity panel

On the Allocate Capacity panel, shown in Figure 3 on page 20, you can specify where to allocate the repository storage capacity.
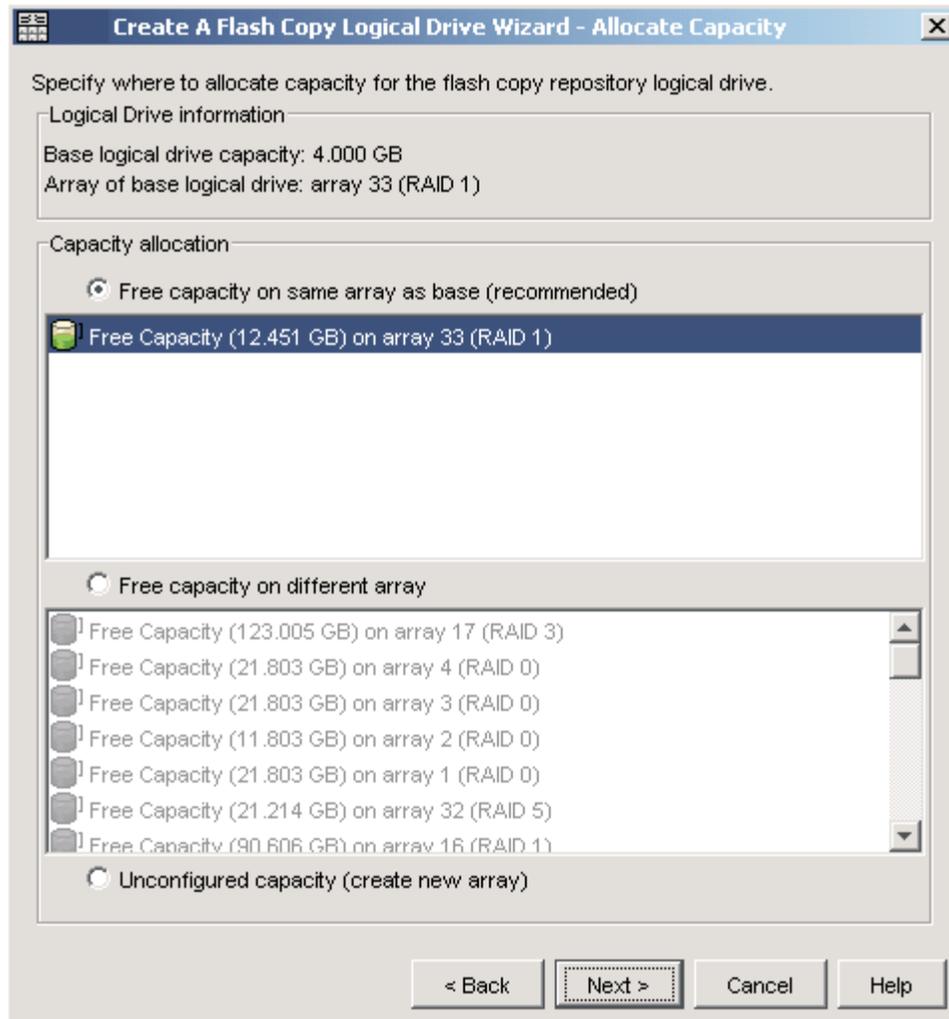
Figure 3. Allocate Capacity panel

Free Capacity You can choose **Free Capacity on same array as base** or **Free capacity on different array**. These paths take you to the Specify Logical Drive Parameters panel, where you can define the mapping and repository logical drive parameters.

Unconfigured Capacity
This path takes you to the Specify Array Parameters panel, where you can specify a new array on which the repository resides and choose the RAID level of the array.

Specify Logical Drive Parameters panel
Use the Specify Logical Drive Parameters panel, shown in Figure 4 on page 21, to specify the action that you want the system to perform when a FlashCopy repository logical drive reaches its capacity and becomes full.
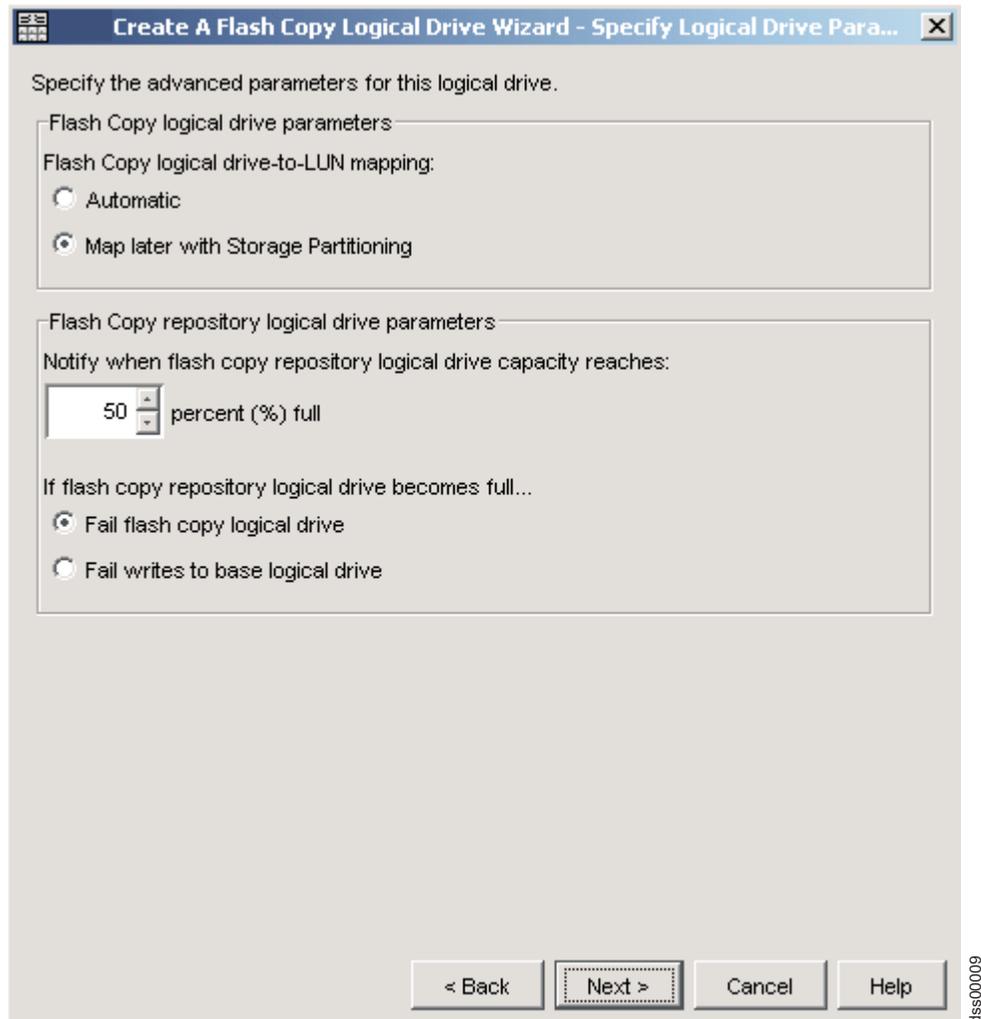
Figure 4. Specify Logical Drive Parameters panel

FlashCopy logical drive parameters

In this section of the panel you can specify one of the following options for logical drive-to-LUN mapping:

Automatic

If you choose this option, the system maps the FlashCopy logical drive automatically.

Map later with Storage Partitioning

If you choose this option, follow the procedure described in "Mapping the FlashCopy logical drive to the host" on page 30 after you have finished using the wizard.

Repository logical drive parameters

In this section of the panel you can specify the threshold warning level and repository fail policy.

Percent (%) full

This field specifies the threshold warning level for the FlashCopy repository logical drive. Storage Manager provides a warning message when the FlashCopy repository logical drive exceeds the threshold level that you specify.

> **Important:** This warning is the only notification that you receive before the repository becomes full.
>
> The threshold warning level for the FlashCopy repository logical drive is initially set to 50%. If you are not sure how high to set the threshold warning level, accept this default setting.

You can specify one of the following actions that you want Storage Manager to perform when the repository becomes full:

Fail FlashCopy logical drive

> If you specify this option, the FlashCopy logical drive data is not recoverable when the FlashCopy repository logical drive becomes full, and the FlashCopy cannot be accessed. In this case, the only possible action is to delete the FlashCopy logical drive or re-create the FlashCopy logical drive to create a new point-in-time image.
>
> This is the default option.

Fail writes to base logical drive

> If you specify this option, the FlashCopy logical drive data is accessible when the FlashCopy repository logical drive becomes full. However, the FlashCopy repository logical drive capacity must be increased so that writes to the base logical drive are not rejected. *This is not a recommended setting.*
>
> **Attention:** AIX does not support the **Fail writes to base logical drive** option. Selecting this option might cause data loss on the base logical drive. If you are using AIX, select the **Fail FlashCopy logical drive** option, which is the default. Be sure to monitor the capacity of the FlashCopy repository logical drive, because you cannot access the FlashCopy if the repository logical drive becomes full.

See "Specifying FlashCopy repository logical drive failure settings" on page 14 for more information about repository capacity and failure settings.

When you click **Next**, the Preview panel opens and displays the parameters that you specified. Click **Back** to return to the previous panels to edit the repository parameters or click **Finish** to proceed to the Specify Names panel.

Specify Array Parameters panel

If you specified the **Unconfigured Capacity** option on the Allocate Capacity panel, the Specify Array Parameters panel shown in Figure 5 on page 23, displays. On this panel you can specify a new array on which to place the repository logical drive. You can also specify the RAID level of the array that meets the FlashCopy repository logical drive data storage and protection requirements.
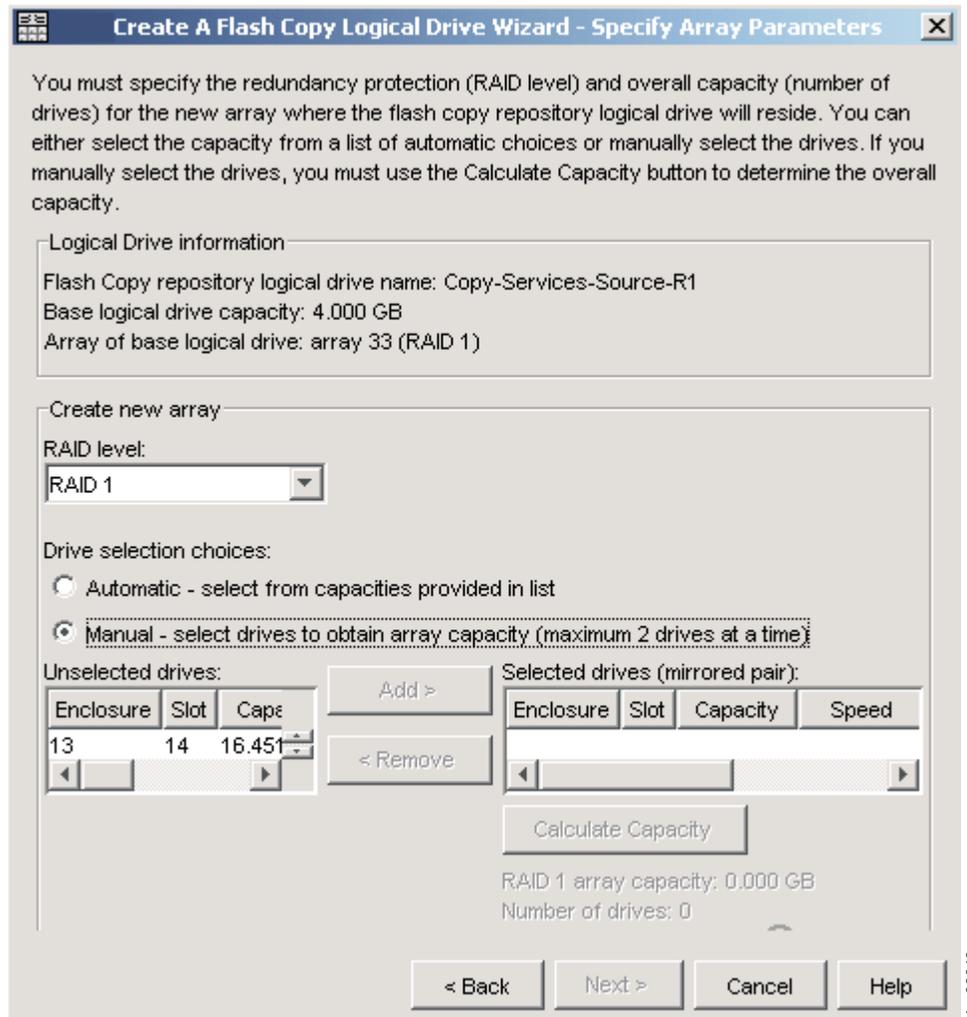
Figure 5. Specify Array Parameters panel

Click **Next** to go to the Specify Names panel.

Specify Names panel

On the Specify Names panel, shown in Figure 6 on page 24, you can define the FlashCopy logical drive name and the name of its associated FlashCopy repository logical drive.
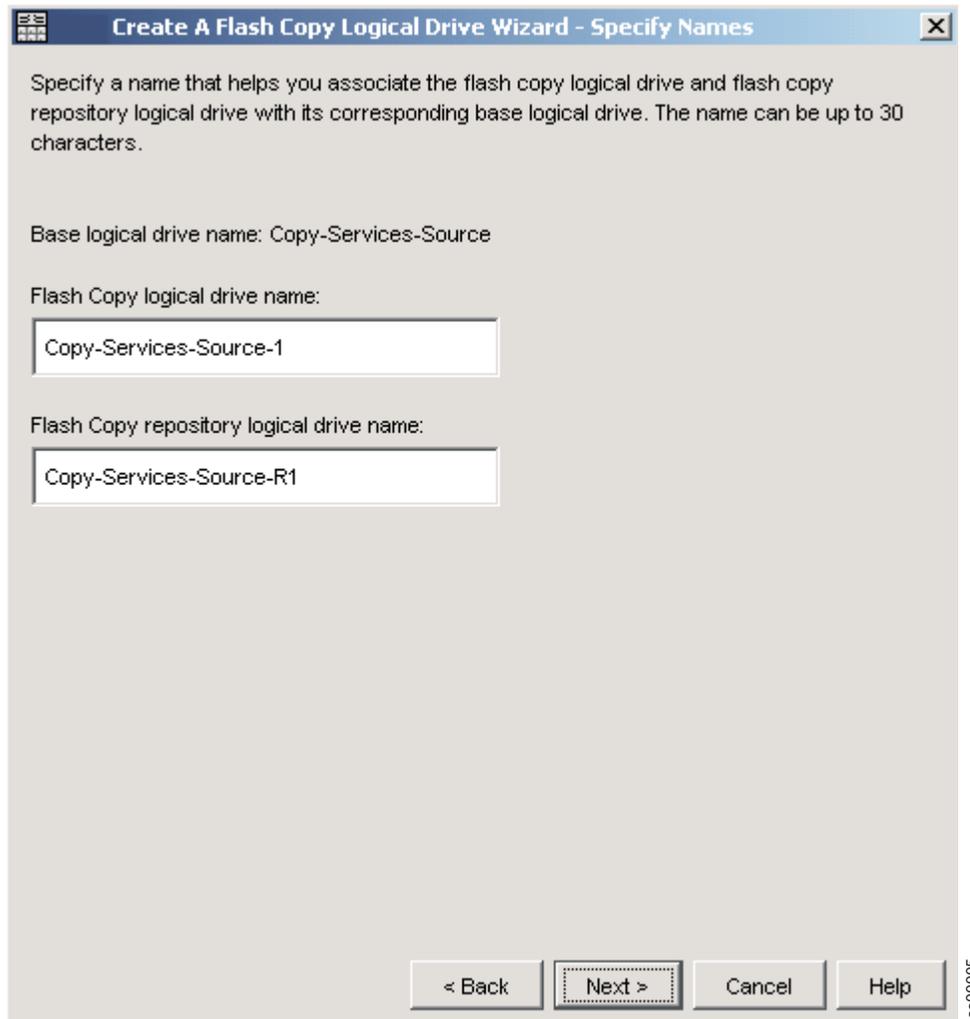
Figure 6. Specify Names panel

The default naming convention for the first FlashCopy uses the base volume name and adds a suffix of ″-1″ for the FlashCopy logical drive and ″-R1″ for the FlashCopy logical repository drive. The second FlashCopy increments this number to 2, and so on, up to the four volumes.

For example, if you are creating the first FlashCopy logical drive for a base logical drive called DataVol, then the default FlashCopy logical drive name is *DataVol-1*. The associated FlashCopy repository logical drive default name is *DataVol-R1*. The default name of the next FlashCopy logical drive that you create based on DataVol is *DataVol-2*, and the corresponding FlashCopy repository logical drive name is *DataVol-R2*.

Change the default names if required.

Tips about names:
- You must choose a unique name for the FlashCopy and FlashCopy repository logical drives. Otherwise, the system displays an error message.
- Regardless of whether you use the software-supplied sequence number that (by default) populates the **FlashCopy logical drive name** or **FlashCopy repository logical drive name** field, the next default name for a FlashCopy or FlashCopy

repository logical drive still receives a sequence number determined by the software. For example, you might name the first FlashCopy of base logical drive DataVol *DataVolMay28*, without using the software-supplied sequence number of -1. Regardless, the software assigns a default name for the next FlashCopy as *DataVol-2*.

- The next available sequence number is based on the number of existing FlashCopies of a base logical drive. If you delete a FlashCopy logical drive, the assigned sequence number becomes available again.

- Names have a 30-character limit, including spaces. When you reach this limit in either the **FlashCopy logical drive name** or **FlashCopy repository logical drive name** field, no more input is accepted. If the base logical drive name contains 30 characters, the default names for the FlashCopy and its associated FlashCopy repository logical drive use the base logical drive name truncated just enough to add the sequence string. For example, for "Host Software Engineering Group GR-1", the default FlashCopy name would be "Host Software Engineering GR-1". The default repository name would be "Host Software Engineering G-R1."

Click **Next** to go to the Specify FlashCopy Repository Logical Drive Capacity panel.

Specify FlashCopy Repository Logical Drive Capacity panel

On the Specify FlashCopy Repository Logical Drive Capacity panel, shown in Figure 7 on page 26, you can set the repository drive capacity as a percentage of the capacity of the base logical drive.
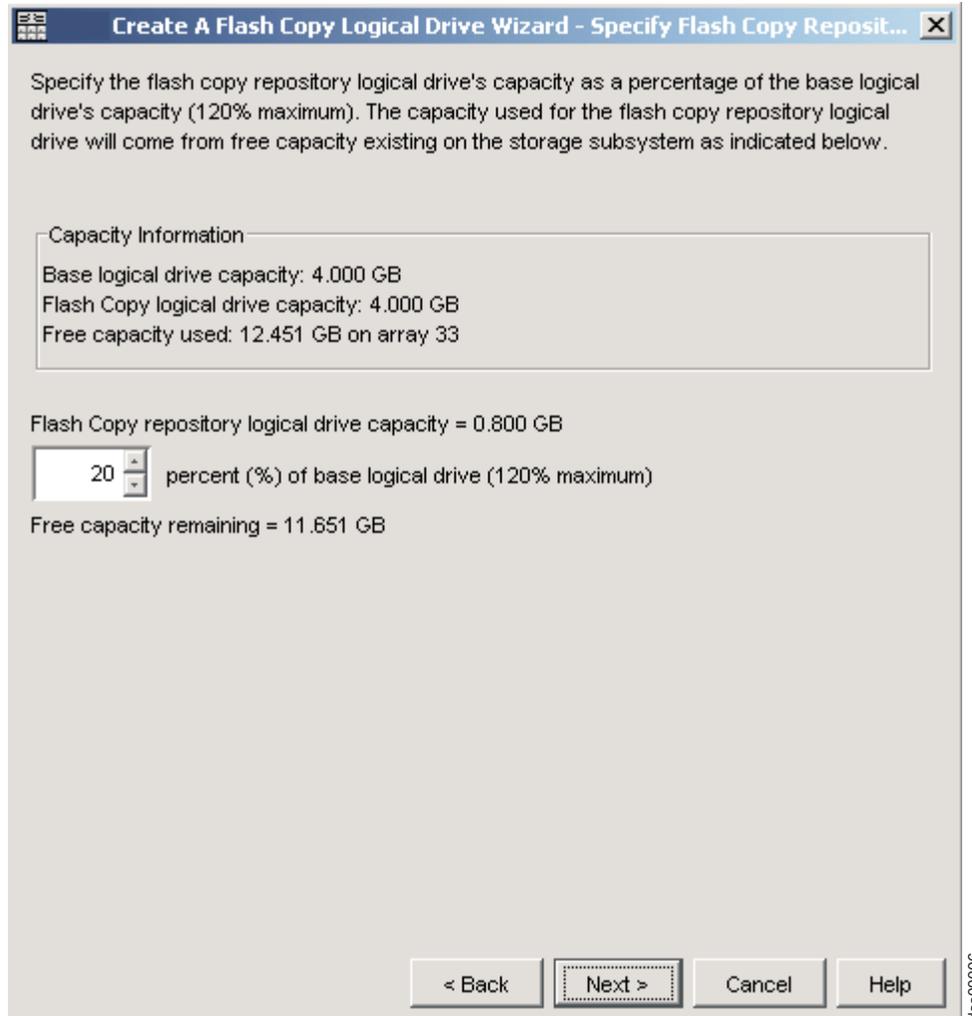
Figure 7. Specify Repository Logical Drive Capacity panel

percent (%) of base logical drive
> This field sets the FlashCopy repository logical drive capacity as a percentage of the base logical drive. The default is 20%.
>
> If you calculate a different capacity using the procedure described in "Estimating FlashCopy repository logical drive capacity" on page 15, you can increase or decrease the percentage in the **percent (%) of base logical drive** field until the FlashCopy Repository Logical Drive Capacity value matches the estimated capacity that you calculated. You might need to round up the number.

Preview panel

The Preview panel, shown in Figure 8 on page 27, displays the parameters that you have specified for the FlashCopy logical drive and the FlashCopy repository logical drive. If you click Finish on this panel, the FlashCopy logical drive create process initiates.
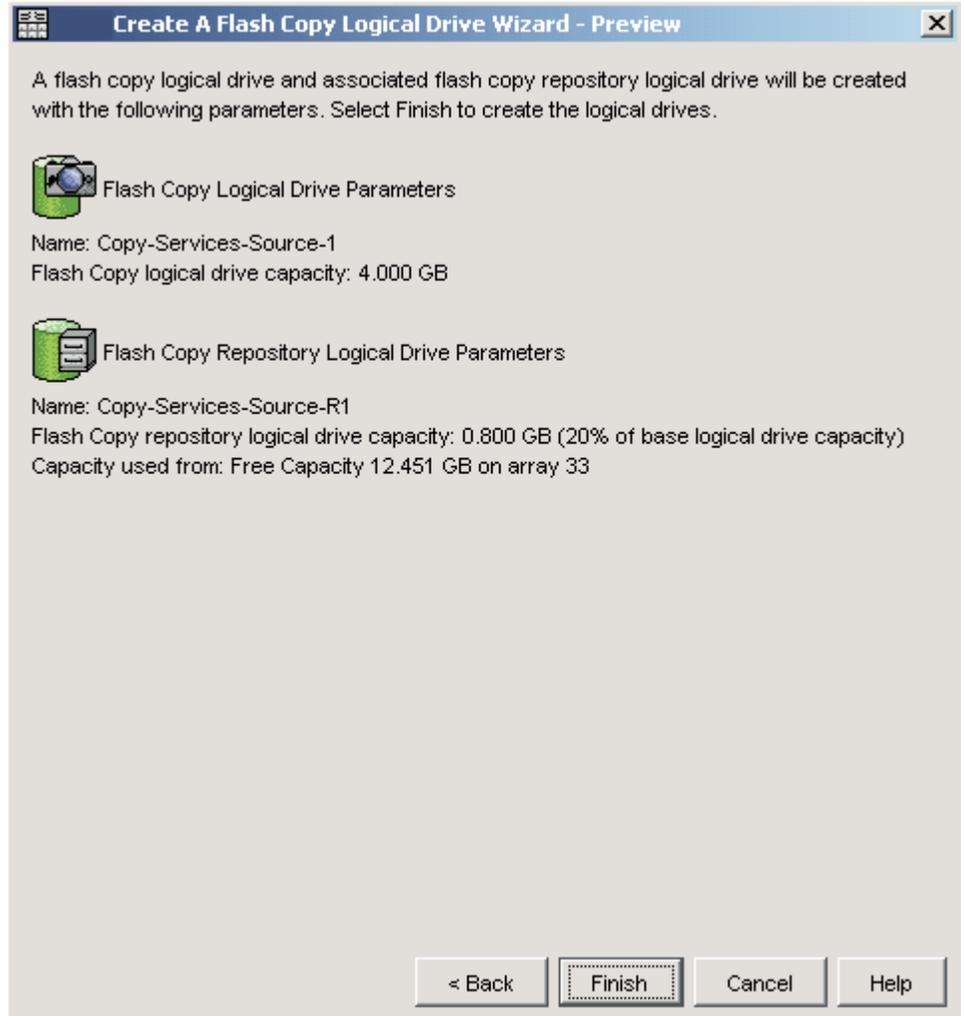
Figure 8. Preview panel

Creating a FlashCopy logical drive

You can create a FlashCopy logical drive using the Create FlashCopy Logical Drive wizard. This section describes how to create a FlashCopy logical drive by performing the following procedures, in the order that they are listed:

1. "Prepare the host operating system"
2. "Creating a FlashCopy logical drive using the FlashCopy Logical Drive wizard" on page 29
3. "Mapping the FlashCopy logical drive to the host" on page 30
4. "Configure the host for the FlashCopy logical drive" on page 33

Attention: Failure to complete the procedures that are required for your host operating system can result in an inaccurate point-in-time image of the base logical drive.

Prepare the host operating system

Before you create the FlashCopy, you must prepare the host operating system. Read the following information, then complete the "Steps for preparing the host operating system" on page 28.

Flushing the operating system cached I/Os to disk

The FlashCopy function provides fast replication of data from the base logical drive to the target logical drive, and copies all data that has been successfully written to the DS4000 by the host. In some environments, data is stored in server memory cache and written to disk at some later time. Two examples of these types of environments are:

- Buffers for a database management subsystem (DBMS)
- Metadata for a journaled file system (JFS)

If buffers from the DBMS or metadata from the journaled file system are not flushed before a FlashCopy operation copies a base to a target, you might have to recreate the FlashCopy. In addition, you might also need to back out of current transactions (for DBMS), or run the fsck utility (for JFS).

To avoid these types of restart actions, ensure that all of the data that is related to the FlashCopy source volume has been written to disk before you perform the FlashCopy operation. For a DBMS, you can accomplish this by quiescing the subsystem or by using a DBMS command such as DB2®'s **LOG SUSPEND**. For a journaled file system, you can accomplish this by unmounting the FlashCopy base logical drive.

Stopping I/O to the base logical drive

In the following procedure, "Steps for preparing the host operating system," you will need to stop I/O by either stopping the host application that is accessing the base logical drive, or by placing the application in backup mode.

If you choose to place the application in backup mode, you must ensure that the application recovery files, such as rollback and redo logs, reside in different physical disk storage or on different logical drives from the FlashCopy base logical drive. Then, back up the application recovery files.

Note: If the recovery files are on the base logical drive, placing the application in backup mode will not stop I/O to the base logical drive.

Steps for preparing the host operating system

Complete the following steps to prepare the host operating system immediately before you create a FlashCopy logical drive. If you plan to use the FlashCopy logical drive at a later date, wait to complete these steps until immediately prior to creating the FlashCopy.

1. Stop the host application that is accessing the base logical drive, or place the application in backup mode.

   Note: Placing the application in backup mode requires some additional preparation. See the preceding section, ″Stopping I/O to the base logical drive.″

2. Synchronize the file system and flush the operating system cached I/Os to disks by unmounting the base logical drive. See the preceding section, ″Flushing the operating system cached I/Os to disk,″ for more information.

   Note: In Microsoft® Windows environments, you can use the SMrepassist utility to flush the operating system cache I/Os, instead of unmounting the base logical drive. For more information on the SMrepassist utility, see the ″SMrepassist″ topic in the Storage Manager online help.

Additional information for Microsoft Windows Server 2003 interfaces:
Windows Server 2003 provides a means for applications to issue calls to flush I/Os and to make flashcopy without having to shut down the applications. The Microsoft Virtual Disk Service (VDS) and Microsoft Volume Shadow-copy Service (VSS) are storage management interfaces for Microsoft Windows Server 2003. VDS and VSS enable your storage array to easily interact with third-party applications that use the VDS or VSS Application Programming Interface (API). Microsoft VDS/VSS is included in the Windows 2003 installation. The SANtricity VDS hardware provider is a Windows Dynamic Linked Library (DLL). It is loaded by VDS and used as a communication channel to your storage array. With the SANtricity VDS hardware provider installed, third-party party applications can send management commands to your storage array. Creating volumes, deleting volumes and unmasking volumes are some the commands supported. It is also possible for third-party applications to obtain status and configuration information on the storage array. The SANtricity VSS hardware provider is a Windows service (.exe). VSS attaches to the service and uses it to coordinate the creation of snapshot volumes on the storage array. VSS-initiated flashcopy volumes can be triggered through third-party backup tools. For information on installing and using SANtricity VDS/VSS, see the README file.

After you have prepared the host operating system, you can create a FlashCopy logical drive using the wizard, as described in the next section.

Creating a FlashCopy logical drive using the FlashCopy Logical Drive wizard

After you prepare the host operating system, create a FlashCopy logical drive using the FlashCopy Logical Drive wizard, which you access through SMclient.

Before you begin: You can refer to "Overview of the FlashCopy Logical Drive wizard" on page 18 to view screen captures of the FlashCopy Logical Drive wizard panels and read descriptions of the parameters.

Perform the following steps to create a FlashCopy logical drive:

1. Select a base logical drive from the Logical/Physical view of the Storage Manager Subsystem Management window.
2. Click **Logical Drive → FlashCopy → Create**.

   Note: If the FlashCopy logical drive is to be based on the root disk of the host operating system, the final point-in-time image might not be completely consistent with the base logical drive.
3. Review the information in the initial panel. Click **OK** to proceed to the wizard introduction panel.
4. Follow the instructions on each wizard panel, and click **Next** when you are ready to continue to the next panel.

   Note: Each wizard panel has context-sensitive help. Click **Help** on a particular panel to receive help for that panel.
5. On the final Preview panel, which displays the associated logical drives and the components that make up the FlashCopy relationship, click **Finish** to continue.
6. The FlashCopy drives are now displayed in the Logical/Physical view of the Subsystem Management window.
7. Restart the host application. After you create one or more FlashCopy logical drives, mount the base logical drive and restart the host application using that base logical drive.

If you did not choose automatic mapping when using the wizard, go to "Mapping the FlashCopy logical drive to the host." If you chose automatic mapping, go to "Configure the host for the FlashCopy logical drive" on page 33.

Note: You are not done creating the FlashCopy logical drive until you have completed the procedure described for your host operating system in "Configure the host for the FlashCopy logical drive" on page 33.

Mapping the FlashCopy logical drive to the host

Use the Mappings view in the SMclient to assign logical drive-to-LUN mappings between the FlashCopy logical drive and the host that will access the FlashCopy logical drive.

Note: Because the FlashCopy logical drive is an exact copy of the original base logical drive, if you map both a base logical drive and its associated FlashCopy logical drives to the same host, it can result in conflicts if the host operating systems or the logical volume manager software depend on the data in the logical drive to identify it. For more information on how to properly configure your host operating system, see "Configure the host for the FlashCopy logical drive" on page 33.

Perform the following steps to map the FlashCopy logical drive to a host:

1. In the SMclient, open the Mappings view of the Subsystem Management window, as shown in Figure 9. The newly-created FlashCopy logical drive displays in the undefined mapping section.
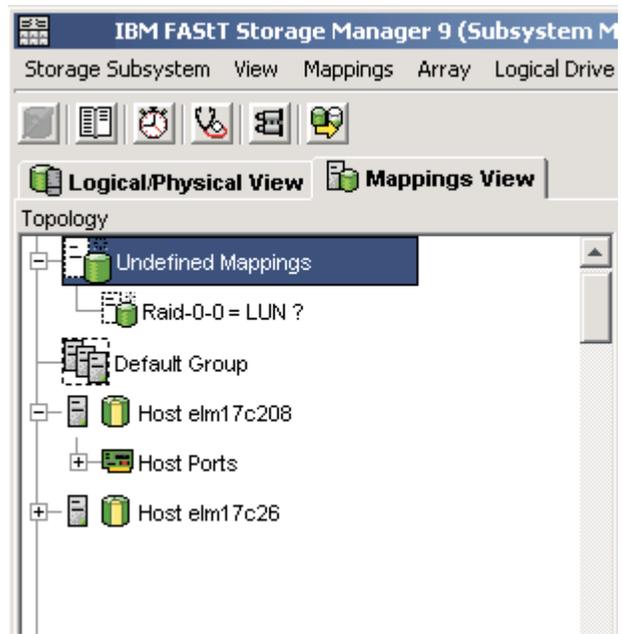
Figure 9. Undefined FlashCopy disk

2. Right-click the host or host group to which you want to map the drive, and click **Define Additional Mapping**, as shown in Figure 10 on page 31.
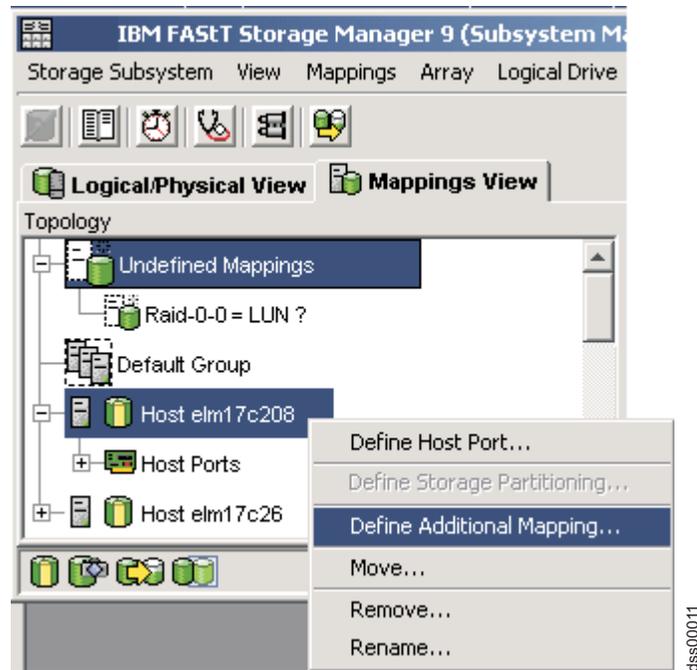
Figure 10. Define Additional Mapping

3. In the Define Additional Mapping window, specify the following options, as shown in Figure 11 on page 32.
   - Select the host or host group.
   - Set the LUN number.
   - Select the FlashCopy logical drive.
   - Click **Add**.
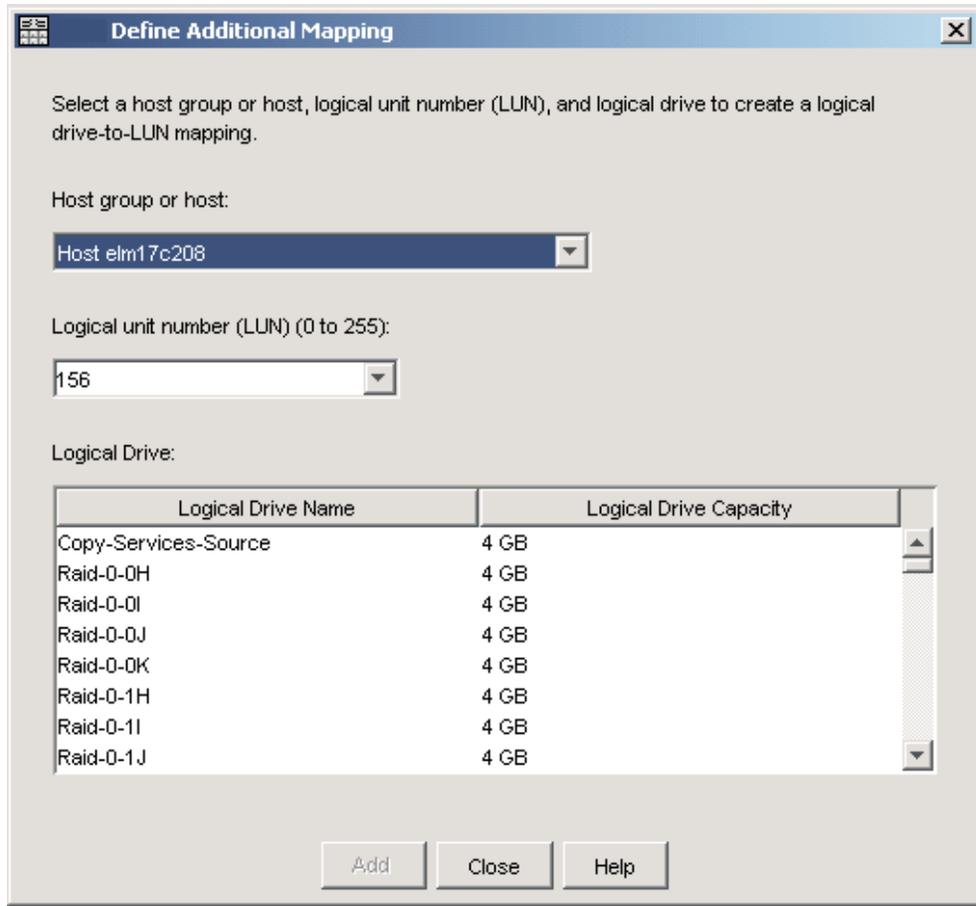
Figure 11. The Define Additional Mapping window

> When you are finished, the FlashCopy logical drive is available to the host or host group, as shown in Figure 12 on page 33.
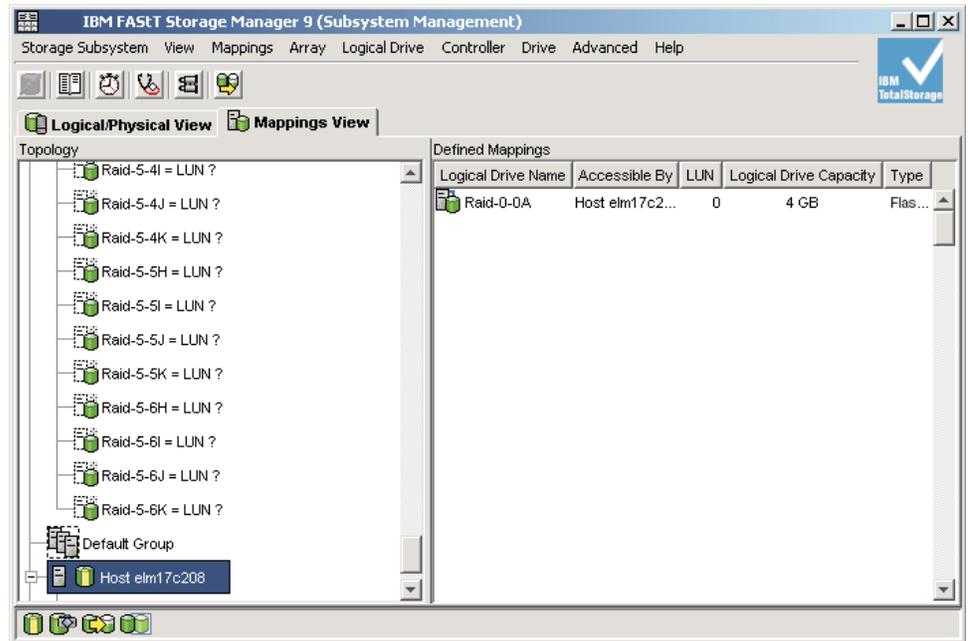
Figure 12. Mapped FlashCopy logical disk

In the mapping example shown in Figure 11 on page 32 and Figure 12, the FlashCopy logical drive named DataVol-1 is made available to the backup server host group. This enables the backup server to access and mount the drive as part of its own file system. It also allows a local backup to be performed by the backup application software.

It is possible to map the FlashCopy logical drive to the same server that owns the base logical drive. However, immediately after you create the FlashCopy, the two logical drives are exactly the same (a block-by-block copy). Many operating systems do not tolerate seeing an exact duplicate logical drive. You might need to complete other steps, such as restarting your computer or running the Hot_Add utility, before you can access the FlashCopy logical drive. For more information, see the *IBM TotalStorage DS4000 Storage Manager Version 9 Installation and Support Guide* for your operating system.

Note: If you use this FlashCopy on a regular basis (for example, for backup purposes), use the Disable FlashCopy and Re-create FlashCopy options to reuse the FlashCopy. Using these options preserves the existing mappings to the FlashCopy logical drive. For more information, see "Disabling a FlashCopy logical drive" on page 48 and "Re-creating a FlashCopy logical drive" on page 50.

After you have mapped the FlashCopy logical drive, configure the host, as described in "Configure the host for the FlashCopy logical drive."

Configure the host for the FlashCopy logical drive

After you use the Create FlashCopy Logical Drive wizard to create the FlashCopy logical drive and map the FlashCopy logical drive to the host, you must complete some additional steps to configure the host operating system.

Complete the procedure that is applicable for your host operating system:
- "Instructions for AIX" on page 34

- "Instructions for HP-UX and Linux" on page 36
- "Instructions for Solaris" on page 38
- "Instructions for Windows 2000 and Windows Server 2003" on page 39
- "Instructions for Windows NT®" on page 39
- "Instructions for Novell NetWare" on page 39

Attention: You must complete the procedure described for your host operating system in this section. Failure to do so can result in an inaccurate point-in-time image of the base logical drive.

Using the script editor and the command-line interface

If you are using an AIX, HP-UX, Linux or Solaris host, you must use the script editor or command line interface (SMcli) to configure your host for the new FlashCopy logical drive.

You can use the script editor to create or edit a script file, save a script file to the local disk of the Storage Management station, or load a script file from disk. You can also use SMcli to issue individual commands to the scripting engine from the host operating system command shell or to call complete prewritten scripts.

For more information about how to use SMcli and the script editor, click on the **Help** tab on the Enterprise Management window.

Instructions for AIX

Use the following procedures on a host that is running AIX using Logical Volume Manager (LVM).

Restrictions:
- FlashCopy logical drives can be created only for AIX arrays. If an array has more than one logical drive, you must create a FlashCopy logical drive for each logical drive in the array.
- AIX does not support the **Fail writes to base logical drive** option of the repository full policy. Selecting this option might cause data loss on the base logical drive. You must ensure that the repository full policy is set to the default option, **Fail FlashCopy logical drive**.

  For information about how to set the repository full policy, see "Changing FlashCopy repository logical drive properties" on page 47.

Before you begin:
- Read the information in "Planning a FlashCopy logical drive" on page 14 and "Using the script editor and the command-line interface."
- Perform the procedures that are described in the previous sections:
  1. "Prepare the host operating system" on page 27
  2. "Creating a FlashCopy logical drive using the FlashCopy Logical Drive wizard" on page 29
  3. "Mapping the FlashCopy logical drive to the host" on page 30

Perform the following steps to configure the AIX host for the new FlashCopy logical drives:
1. Log in to the host as `root`.
2. Ensure that the host operating system recognizes the FlashCopy logical drives. At the host prompt, type the following command and press Enter.

```
cfgmgr
```

Several minutes might pass while the operating system accesses the drives. When the operation completes, a window opens with the following message:

```
Device nodes have been updated
```

The new logical drives are now available from the operating system.

3. At the host prompt, type the following command and press Enter.

```
lspv
```

A list of the physical drives that are recognized by the operating system is displayed.

4. Look for the operating system device name of your FlashCopy logical drive in the list. The list shows a physical logical drive ID (PVID) for the FlashCopy logical drive. This is the same as the PVID for the associated base logical drive, because the FlashCopy logical drive contains the same array data structures as the base logical drive.

5. Clear the PVID for the FlashCopy logical drives. At the host prompt, type the following command and press Enter.

```
chdev -l os_device_name -a pv=clear
```

where *os_device_name* is the operating system device name of the FlashCopy logical drive.

Repeat this step for each FlashCopy logical drive in the AIX array.

6. Re-create a new array using the **recreatevg** command. This command reads the array data structure inside a logical drive and reconstructs it. It also allocates new physical logical drive identifiers (PIDs) to the FlashCopy logical drives and enables access to the FlashCopy logical drive for the selected host.

At the host prompt, type the following command and press Enter:

```
recreatevg -y logical drivegroupname -L /directoryname os_device_name
```

where:

- *logical drivegroupname* is the name that you want to assign to the FlashCopy array.
- *directoryname* is the name of the directory where you want to mount the FlashCopy logical drive.
- *os_device_name* is the operating system device name of the FlashCopy logical drive. If your AIX array contains more than one FlashCopy logical drive, add an *os_device_name* for each logical drive.

The array is re-created, and contains the FlashCopy logical drive or drives.

7. Mount the FlashCopy logical drive to its intended host. At the host prompt, type the following command and press Enter.

```
mount mount-point
```

where *mount-point* is the name of the filesystem that being mounted. Include the *directoryname* that was used in step 6.

8. Ensure that the logical drives are back online. At the host prompt, type the following command and press Enter.

```
df -k
```

A list of the mounted disks displays.

9. Use the FlashCopy logical drive with your backup application or with another application.

10. When the FlashCopy logical drive is no longer required, unmount the filesystem. At the host prompt, type the following command and press Enter.

```
umount mount-point
```

11. Disable or delete the FlashCopy logical drive after it is no longer needed.

If you disable the FlashCopy logical drive instead of deleting it, you can retain the FlashCopy logical drive and its associated FlashCopy repository logical drive. Then, when you need to create a different FlashCopy of the same base logical drive, you can re-create the disabled FlashCopy logical drive. This takes less time than creating a new FlashCopy logical drive and avoids any reduction in performance that might occur if the FlashCopy logical drive remains available.

To disable or delete a FlashCopy logical drive, in the Subsystem Management window, right-click the FlashCopy logical drive icon and select either **Disable** or **Delete**.

12. Delete the array that you created in step 6 on page 35, that contains the FlashCopy logical drives. At the host prompt, type the following commands and press Enter.

```
varyoffvg logical drivegroupname exportvg logical drivegroupname
```

where *logical drivegroupname* is the name of the FlashCopy array.

Instructions for HP-UX and Linux

Use the following procedures on a host that is running HP-UX 11.0 (or higher) and uses LVM (or higher). Failure to complete the steps listed can result in an inaccurate point-in-time image of the base logical drive.

Before you begin:
- Read the information in "Planning a FlashCopy logical drive" on page 14 and "Using the script editor and the command-line interface" on page 34.
- Perform the procedures that are described in the previous sections:
  1. "Prepare the host operating system" on page 27
  2. "Creating a FlashCopy logical drive using the FlashCopy Logical Drive wizard" on page 29
  3. "Mapping the FlashCopy logical drive to the host" on page 30

Perform the following steps to configure the HP-UX host for the new FlashCopy logical drives:

1. At the host prompt, type the following command and press Enter.

```
ioscan -fn
```

A list of the mapped devices that are recognized by the host displays.

Note: If the required device names are not displayed by using this command, type the following command at the host prompt and press Enter.

```
insf
```

2. Remount the base logical drive to its original host.

   Note: If I/O activity to the base logical drive was stopped or data transfer was suspended, resume I/O activity to the base logical drive or re-enable data transfer at this time.

3. Perform the following steps to import the FlashCopy logical drives into the LVM:

   a. Create a new directory for the new array, as shown in the following example.

```
mkdir /dev/vg02
```

   b. Create a group node for the new array, as shown in the following example.

```
mknod /dev/vg02/group c 64 -0x020000
```

   c. Import the FlashCopy logical drive LUNs. At the host prompt, type the following command and press Enter.

```
vgimport /dev/vg02 FlashCopy-block-node-1 FlashCopy-block-node-2
```

   The following example addresses how to handle redundancy with multiple paths. The two paths or nodes represent the primary and alternate paths of the FlashCopy volume.

```
vgimport /dev/vg02 /dev/dsk/c66t0d1 /dev/dsk/c69t0d1
```

   Note: You must verify that the */dev/dsk* device files exist on the FlashCopy logical drive. Use the SMdevices utility or the HP-UX ioscan utility to perform the verification.

   The system displays a warning indicating that a backup of the array that is being imported might not exist on the host. This message is only a warning and requires no response. The import operation continues and completes successfully.

   The backup for this array is created later, when it is exported.

   d. Activate the new array, as shown in the following example:

```
vgchange -a y /dev/vg02
```

4. If a file system existed on the base logical drive, then it also exists on the FlashCopy logical drive. Before you mount the FlashCopy logical drive, however, perform a file system check to ensure that the file system is consistent, for example:

```
fsck /dev/vg02/lvol01
```

5. Mount the FlashCopy logical drive to its intended host.
6. Use the FlashCopy logical drive with your backup application or with another application.
7. Unmount the FlashCopy logical drive.
8. Disable or delete the FlashCopy logical drive after it is no longer needed.

   If you disable the FlashCopy logical drive instead of deleting it, you can retain the FlashCopy logical drive and its associated FlashCopy repository logical drive. Then, when you need to create a different FlashCopy of the same base

logical drive, you can re-create the disabled FlashCopy logical drive. This takes less time than creating a new FlashCopy logical drive and avoids any reduction in performance that might occur if the FlashCopy logical drive remains available.

To disable or delete a FlashCopy logical drive, in the Subsystem Management window, right-click the FlashCopy logical drive icon and select either **Disable** or **Delete**.

Instructions for Solaris

Use the following procedure on a host that is running Solaris 7 and 8. Failure to complete the steps listed can result in an inaccurate point-in-time image of the base logical drive.

Before you begin:
- Read the information in "Planning a FlashCopy logical drive" on page 14 and "Using the script editor and the command-line interface" on page 34.
- Perform the procedures that are described in the previous sections:
    1. "Prepare the host operating system" on page 27
    2. "Creating a FlashCopy logical drive using the FlashCopy Logical Drive wizard" on page 29
    3. "Mapping the FlashCopy logical drive to the host" on page 30

Perform the following steps to configure your operating system:
1. At the host prompt, type the following command and press Enter.

```
/etc/raid/bin/hot_add
```

    This step ensures that the operating system is aware of the newly-created logical drives, without having to restart the host.
2. Run the SMdevices utility to associate the LUN with a host operating system device and to ensure that the FlashCopy logical drive is recognized by the host.

    This step ensures that the logical drive name and the operating system device name (assigned by the operating system) correlate.
3. If you plan to use the FlashCopy logical drive immediately, go to step 4. If you plan to use the FlashCopy logical drive at a later date, disable the FlashCopy logical drive now. Click **Logical Drive → FlashCopy → Disable** in the Subsystem Management window.

    Note: If I/O activity to the base logical drive was stopped or data transfer was suspended, resume I/O activity to the base logical drive or re-enable data transfer at this time.
4. Mount the FlashCopy logical drive to its intended host.
5. Use the FlashCopy logical drive with your backup application, for speculative testing, or with another application.
6. Unmount the FlashCopy logical drive.
7. Disable or delete the FlashCopy logical drive after it is no longer needed.

    If you disable the FlashCopy logical drive instead of deleting it, you can retain the FlashCopy logical drive and its associated FlashCopy repository logical drive. Then, when you need to create a different FlashCopy of the same base logical drive, you can re-create the disabled FlashCopy logical drive. This takes less time than creating a new FlashCopy logical drive and avoids any reduction in performance that might occur if the FlashCopy logical drive remains available.

To disable or delete a FlashCopy logical drive, in the Subsystem Management window, right-click the FlashCopy logical drive icon and select either **Disable** or **Delete**.

Instructions for Windows 2000 and Windows Server 2003

You cannot add the FlashCopy logical drive to the same Windows 2000 or Windows Server 2003 server that the FlashCopy base logical drive is mapped to. You must add the FlashCopy logical drive to another Windows 2000 or Windows Server 2003 server, or unmap the base logical drive from the server that it is mapped to.

Note: Making a FlashCopy of a ″Dynamic Disk″ type of logical drive is not supported on Windows operating systems.

Complete the following steps to configure your host for the new FlashCopy logical drives:

1. Run the hot_add utility to let the system recognize the newly-added FlashCopy logical drive.

   Note: If the system does not recognize the FlashCopy logical drive after you run the hot_add utility, restart the server.

2. In the System Management window, open the Disk Management directory and assign a drive letter or mount point to the new FlashCopy logical drive.

3. When you no longer need the FlashCopy logical drive, remove the drive letter or mount point from the Disk Management directory *before* you delete the FlashCopy logical drive.

Instructions for Windows NT®

Complete the following steps to configure your host for the new FlashCopy logical drive:

1. Run the hot_add utility to let the system recognize the newly-added FlashCopy logical drive.

   Note: If the system does not recognize the FlashCopy logical drive after you run the hot_add utility, restart the server.

2. Resolve duplicate logical drive signatures by typing the following command:

```
SMrepassist -r
```

3. In the NT4 Disk Administrator window, assign a drive letter to the new FlashCopy logical drive.

4. When you no longer need the FlashCopy logical drive, open the NT4 Disk Management window and remove the drive letter *before* you delete the FlashCopy logical drive.

Instructions for Novell NetWare

You cannot add the FlashCopy logical drive to the same NetWare server where the FlashCopy base logical drive is located. You must add the FlashCopy logical drive to another NetWare server, or unmap the base logical drive from the server that it is mapped to.

Complete the following steps to configure your host for the new FlashCopy logical drive:

1. Run the hot_add utility to let the system recognize the newly-added FlashCopy logical drive.

> **Note:** If the system does not recognize the FlashCopy logical drive after you run the hot_add utility, restart the server.

2. Type the logical drive in the command window, or use the Disk Management menu in the ConsoleOne window to verify that the drive is added.

Reusing a FlashCopy logical drive

Typically, after a FlashCopy logical drive is created, it is disabled until a new point-in-time image of the same base logical drive is needed.

To create a new point-in-time image of the same base logical drive, complete the procedure that is applicable for your host operating system:

- "Instructions for AIX"
- "Instructions for HP-UX and Linux" on page 41
- "Instructions for Solaris" on page 43

Instructions for AIX

Before you begin: Stop all I/O activity to the base logical drive, or suspend data transfer. This ensures that you capture an accurate point-in-time image of the base logical drive.

Perform the following steps to create a new point-in-time image of the same base logical drive:

1. Unmount the file systems in the array on which the FlashCopy logical drive is to be based. At the host prompt, type the following command and press Enter.

```
umount mount-point
```

where *mount-point* is the name of the filesystem that is being unmounted.

2. Ensure that the host operating system recognizes the FlashCopy logical drive. At the host prompt, type the following command and press Enter.

```
cfgmgr
```

Several minutes might pass while the operating system accesses the drives. When the operation completes, a window opens that contains the following message:

```
Device nodes have been updated
```

The new logical drives are now available from the operating system.

3. Start the storage management software. The Enterprise Management window opens.

4. Launch a Subsystem Management window using one of the following methods:

   - Select the storage subsystem in either the Device Tree view or Device Table. Click **Manage Device** on the toolbar or click **Tools → Manage Device**.
   - Right-click the storage subsystem in the Device Tree view or from the Device Table, and click **Manage Device**.
   - Double-click a storage subsystem node in the Device Table.
   - Select the storage subsystem in the Device Tree view or from the Device Table, and press Enter.

   The Subsystem Management window opens in a separate window.

5. In the Storage Management software, re-create the FlashCopy logical drive. Click **Logical Drive → FlashCopy → Re-create** in the Subsystem Management window.

6. Clear the PVID for the FlashCopy logical drives. At the host prompt, type the following command and press Enter.

```
chdev -l os_device_name -a pv=clear
```

where *os_device_name* is the operating system device name of the FlashCopy logical drive.

Repeat this step for each FlashCopy logical drive in the AIX array.

7. Re-create a new array. At the host prompt, type the following command and press Enter:

```
recreatevg -y logical drivegroupname -L /directoryname os_device_name
```

where:
- *logical drivegroupname* is the name that you want to assign to the FlashCopy array.
- *directoryname* is the name of the directory where you want to mount the FlashCopy logical drive.
- *os_device_name* is the operating system device name of the FlashCopy logical drive. If your AIX array contains more than one FlashCopy logical drive, add an *os_device_name* for each logical drive.

The array is re-created and contains the FlashCopy logical drive or drives.

8. Mount the filesystem to its intended host. At the host prompt, type the following command and press Enter:

```
mount mount-point
```

where *mount-point* is the name of the filesystem that is being mounted. Include the *directoryname* that was used in step 7.

9. Ensure that the logical drives are back online. At the host prompt, type the following command and press Enter:

```
df -k
```

A list of the mounted disks is displayed.

10. Use the FlashCopy logical drive with your backup application or other application.

11. Disable the FlashCopy logical drive after it is no longer needed.

If you disable the FlashCopy logical drive instead of deleting it, you can retain the FlashCopy logical drive and its associated FlashCopy repository logical drive. Then when you need to create a different FlashCopy of the same base logical drive, you can re-create the disabled FlashCopy logical drive. This takes less time than creating a new FlashCopy logical drive and stops any performance reduction that might occur if the FlashCopy logical drive remains available.

Instructions for HP-UX and Linux

Before you begin: Stop all I/O activity to the base logical drive, or suspend data transfer. This ensures that you capture an accurate point-in-time image of the base logical drive.

Perform the following steps to create a new point-in-time image of the same base logical drive:

1. Start the storage management software. The Enterprise Management window opens.

2. Launch a Subsystem Management window using one of the following methods:
   - Select the storage subsystem in either the Device Tree view or from the Device Table. Then, click **Manage Device** on the toolbar or click **Tools→ Manage Device**.
   - Right-click the storage subsystem in the Device Tree view or from the Device Table, and click **Manage Device**.
   - Double-click a storage subsystem node in the Device Table.
   - Select the storage subsystem in the Device Tree view or from the Device Table, and then press Enter.

   The Subsystem Management window opens in a separate window.

3. Unmount the base logical drive.

4. In the storage management software, re-create the FlashCopy logical drive. Click **Logical Drive → FlashCopy → Re-create** in the Subsystem Management window.

5. Remount the base logical drive to its original host.

   Note: If you stopped I/O activity to the base logical drive or suspended a data transfer, resume I/O activity to the base logical drive or re-enable data transfer at this time.

6. Perform the following steps to import the FlashCopy logical drives into the Logical Volume Manager:

   a. Create a new directory for the new array, as shown in the following example.

   ```
   mkdir /dev/vg02
   ```

   b. Create a group node for the new array, as shown in the following example.

   ```
   mknod /dev/vg02/group c 64 -0x020000
   ```

   c. Import the FlashCopy logical drive LUNs. At the host prompt, type the following command and press Enter.

   ```
   vgimport /dev/vg02 FlashCopy-block-node-1 FlashCopy-block-node-2 ...
   ```

   An alternate command can be used, as shown in the following example.

   ```
   vgimport /dev/vg02 /dev/dsk/c66t0d1 /dev/dsk/c69t0d1
   ```

   Note: You must verify that the */dev/dsk* device files exist on the FlashCopy logical drive. Use the SMdevices utility or the HP-UX ioscan utility to perform this verification.

   A warning is displayed indicating that a backup of the array that is being imported might not exist on the host. This message is only a warning and can be ignored. The import operation continues and completes successfully.

   The backup for this array is created when it is exported later.

d. Activate the new array, as shown in the following example.

```
vgchange -a y /dev/vg02
```

7. If a file system existed on the base logical drive, then it also exists on the FlashCopy logical drive. However, before you mount the FlashCopy logical drive, perform a file system check to ensure that the file system is consistent. For example:

```
fsck /dev/vg02/lvol101
```

8. Mount the FlashCopy logical drive to its intended host.
9. Use the FlashCopy logical drive with your backup application or other application.
10. Unmount the FlashCopy logical drive.
11. Disable the FlashCopy logical drive after it is no longer needed.

    If you disable the FlashCopy logical drive instead of deleting it, you can retain the FlashCopy logical drive and its associated FlashCopy repository logical drive. Then when you need to create a different FlashCopy of the same base logical drive, you can re-create the disabled FlashCopy logical drive. This takes less time than creating a new FlashCopy logical drive and stops any performance reduction that might occur if the FlashCopy logical drive remains available.

Instructions for Solaris

Perform the following steps to create a new point-in-time image of the same base logical drive:

1. Unmount the base logical drive.
2. In the storage management software, re-create the FlashCopy logical drive. Click **Logical Drive → FlashCopy → Re-create** in the Subsystem Management window.
3. Remount the base logical drive to its original host.
4. Mount the FlashCopy logical drive to its intended host.

    Note: If you stopped I/O activity to the base logical drive or suspended data transfer, resume I/O activity to the base logical drive or re-enable data transfer at this time.

5. Use the FlashCopy logical drive with your backup application or with another application.
6. Unmount the FlashCopy logical drive.
7. After the FlashCopy logical drive is no longer needed, disable the FlashCopy logical drive.

    If you disable the FlashCopy logical drive instead of deleting it, you can retain the FlashCopy logical drive and its associated FlashCopy repository logical drive. Then when you need to create a different FlashCopy of the same base logical drive, you can re-create the disabled FlashCopy logical drive. This takes less time than creating a new FlashCopy logical drive and stops any performance reduction that might occur if the FlashCopy logical drive remains available.

Instructions for Windows

Perform the following steps to create a new point-in-time image of the same base logical drive:

1. Stop the host application or suspend data transfer.
2. Run `SMrepassist -f` on the host where the FlashCopy logical drive resides.
3. Disable the FlashCopy logical drive.

   If you disable the FlashCopy logical drive instead of deleting it, you can retain the FlashCopy logical drive and its associated FlashCopy repository logical drive. Then, when you need to create a different FlashCopy of the same base logical drive, you can re-create the disabled FlashCopy logical drive. This takes less time than creating a new FlashCopy logical drive and avoids any reduction in performance that might occur if the FlashCopy logical drive remains available.

   To disable or delete a FlashCopy logical drive, right-click the icon for that FlashCopy logical drive in the Subsystem Management window, and select either **Disable** or **Delete**.

4. Run `SMrepassist -f` on the host where the base logical drive resides.
5. Re-create the FlashCopy logical drive. For instructions about how to re-create a FlashCopy logical drive, see "Re-creating a FlashCopy logical drive" on page 50.
6. Restart the host application or re-enable data transfer.
7. The FlashCopy logical drive is ready to use.
8. Disable the FlashCopy logical drive until it is required again.

Instructions for Novell NetWare

Perform the following steps to create a new point-in-time image of the same base logical drive:

1. Stop the host application or suspend data transfer.
2. Unmount the base logical drive.
3. Re-create the FlashCopy logical drive. For instructions about how to re-create a FlashCopy logical drive, see "Re-creating a FlashCopy logical drive" on page 50.
4. Remount the base logical drive.
5. Restart the host application.
6. Remount the FlashCopy logical drive.
7. The FlashCopy logical drive is ready to use (for backup, speculative test, or upgrades).
8. Unmount the FlashCopy logical drive.
9. Disable the FlashCopy logical drive until it is required again.

   If you disable the FlashCopy logical drive instead of deleting it, you can retain the FlashCopy logical drive and its associated FlashCopy repository logical drive. Then, when you need to create a different FlashCopy of the same base logical drive, you can re-create the disabled FlashCopy logical drive. This takes less time than creating a new FlashCopy logical drive and avoids any reduction in performance that might occur if the FlashCopy logical drive remains available.

   To disable or delete a FlashCopy logical drive, in the Subsystem Management window, right-click the FlashCopy logical drive icon and select either **Disable** or **Delete**.

Performing FlashCopy tasks

This section describes the following FlashCopy tasks:

- Viewing the FlashCopy logical drive status
- Disabling a FlashCopy logical drive
- Re-creating a FlashCopy logical drive
- Resizing a FlashCopy repository logical drive
- Deleting a FlashCopy logical drive
- Viewing and recovering missing logical drives

Viewing the FlashCopy logical drive status

You can determine the status of the FlashCopy logical drive by viewing the icons. The icons change depending of the state of the drive. The logical drive component property display is also useful in determining the state of the logical drives.

Use the FlashCopy Repository Logical Drive - Properties window to view the FlashCopy repository logical drive base and capacity properties. You can also use this window to specify the capacity percentage full and the action to be taken if the FlashCopy repository logical drive becomes full.

The progress of the modification operations displays at the bottom of the window.

FlashCopy icon states

To view the FlashCopy icon, open the Storage Management Device Manager GUI Physical/Logical view. The icon states are shown in Figure 13.

FlashCopy status representation in logical view		
Logical drive status icon	**Mirror status**	**Icon**
FlashCopy	Optimal	
	Disabled	
	Failed	
	Offline	
Repository	Optimal	
	Degraded	
	Failed	
	Full	
	Offline	
	Warning	
Free capacity	Spare capacity	

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Figure 13. FlashCopy icon states

What to do if the FlashCopy repository logical drive becomes full

If the FlashCopy repository logical drive becomes full, you should first, view the current FlashCopy logical drive properties, then you can change the failure settings.

Viewing the current FlashCopy logical drive properties: Complete the following steps to view the current FlashCopy logical drive properties.

1. Select a FlashCopy repository logical drive in the Logical view of the Subsystem Management window.
2. Click **Logical Drive → Properties**. The FlashCopy Repository Logical Drive - Properties window opens. See Figure 14.
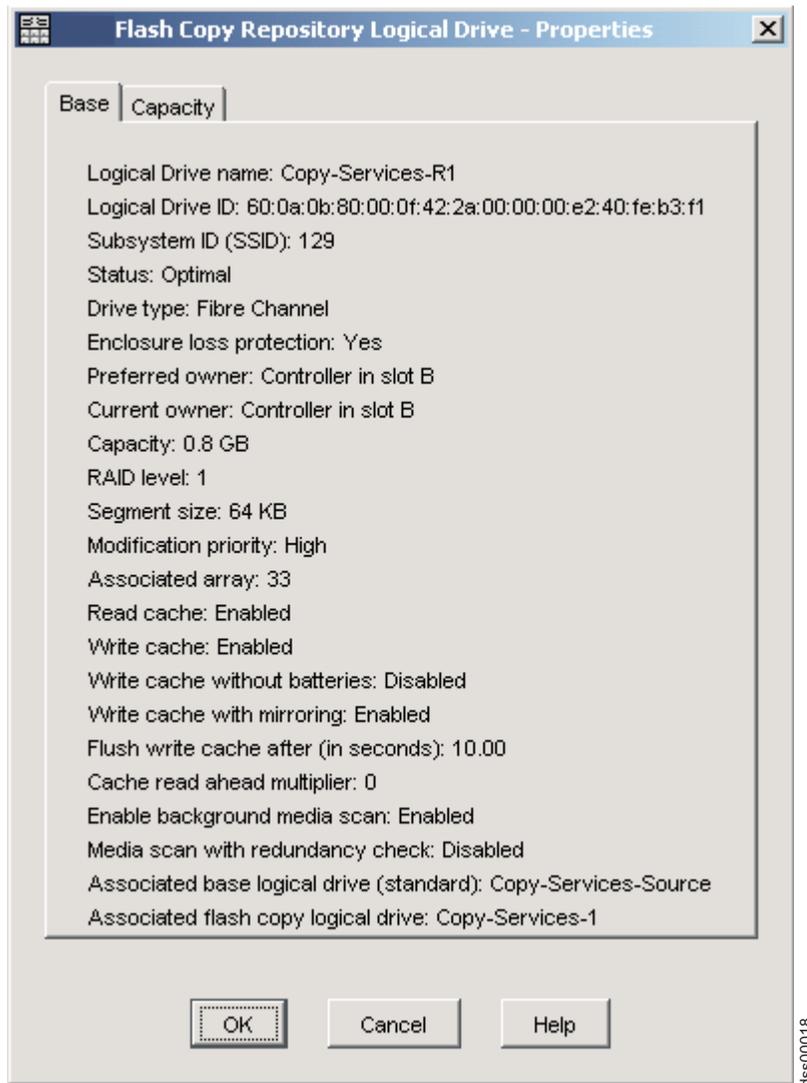
Figure 14. FlashCopy repository logical drive properties

3. Click the **Capacity** tab to view the currently defined settings, as shown in Figure 15 on page 47.
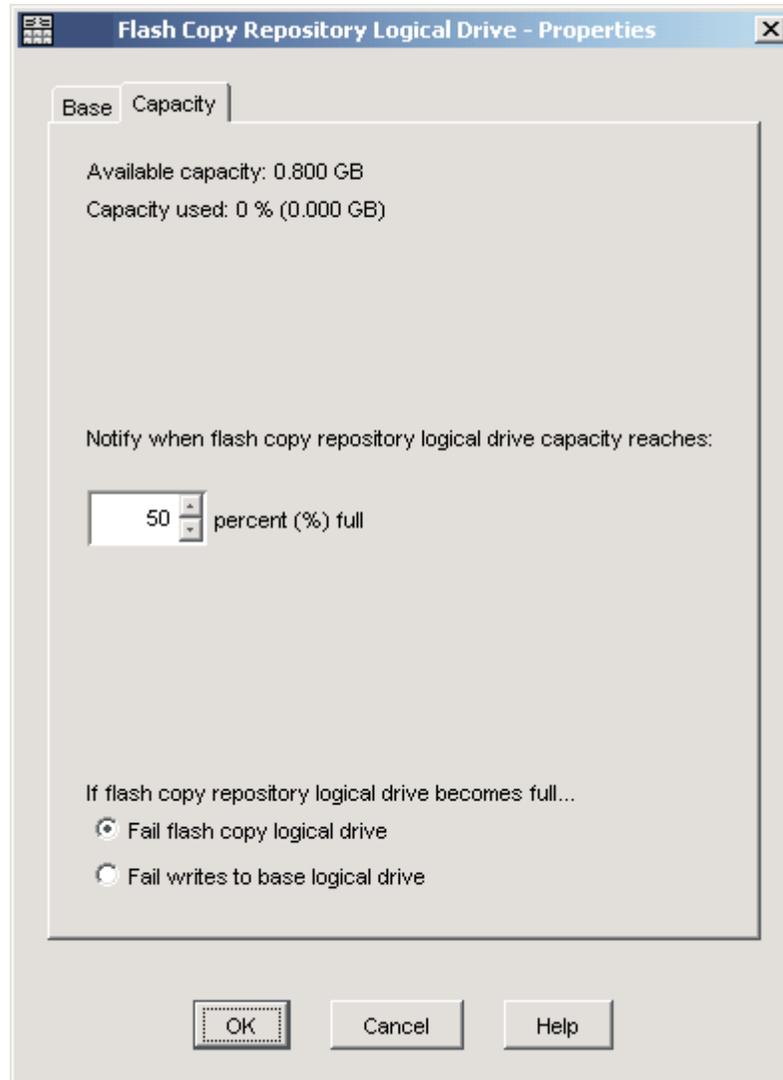
Figure 15. Repository capacity settings

Changing FlashCopy repository logical drive properties: If the repository full policy is set to **Fail FlashCopy logical drive** (default setting), the data is not recoverable when the drive becomes full and FlashCopy cannot be accessed. If this situation occurs, you can perform one of the following actions:

- Delete the FlashCopy logical drive
- Re-create the FlashCopy logical drive to create a new point-in-time image

If the repository full policy is set to **Fail writes to base logical drive**, the data is accessible. However, all write requests to the base logical drive are rejected until the FlashCopy repository logical drive capacity is increased. This is not a recommended setting.

Attention: AIX does not support the **Fail writes to base logical drive** option of the repository full policy. Selecting this option might cause data loss on the base logical drive. If you are using AIX ensure that the default option, **Fail FlashCopy logical drive**, is selected. Be sure to monitor the capacity of the FlashCopy repository logical drive, because the you cannot access the FlashCopy if the repository logical drive becomes full.

For information about increasing the capacity of a FlashCopy repository logical drive, see "Resizing a FlashCopy repository logical drive" on page 51.

Notes:

1. Deleting a FlashCopy logical drive automatically deletes the associated FlashCopy repository logical drive.

2. Deleting a FlashCopy repository logical drive automatically deletes the associated FlashCopy logical drive.

3. Deleting a FlashCopy logical drive, and then creating it again, forces you to stop the host application and unmount the base logical drive while the FlashCopy is being created again.

4. If you re-create a FlashCopy logical drive, you do not need to create a FlashCopy repository logical drive, or remap the assigned logical drive-to-LUN mappings between the FlashCopy logical drive and the host.

5. After you re-create the FlashCopy logical drive, you can change parameters on the FlashCopy repository logical drive through the appropriate menu options.

6. To avoid another *FlashCopy repository logical drive full* failure, increase the capacity of the FlashCopy repository logical drive. For more information, see "Resizing a FlashCopy repository logical drive" on page 51.

Viewing the progress of a modification operation

The progress bar at the bottom of the FlashCopy Repository Logical Drive Properties window displays the progress of an operation. You can view the progress of the following operations:

- Copyback
- Reconstruction
- Initialization
- RAID level change
- Dynamic logical drive expansion
- Capacity increase
- Defragmentation
- Segment size change

> **Note:** The storage management software cannot obtain progress information from the storage subsystem controllers if the network management connection to the controllers is down or if the storage subsystem is partially managed. For more information about a partially managed storage subsystem or an unresponsive controller or storage subsystem condition, see the Enterprise Management window online help.

Disabling a FlashCopy logical drive

If you no longer need a FlashCopy logical drive, you might want to disable it. As long as a FlashCopy logical drive is enabled, your storage subsystem performance can be impacted by copy-on-write activity that is directed to the associated FlashCopy repository logical drive. The copy-on-write activity ends when you disable a FlashCopy logical drive.

If you disable a FlashCopy logical drive instead of deleting it, you can retain it and its associated repository for future use. When you need to create a different FlashCopy of the same base logical drive, you can use the Re-create option to re-enable the previously disabled FlashCopy. This takes less time than creating a new FlashCopy.

When you disable a FlashCopy logical drive, note the following points:

- You cannot use that FlashCopy logical drive again until you use the Re-create option on that logical drive.
- Only that FlashCopy logical drive is disabled. All other FlashCopy logical drives remain functional.

If you do not intend to re-create a FlashCopy, you can delete that FlashCopy logical drive instead of disabling it.

Perform the following steps to disable a FlashCopy logical drive:

1. Select the FlashCopy logical drive. Right-click and select **Disable**, as shown in Figure 16.
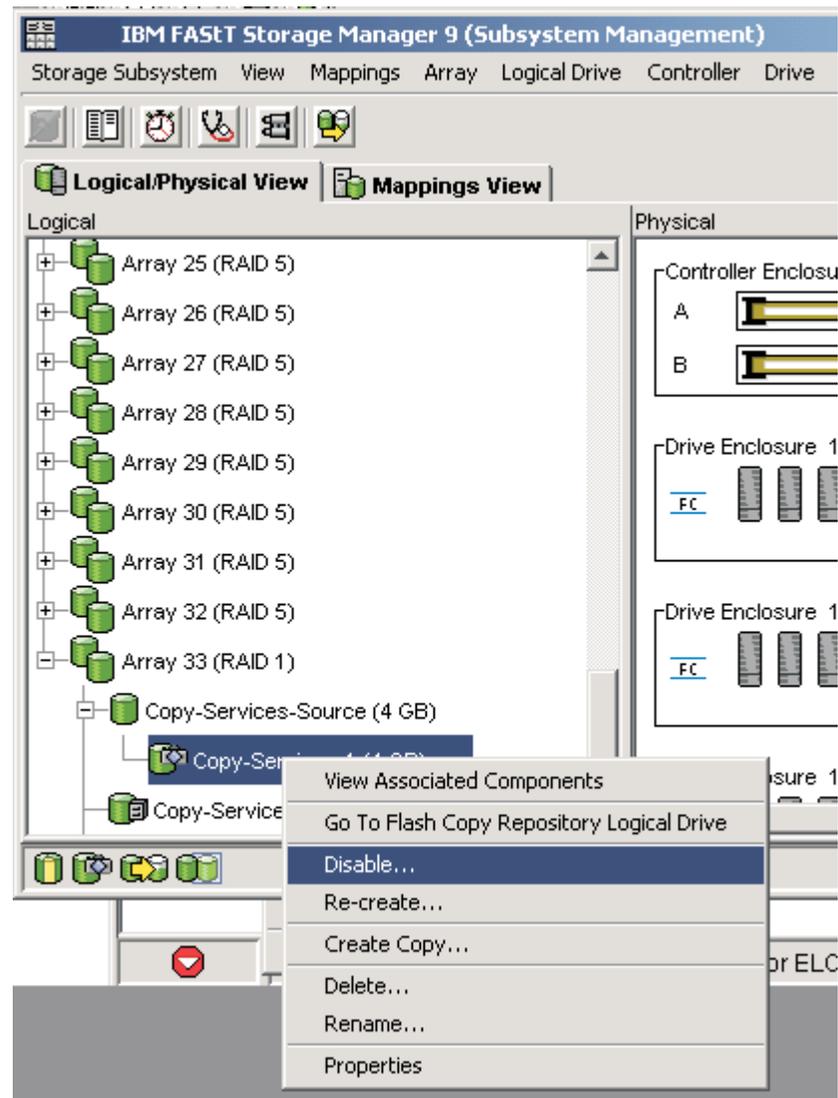
Figure 16. Choosing to disable the FlashCopy drive

2. The Disable FlashCopy Logical Drive confirmation window opens, as shown in Figure 17 on page 50. In this window, type `Yes` and click **OK** to begin the disable operation.
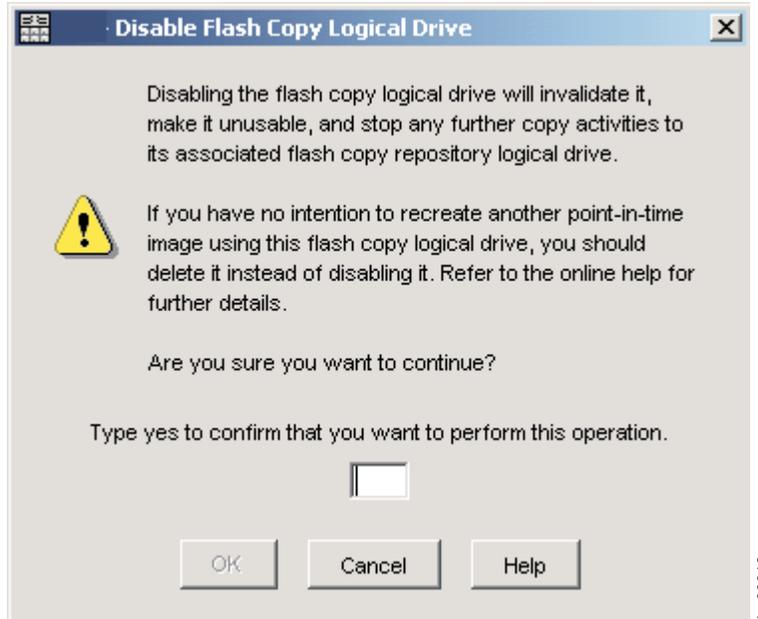
Figure 17. Disable FlashCopy confirmation window

The FlashCopy icon in the Physical/Logical view now displays as disabled.

Re-creating a FlashCopy logical drive

Re-creating a FlashCopy logical drive takes less time than creating a new one. If you have a FlashCopy logical drive that you no longer need, instead of deleting it, you can reuse it (and its associated FlashCopy repository logical drive) to create a different FlashCopy logical drive of the same base logical drive.

When you re-create a FlashCopy logical drive, note the following points:
- The FlashCopy logical drive must be in either an optimal or a disabled state.

  If the FlashCopy logical drive is in an optimal state, the process first disables and then re-creates the FlashCopy logical drive. This process invalidates the current FlashCopy.
- All copy-on-write data on the FlashCopy repository logical drive is deleted.
- When you use the Re-create option, the previously-configured FlashCopy name, parameters, and FlashCopy repository logical drive are used.

  FlashCopy and FlashCopy repository logical drive parameters remain the same as the previously-disabled FlashCopy logical drive and its associated FlashCopy repository logical drive. After you re-create a FlashCopy logical drive, you can change parameters on its associated FlashCopy repository logical drive through the appropriate menu options.
- The system retains the original names for the FlashCopy and FlashCopy repository logical drives. You can change these names, however, after the Re-create option completes.

Before you re-create a FlashCopy logical drive, go to "Prepare the host operating system" on page 27 and perform the procedure to prepare your host operating system. Then, perform the following steps to re-create a FlashCopy drive:
1. Select the FlashCopy logical drive. Right-click and select **Re-Create**, as shown in Figure 18 on page 51.
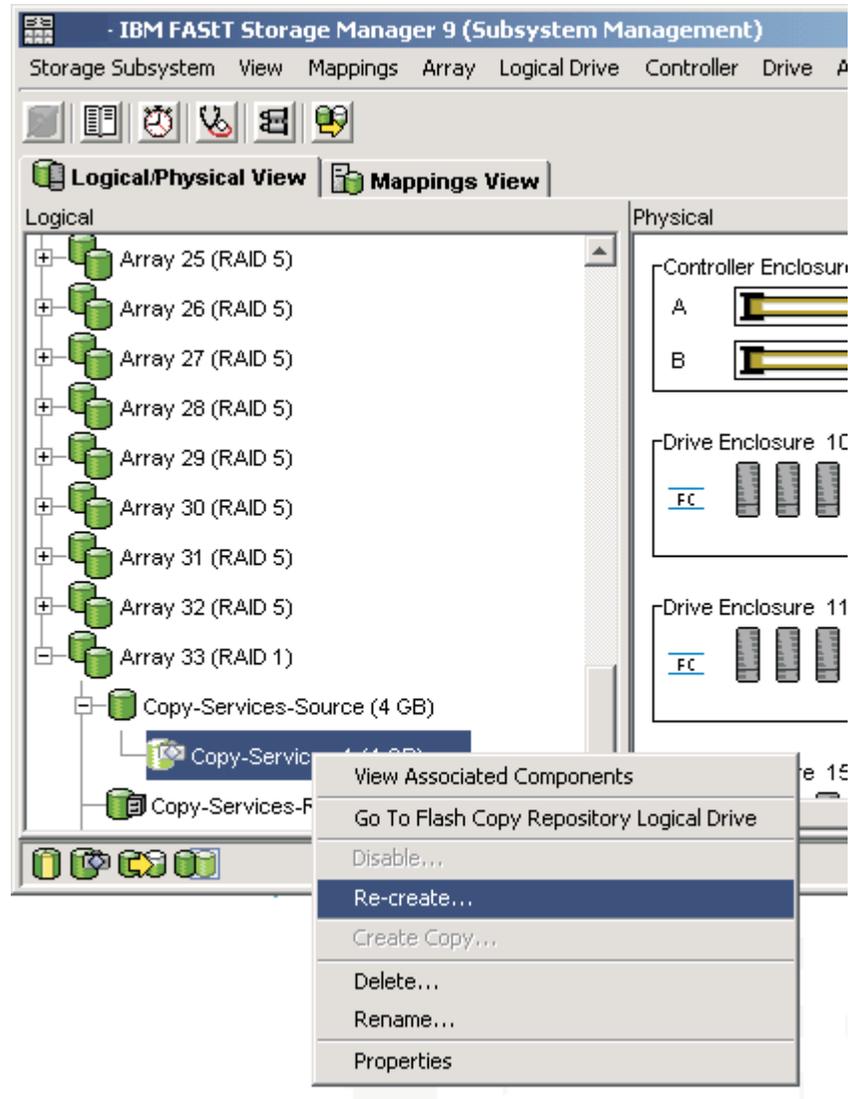
Figure 18. Recreating a FlashCopy logical drive

2. The Re-create FlashCopy Logical Drive window opens. Type `Yes` and click **OK**.

This disables and re-creates the FlashCopy logical drive (if it had not been previously disabled) and displays it in the Logical view in an Optimal state. The creation timestamp shown on the FlashCopy Logical Drive Properties window is updated to reflect the new point-in-time image. Copy-on-write activity resumes to the associated FlashCopy repository logical drive.

Resizing a FlashCopy repository logical drive

Use this option to increase the storage capacity of an existing FlashCopy repository logical drive. Typically, this option is used when you receive a warning that the FlashCopy repository logical drive is in danger of becoming full.

You can achieve an increase in storage capacity by using one of the following methods:

- Use the free capacity that is available on the array of the FlashCopy repository logical drive.

- Add unconfigured capacity (in the form of unused drives) to the array of the FlashCopy repository logical drive. Use this method when no free capacity exists on the array.

    Note: A maximum of two drives can be added at one time to increase FlashCopy repository logical drive capacity.

The storage capacity of a FlashCopy repository logical drive cannot be increased if any of the following conditions exists:

- One or more hot spare drives are in use in the logical drive.
- The logical drive has a non-optimal status.
- Any logical drive in the array is in any state of modification.
- The controller that owns this logical drive is in the process of adding capacity to another logical drive. Each controller can add capacity to only one logical drive at a time.
- No free capacity exists in the array.
- No unconfigured capacity (in the form of drives) is available to add to the array.

Perform the following steps to resize a FlashCopy repository drive:

1. Select a FlashCopy repository logical drive in the Logical view of the Subsystem Management window.
2. Click **Logical Drive → Increase Capacity**.

    Note: If no free capacity or unconfigured capacity is available, the Increase Capacity option is not available.

    An Additional Instructions window opens. Read the information, and click OK if you still want to increase capacity. The Increase Repository Capacity window opens.

    You can see the FlashCopy repository logical drive name, the associated FlashCopy logical drive name, the associated base logical drive name, the current capacity, and the amount of free capacity that is available for the selected repository.

    If free capacity is available, the maximum free space is shown in the **Increase Capacity by** field. If there is no free capacity on the array, the value that is shown in the **Increase Capacity by** field is 0. Add drives to create free capacity on the array of the standard logical drive.
3. Use one of the following two methods to increase capacity:
    - Using the free capacity on the array of the FlashCopy repository logical drive:
        a. Accept the final capacity increase or use the **Increase Capacity by** field to adjust the capacity. Click **OK**.
        b. A confirmation window displays. Type `Yes` and click **OK** to continue.

            The Logical view is updated. The FlashCopy repository logical drive with its capacity increased shows a status of `Operation in Progress`, together with its original capacity and the total capacity being added.
        c. The Free Capacity node involved shows a reduction in capacity. If all of the free capacity is used to increase the logical drive size, then the Free Capacity node involved is removed from the Logical view.
    - Adding unconfigured capacity (drives) to the array of the FlashCopy repository logical drive:
        a. If there are no unassigned drives available and empty slots in the storage expansion enclosures are available, insert new drives.

If there are no unassigned drives available, and there are no empty slots available in the storage expansion enclosures, install another storage expansion enclosure and additional drives.

b. Click **Add Drives**.

The Increase Repository Capacity - Add Free Capacity window opens. Details about enclosure, slot, and usable capacity for the available free drives are displayed.

> **Note:** The drives that are displayed have a capacity that is either equivalent to or larger than those that are already employed by the array.

c. Select a single drive, or two drives, to be added:
   – Press Ctrl+Enter to select the nonadjacent drives.
   – Press Shift+Enter to select the adjacent drives.

d. Click **Add**.

The Add Free Capacity window closes. Check the **Drives to add [enclosure, slot]** field to ensure that the correct drives are added.

e. Accept the final capacity or use the **Increase Capacity by** field to adjust the capacity.

f. Click **OK**.

g. A confirmation window opens. Type `Yes` to confirm the operation, and click **OK** to continue.

The Logical view is updated. The FlashCopy repository logical drive that is having its capacity increased shows a status of `Operation in Progress`. It also shows its original capacity and the total capacity that is being added. The Free Capacity node involved in the increase shows a reduction in capacity.

If all of the free capacity is used to increase the size of the logical drives, then the Free Capacity node that is involved is removed from the Logical view.

If a Free Capacity node did not exist before you added capacity and not all of the capacity that is added will be used to increase the capacity of the FlashCopy repository logical drive, a new Free Capacity node is created and displayed in the Logical view.

Unassigned drives (unconfigured capacity) that are added to increase the FlashCopy repository logical drives capacity change in the Physical view to assigned drives. They become associated to the array of the FlashCopy repository logical drive.

4. View the progress of the capacity increase process. Select the FlashCopy repository logical drive. Click **Logical Drive → Properties**.

The FlashCopy Repository Logical Drive - Properties window opens. A progress bar at the bottom of the window indicates the status of the capacity increase.

Deleting a FlashCopy drive

Use this option to delete a FlashCopy logical drive that is no longer needed for backup or application testing purposes. This option results in an increase of free capacity in the array or additional unconfigured capacity.

Notes:

1. When you delete a logical drive, all data on the logical drive is lost. Back up the data and stop all I/O before you perform this operation, if necessary.

2. If a file system is mounted on the logical drive, unmount it before you perform this operation.

3. When you delete a base logical drive, the associated FlashCopy logical drive and FlashCopy repository logical drive are automatically deleted.

Perform the following steps to delete a FlashCopy drive:

1. Select the FlashCopy logical drive in the Logical view.

2. Click **Logical Drive → Delete**, as shown in Figure 19.
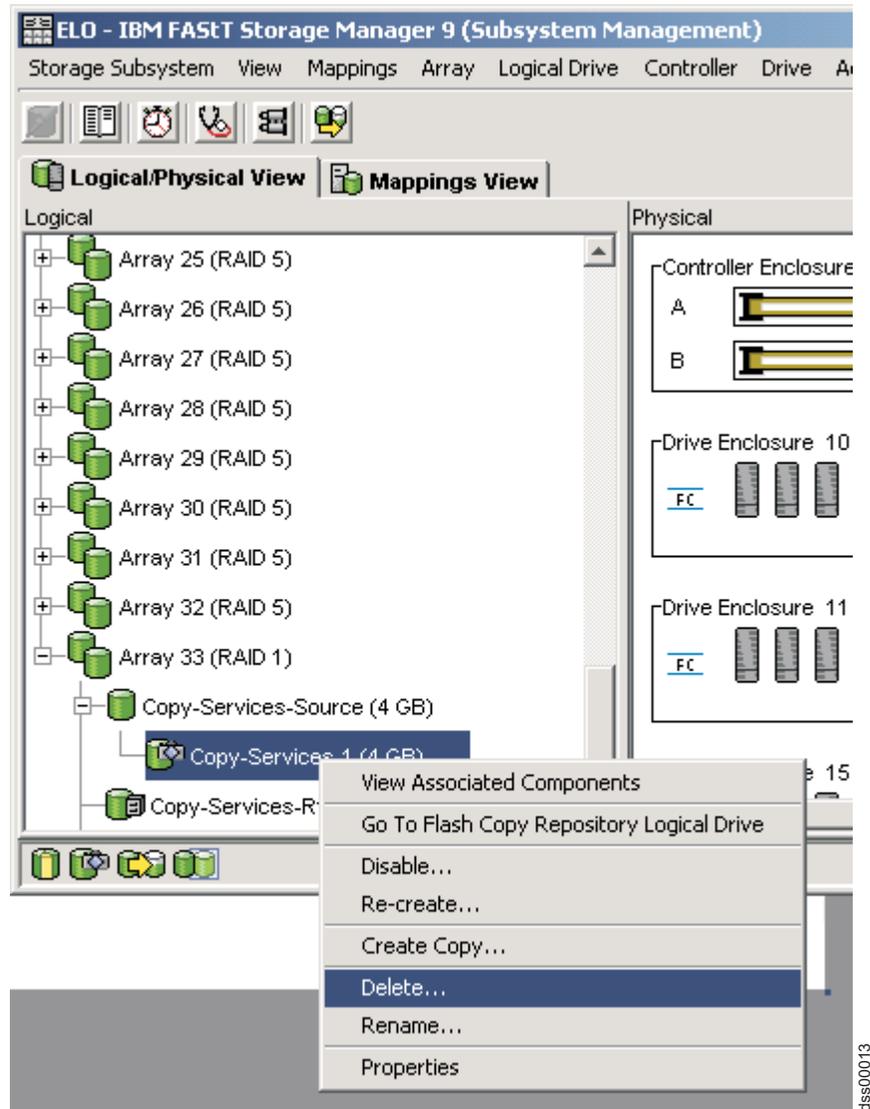
Figure 19. Deleting the FlashCopy logical drive

3. The Delete FlashCopy Logical Drive window opens, as shown in Figure 20 on page 55. Type `Yes` and click **OK**.
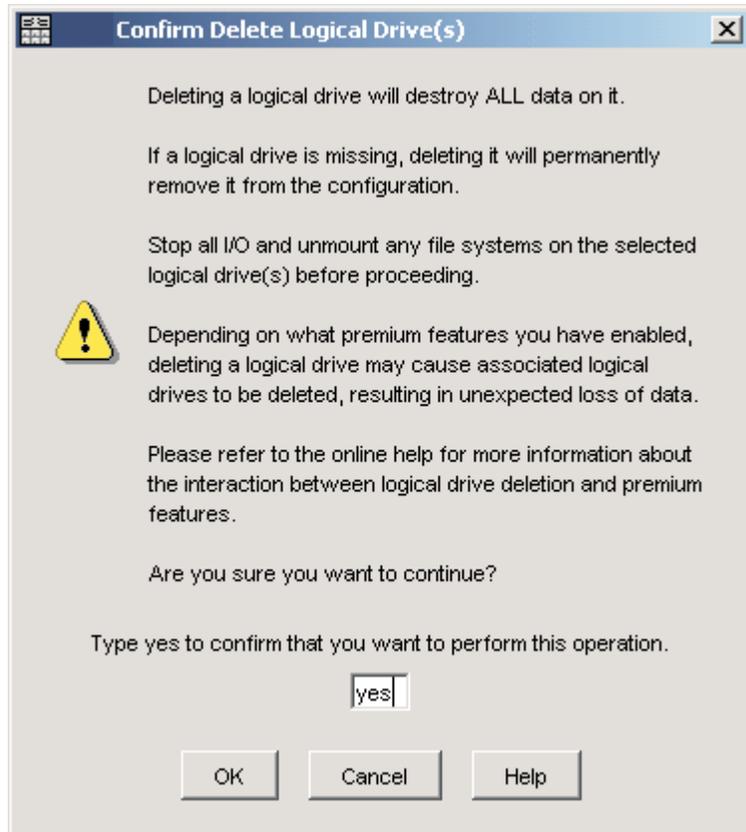
Figure 20. Delete FlashCopy Logical Drive window

The FlashCopy logical drive and the FlashCopy repository logical drive are deleted, destroying any data that they contained.

Chapter 3. Overview of VolumeCopy

VolumeCopy is a premium feature that comes with the DS4000 Storage Manager software and is enabled by purchasing a premium feature key. VolumeCopy is used in conjunction with FlashCopy and, therefore, it can be purchased together with FlashCopy as a single copy service option, or at a later time as an enhancement to FlashCopy.

The VolumeCopy feature is a firmware-based mechanism that you use to copy data from one logical drive (the *source* logical drive) to another logical drive (the *target* logical drive) in a single storage subsystem. The source logical drive and the target logical drive in a VolumeCopy operation that are located on the same storage subsystem can also be referred to as a *VolumeCopy pair*.

Important: If the logical drive that you want to copy is used in a production environment, the FlashCopy feature must be enabled. A FlashCopy of the logical drive must be created and then specified as the VolumeCopy source logical drive, instead of using the actual logical drive itself. This requirement allows the original logical drive to continue to be accessible during the VolumeCopy operation.

With VolumeCopy, you can also copy data from arrays that use smaller capacity drives to arrays that use larger capacity drives, back up data, or restore FlashCopy logical drive data to the base logical drive. The VolumeCopy feature includes a Create Copy wizard that you use to create a VolumeCopy operation, and a Copy Manager that you use to monitor logical drive copies after they have been created.

The VolumeCopy feature is useful for the following tasks:

Copying data for greater access
> As your storage requirements for a logical drive change, you can use VolumeCopy to copy data to a logical drive in an array that uses larger capacity disk drives within the same storage subsystem. You can move data to larger drives (for example, 73 GB to 146 GB), change to drives with a higher data transfer rate (for example, 1 Gbps to 2 Gbps), or change to drives that use new technologies for higher performance.

Backing up data
> With VolumeCopy you can create a backup of a logical drive by copying data from one logical drive to another logical drive in the same storage subsystem. You can use the target logical drive as a backup for the source logical drive, for system testing, or to back up to another device, such as a tape drive.

Restoring FlashCopy logical drive data to the FlashCopy base logical drive
> If you need to restore data to the FlashCopy base logical drive from its associated FlashCopy logical drive, you can use the VolumeCopy feature to copy the data from the FlashCopy logical drive to another logical drive (the VolumeCopy target logical drive) first. Then, copy the data on the VolumeCopy target logical drive back to the FlashCopy base logical drive.
>
> For more information about FlashCopy, see Chapter 2, "Overview of FlashCopy," on page 13.

Using VolumeCopy with FlashCopy

VolumeCopy is used with FlashCopy. It can be purchased together with FlashCopy as a single copy service option, or at a later time as an enhancement to FlashCopy.

Before you create a VolumeCopy, you first create a FlashCopy of the logical drive that you want to copy. During the VolumeCopy operation, use the FlashCopy as the source logical drive of the VolumeCopy pair.

Note: A VolumeCopy operation will fail all FlashCopy logical drives that are associated with the target logical drive, if any exist. You must disable all FlashCopy logical drives that are associated with the base logical drive before you can select the base logical drive as a target logical drive. Otherwise, you cannot use the base logical drive as a target logical drive.

Enabling the VolumeCopy feature

To enable VolumeCopy, you must perform the following two procedures in the following order:

1. Obtain the feature enable identifier. This procedure is described in detail in "Obtaining the feature enable identifier" on page 9.

2. Generate the feature key file and enabling VolumeCopy. This procedure is described in detail in "Generating the feature key file and enabling the premium feature" on page 9.

Before you begin, gather the following information:

- Your Feature Activation Code, which is printed on the IBM FlashCopy Premium entitlement card
- Your controller unit IBM serial number, which is printed on the label on the back of your DS4000 controller unit
- A 32 alphanumeric IBM DS4000 Storage Subsystem premium feature identifier string.

To obtain the storage subsystem premium feature identifier string, ensure that your controller unit and storage expansion enclosures are connected, powered on, and managed using the SMclient.

For more details about how to enable the VolumeCopy feature, see "Enabling premium features" on page 8. For information about how to view a list of those premium features that are enabled on your storage subsystem, see "Viewing the status of premium features" on page 9.

If the VolumeCopy feature is disabled, but VolumeCopy pairs exist, all of the options in the Copy Manager (stop copy, remove copy pairs, start copy, enable and disable read-only) will still be available. However, you will not be permitted to create any new VolumeCopies.

Create Copy wizard

The Create Copy wizard guides you through the VolumeCopy process. The Create Copy wizard helps you to select a source logical drive from a list of available logical drives, select a target logical drive from a list of available logical drives, and set the copy priority for the VolumeCopy operation. When you have completed the wizard panels, the VolumeCopy operation starts and data is read from the source logical drive and written to the target logical drive.

Creating a VolumeCopy

The process of creating a VolumeCopy (copying data from the source volume to the target volume) is managed by the controllers and is transparent to host machines

and applications. This section describes how you use the storage management software to copy data with VolumeCopy, and the actions taken by the controllers during the creation of a VolumeCopy.

The Create Copy wizard guides you through the steps to create a new VolumeCopy.

Before you begin: Create a FlashCopy of the logical drive that you want to copy. During the VolumeCopy operation, you use the FlashCopy logical drive as the source logical drive of the VolumeCopy pair.

See "Creating a FlashCopy logical drive" on page 27 for information about how to create a FlashCopy.

Note: Before you use the Create FlashCopy Logical Drive wizard to create a FlashCopy logical drive, you must read the information in "Prepare the host operating system" on page 27.

Perform the following steps to create a VolumeCopy using the Create Copy wizard:
1. Stop all I/O activity to the target logical drive.

   For more information about what types of logical drives are acceptable for source and target logical drives, see "Selecting the source logical drive" on page 60 and "Selecting the target logical drive" on page 61.
2. Unmount any filesystems on the target logical drive.
3. Select the source logical drive (the FlashCopy that you just created) in the Logical view of the Subsystem Management window.
4. Click **Logical Drive → VolumeCopy → Create** .

   The Create Copy Wizard - Introduction panel displays. Select the source logical drive from the list of valid source logical drives on the storage subsystem.

   Note: If the FlashCopy logical drive that you selected to start the wizard is a valid source logical drive, it is highlighted in the table.
   Click **Next**. The Select Target Volume and Copy Priority panel opens.
5. Select the target logical drive for the VolumeCopy operation and set the copy priority.

   The copy priority determines how much of the resources of the controller are used to complete the VolumeCopy operation versus to fulfill I/O activity. For more information about selecting a target logical drive, see "Selecting the target logical drive" on page 61. For more information about the copy priority, see "Setting the copy priority" on page 64.

   Click **Next**. The Preview panel opens.
6. Review the source logical drive, the target logical drive and copy priority that you specified in the previous steps. If all the information is correct, type yes and click **Finish** to start the VolumeCopy operation.

   Note: For more information about the Preview panel, see "The Preview panel of the Create Copy wizard" on page 65.

When you have completed the wizard tasks, the VolumeCopy operation starts and the preferred controller of the source logical drive reads data from the source logical drive and writes it to the target logical drive. **Operation in Progress** icons display on the source logical drive and target logical drive while the VolumeCopy operation completes.

While a VolumeCopy operation has a status of `In Progress`, `Pending`, or `Failed`:
- The source logical drive is available for read I/O activity only
- The target logical drive is not available for read or write I/O activity

After the VolumeCopy operation completes:
- The source logical drive is available for both read and write I/O activity
- The target logical drive is available for read I/O activity, unless the Read-Only attribute has been disabled. For more information about setting the Read-Only attribute on the target logical drive, see "Setting the target logical drive read-only attribute option" on page 77.

Important: A maximum of eight VolumeCopy copies can be `In Progress` at one time. If you create more than eight VolumeCopy copies, they will have a status of `Pending` until one of the VolumeCopies with a status of `In Progress` completes.

While a VolumeCopy operation is `In Progress`, the same controller must own both the source logical drive and target logical drive. If the same controller does not own both the source logical drive and target logical drive before you begin the the VolumeCopy operation, ownership of the target logical drive is automatically transferred to the controller owner of the source logical drive.

When the VolumeCopy operation completes or is stopped, ownership of the target logical drive is restored to its preferred controller. If ownership of the source logical drive changes during the VolumeCopy operation, ownership of the target logical drive also changes.

Selecting the source logical drive

The first panel of the Create Copy wizard is the Introduction panel. The Introduction panel defines what a VolumeCopy is and allows you to select a source logical drive. The table that is displayed on the Introduction panel contains all the valid source logical drives on the storage subsystem, including the logical drive that you selected to start the wizard.

Note: Before you start the VolumeCopy operation, use the FlashCopy feature to create a FlashCopy of the logical drive that you want to copy, and use it as the source logical drive of the VolumeCopy pair.

The source logical drive is a FlashCopy logical drive that accepts host I/O requests and stores application data. When the VolumeCopy operation is started, all data from the source logical drive is copied to the target logical drive.

The source logical drive is available for read I/O activity only while a VolumeCopy operation has a status of `In Progress`, `Pending`, or `Failed`. Write requests are allowed after the VolumeCopy operation is completed.

All valid source logical drives on the storage subsystem are displayed in the list in the Introduction panel. The logical drive that you selected to start the wizard is highlighted.

Note: In addition to the FlashCopy logical drives that are listed in the Introduction panel, standard logical drives and Remote Mirror primary logical drives are also displayed. However, do not use standard or Remote Mirror primary logical drives as source logical drives for a VolumeCopy.

The following logical drives are not valid source logical drives and do not display on the list:

- A Remote Mirror secondary logical drive
- A Remote Mirror repository logical drive
- A FlashCopy repository logical drive
- A failed logical drive
- A missing logical drive
- A logical drive that is currently in a modification operation
- A logical drive that is holding a legacy or persistent reservation
- A logical drive that is a source logical drive or target logical drive in another VolumeCopy operation with a status of `In Progress`, `Failed`, or `Pending`

From the Introduction panel, you can open the View Drives window to view drive, slot, and capacity of the selected source logical drive. You can use this information to copy high-access logical drives to different arrays for increased accessibility, or to copy logical drives to an array that uses larger capacity drives.

Note: After the VolumeCopy operation completes for a VolumeCopy pair, you do not need to perform any additional processing or synchronization between the source and the target logical drives. If you recopy, it causes the VolumeCopy to start copying from the beginning of the source logical drive. Therefore, a source logical drive can be in as many VolumeCopy pairs as there are eligible target logical drives in the storage subsystem.

Selecting the target logical drive

In the Create Copy Wizard: Select Target Logical Drive and Copy Priority panel, you can select the target logical drive for the VolumeCopy and set the copy priority as shown in Figure 21 on page 62. For more information about setting the copy priority, see "Setting the copy priority" on page 64.
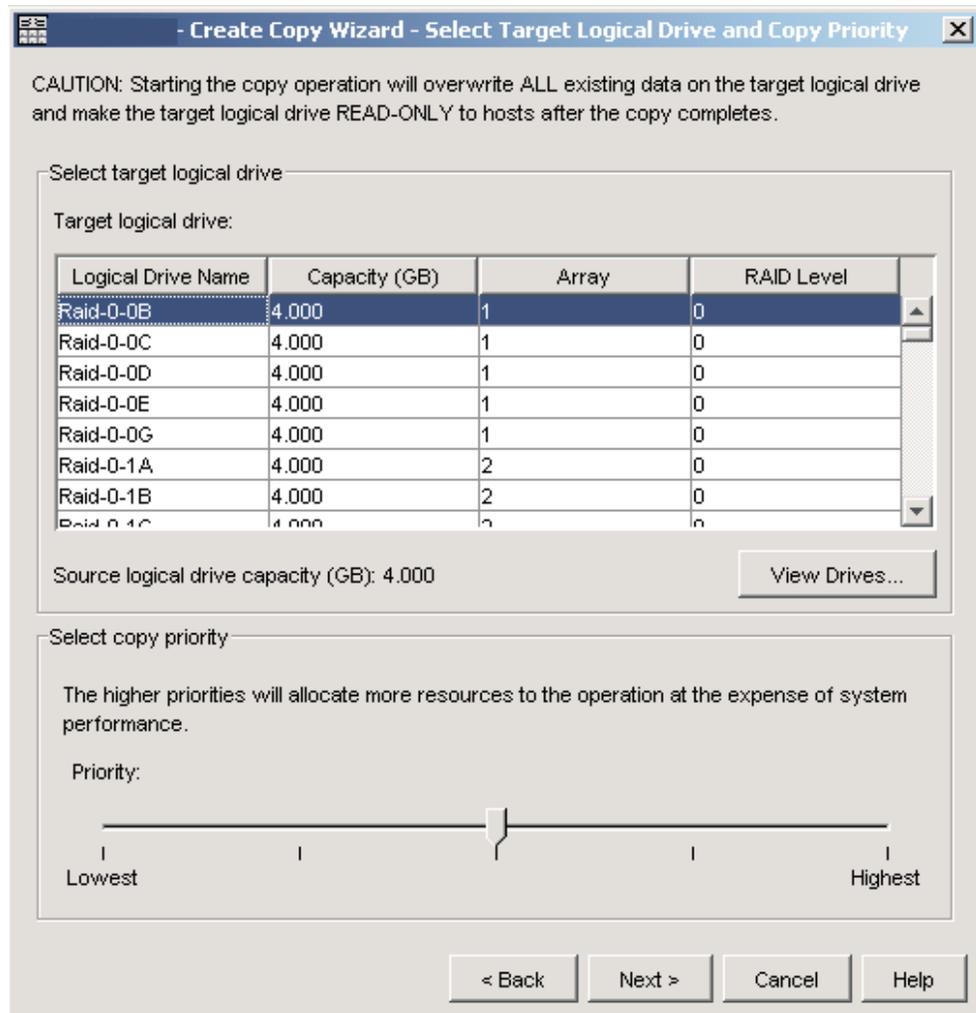
Figure 21. Select Target Logical Drive and Copy Priority panel of the Create Copy wizard

A target logical drive is a standard logical drive in a VolumeCopy logical drive pair that contains a copy of the data from the source logical drive. Read and write requests to the target logical drive will not take place while the VolumeCopy operation has a status of `In Progress`, `Pending`, or `Failed`.

Note: The target logical drive capacity must be equal to or greater than the usable capacity of the *original* source logical drive (not the FlashCopy of the original logical drive).

Important: A VolumeCopy overwrites data on the target logical drive and automatically makes the target logical drive read-only to hosts.

When a VolumeCopy operation is started, the data from the source logical drive is written to the target logical drive. However, if the VolumeCopy operation is stopped, and then restarted using the Re-Copy option, the data on the source logical drive might not be the same as the data on the target logical drive. If hosts have been mapped to the source logical drive before the VolumeCopy operation was restarted, the data that will be copied to the target logical drive when you re-copy might have changed since the previous VolumeCopy was created. So the VolumeCopy operation always copies the image of the source logical drive at the time the copy operation starts, not a second earlier or later.

Important: A VolumeCopy operation will overwrite data on the target logical drive and automatically make the target logical drive read-only to hosts. After the VolumeCopy operation completes, use the Copy Manager to disable the read-only attribute for the target logical drive. If you have used the target logical drive in a VolumeCopy operation before, make sure that you no longer need that data or have backed it up. For more information about the read-only attribute, see "Setting the target logical drive read-only attribute option" on page 77.

All valid target logical drives on the storage subsystem are displayed in the list in the Select Target Logical Drive window.

The following drives can be used as a target logical drive:
- A standard logical drive
- A Remote Mirror primary logical drive
- A base logical drive of a disabled or failed FlashCopy logical drive

   Note: You must disable all FlashCopy logical drives that are associated with the base logical drive before you can select it as a target logical drive. Otherwise, the base logical drive cannot be used as a target logical drive.

The following logical drives are not valid target logical drives and do not display on the list:
- A Remote Mirror secondary logical drive
- A Remote Mirror repository logical drive
- A FlashCopy logical drive
- A FlashCopy repository logical drive
- A base logical drive of an optimal FlashCopy logical drive
- A failed logical drive
- A missing logical drive
- A logical drive with a status of `Degraded`
- A logical drive that is currently in a modification operation
- A logical drive that is holding a legacy or persistent reservation
- A logical drive that is a source logical drive or target logical drive in another VolumeCopy operation that has a status of `In Progress`, `Failed`, or `Pending`
- A logical drive that has already been defined as a target logical drive for another VolumeCopy pair

You can also create a target logical drive specifically for the VolumeCopy operation. For more information, see "Creating a Storage Subsystem Logical Drive" in the Subsystem Management online help.

Note: After you have selected or created a target logical drive, give it a unique name so that it is easily recognizable in the Logical view. For example, if the source logical drive name is `Accounting`, name the target logical drive `Accounting-Copy`. That way you can quickly identify the source logical drives and target logical drives that are available on the storage subsystem.

From the Select Target Logical Drive and Copy Priority panel, you can open the View Drives window to view drive, slot, and capacity of the target logical drive. You can use this information to copy high-access logical drives to different arrays for increased accessibility, or to copy logical drives to an array that uses larger capacity drives.

For more information about source logical drives and target logical drives, see "Restrictions" on page 73.

Setting the copy priority

In the Select Target Logical Drive and Copy Priority panel you can set the copy priority for the VolumeCopy operation as shown in Figure 21 on page 62.

Several factors contribute to system performance including the following factors:

- I/O activity

    VolumeCopy diverts controller processing resources from I/O activity. The copy priority defines how much of the system resources are used to complete a VolumeCopy operation versus fulfill I/O requests.

- The logical drive RAID level
- The logical drive configuration

    The number of drives in the array or cache parameters

- The logical drive type

    FlashCopy logical drives may take more time to copy than standard logical drives

- The source logical drive capacity

    All the data in the source logical drive copies to the target logical drive.

- The number of other VolumeCopy operations being performed at the same time
- The hard drive family type
- The number of hard drives that make up the logical drive

You can set the priority of each active VolumeCopy operation in the Create Copy wizard with respect to other tasks in the DS4000 Storage Subsystem. You can use the Copy Manager to change the copy priority after it is set and you can change the priority of the VolumeCopy operation while it is actively copying.

The following copy priority rates are available:

- Lowest
- Low
- Medium
- High
- Highest

The Highest priority rate supports the VolumeCopy operation, but I/O activity might be affected. The Lowest priority rate supports I/O activity, but the VolumeCopy operation will take longer.

For more information, see "Changing Copy Priority" on the **How To** tab in the Subsystem Management window online help.

The Preview panel of the Create Copy wizard

The Preview panel provides an overview of the selected source logical drive, target logical drive, and copy priority for the VolumeCopy operation as shown in Figure 22.
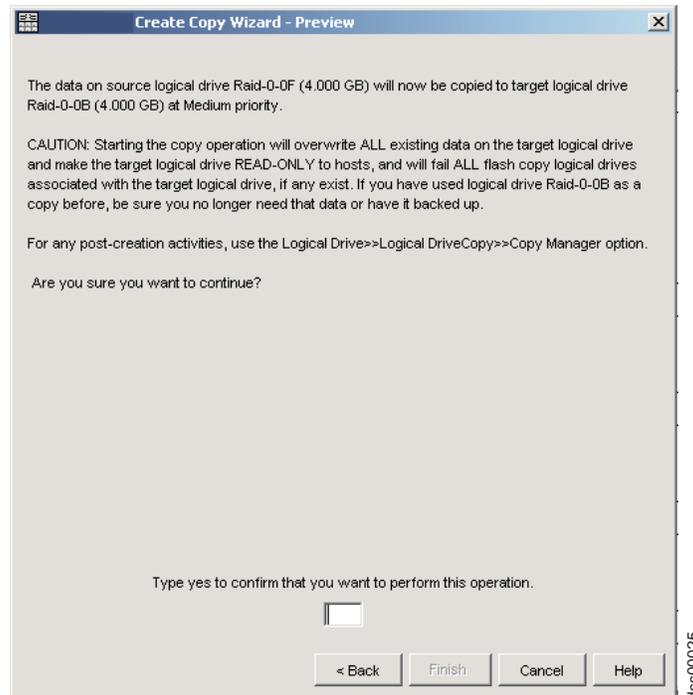
Figure 22. The Preview panel of the Create Copy wizard

You can also return to previous panels to edit the parameters you have chosen.

When you type `Yes` in the text box and click **Finish**, the Copy Started window opens to verify that the VolumeCopy operation has begun.

Note: You can also click **Back** to change your choices.

You can create a new VolumeCopy operation or exit the wizard. To close the Copy Started window, you must select one of the following options:
- Yes - Create a new VolumeCopy
- No - Exit the wizard

Icons that show the progress of the operation display on the source logical drive and target logical drive while the VolumeCopy operation has a status of `In Progress` or `Pending`. For more information about copy status, see "Copy status" on page 74.

The progress of the VolumeCopy operation displays in the status bar at the bottom-right of the Copy Manager. The status bar shows the estimated time remaining for the VolumeCopy operation to complete. You can view the progress of a VolumeCopy operation in the Copy Manager only when a VolumeCopy operation has a status of `In Progress`. For more information about the Copy Manager and how to access it, see Chapter 4, "Managing VolumeCopy," on page 73.

Viewing drives

The View Drives panel displays the drive tray, slot, and capacity information for the selected source logical drive or target logical drive. The View Drives panel is available in the Create Copy Wizard - Introduction and Create Copy Wizard - Select Target Logical Drive panels.

Content for this panel will automatically update dynamically if you select a different source logical drive or target logical drive in the Copy Wizard panel while the View Drives panel is open.

The information presented in the View Drives panel can be used to copy high-access logical drives to different logical drive groups for increased accessibility, or to copy logical drives to a logical drive group that uses drives with a greater capacity.

Accessing the VolumeCopy target logical drive on the host

To access the target logical drive after you have created the VolumeCopy, you must complete some steps on the host, as described in the following sections:
- "Accessing the VolumeCopy target logical drive on an AIX host"
- "Accessing the VolumeCopy target logical drive on an HP-UX or Solaris host" on page 68
- "Accessing the VolumeCopy target logical drive on a Windows NT host" on page 68
- "Accessing the VolumeCopy target logical drive on a Novell NetWare host" on page 69

Accessing the VolumeCopy target logical drive on an AIX host

To access the target logical drive after you have created the VolumeCopy, you must first change the target permissions, then mount the target logical drive to a directory.

Complete the following steps to change the target permissions to `Disable Read Only`:

1. In the Logical view of the SMclient Subsystem Management window, right-click the icon for target logical drive and click **Copy Manager**. The Copy Manager Window opens.
2. From the top menu, select **Change → Target Volume Permissions → Disable Read Only**.

Complete the following steps to configure the AIX host for the new VolumeCopy logical drive:

1. Log in to the host as `root`.
2. Ensure that the host operating system recognizes the VolumeCopy logical drive. At the host prompt, type the following command and press Enter.

```
cfgmgr
```

Several minutes might pass while the operating system accesses the drive. When the operation completes, a window opens with the following message:

```
Device nodes have been updated
```

The new logical drive is now available from the operating system.

3. At the host prompt, type the following command and press Enter.

```
lspv
```

A list of the physical drives that are recognized by the operating system is displayed.

4. Look for the operating system device name of your VolumeCopy logical drive in the list. The list shows a physical logical drive ID (PVID) for the VolumeCopy logical drive. This is the same as the PVID for the associated base logical drive, because the VolumeCopy logical drive contains the same array data structures as the base logical drive.

5. Clear the PVID for the VolumeCopy logical drives. At the host prompt, type the following command and press Enter.

```
chdev -l os_device_name -a pv=clear
```

where *os_device_name* is the operating system device name of the VolumeCopy logical drive.

Repeat this step for each VolumeCopy logical drive in the AIX array.

6. Re-create a new array using the **recreatevg** command. This command reads the array data structure inside a logical drive and reconstructs it. It also allocates new physical logical drive identifiers (PIDs) to the VolumeCopy logical drive and enables access to the VolumeCopy logical drive for the selected host.

At the host prompt, type the following command and press Enter:

```
recreatevg -y logical drivegroupname -L /directoryname os_device_name
```

where:

- *logical drivegroupname* is the name that you want to assign to the VolumeCopy array.
- *directoryname* is the name of the directory where you want to mount the VolumeCopy logical drive.
- *os_device_name* is the operating system device name of the VolumeCopy logical drive. If your AIX array contains more than one VolumeCopy logical drive, add an *os_device_name* for each logical drive.

The array is re-created, and contains the VolumeCopy logical drive or drives.

7. Mount the VolumeCopy logical drive to its intended host. At the host prompt, type the following command and press Enter.

```
mount mount-point
```

where *mount-point* is the name of the filesystem that being mounted. Include the *directoryname* that was used in step 6.

8. Ensure that the logical drives are back online. At the host prompt, type the following command and press Enter.

```
df -k
```

A list of the mounted disks displays.

Accessing the VolumeCopy target logical drive on an HP-UX or Solaris host

To access the target logical drive after you have created the VolumeCopy, you must first change the target permissions, then mount the target logical drive to a directory.

Complete the following steps to change the target permissions to `Disable Read Only`:

1. In the Logical view of the SMclient Subsystem Management window, right-click the icon for target logical drive and click **Copy Manager**. The Copy Manager Window opens.
2. From the top menu, select **Change → Target Volume Permissions →Disable Read Only**.

Next, complete the following steps on your HP-UX or Solaris host to access the VolumeCopy target logical drive:

1. Create a directory for the mount point (the target logical drive) in the root directory. At the command prompt, type the following command:

```
#mkdir /target_directory
```

where *target_directory* is the name of the directory that you want to create.

Mount the target logical drive to the new directory, using the following command:

```
#mount /target_logical_drive/target_directory /target_directory
```

where *target_logical_drive* is the target logical drive for the VolumeCopy, and *target_directory* is the name of the directory that you created in step 1.

Accessing the VolumeCopy target logical drive on a Windows NT host

To access the target logical drive after you have created the VolumeCopy, you must first change the target permissions, and then mount the target logical drive to a drive letter or mount point.

Complete the following steps to change the target permissions to `Disable Read Only`:

1. In the Logical view of the SMclient Subsystem Management window, right-click the icon for target logical drive and click **Copy Manager**. The Copy Manager Window opens.
2. From the top menu, select **Change → Target Volume Permissions → Disable Read Only**.

Complete the following steps to configure your host for the new VolumeCopy target logical drive:

1. Run the hot_add utility to let the system recognize the newly-added VolumeCopy target logical drive.

   Note: If the system does not recognize the VolumeCopy target logical drive after you run the hot_add utility, restart the server.

2. Resolve duplicate logical drive signatures by typing the following command:

```
SMrepassist -r
```

3. In the NT4 Disk Administrator window, assign a drive letter to the new VolumeCopy target logical drive.
4. When you no longer need the VolumeCopy target logical drive, open the NT4 Disk Management window and remove the drive letter *before* you delete the VolumeCopy target logical drive.

Accessing the VolumeCopy target logical drive on a Novell NetWare host

You cannot map the VolumeCopy target logical drive to the same Novell NetWare servers that the VolumeCopy source logical drive is mapped to. You must use another server, or unmap the VolumeCopy source logical drive from the server.

To access the target logical drive after you have created the VolumeCopy, you must first change the target permissions, and then mount the target logical drive to a drive letter or mount point.

Complete the following steps to change the target permissions to `Disable Read Only`:

1. In the Logical view of the SMclient Subsystem Management window, right-click the icon for target logical drive and click **Copy Manager**. The Copy Manager Window opens.
2. From the top menu, select **Change → Target Volume Permissions → Disable Read Only**.

Complete the following steps to configure your host for the new VolumeCopy target logical drive:

1. Run the hot_add utility to let the system recognize the newly-added VolumeCopy target logical drive.

   Note: If the system does not recognize the VolumeCopy target logical drive after you run the hot_add utility, restart the server.
2. Type the logical drive in the command window, or use the Disk Management menu in the ConsoleOne window to verify that the drive is added.

SMrepassist utility for Windows NT, Windows 2000, and Windows Server 2003

SMrepassist (replication assistance) is a host-based utility for Windows NT®, Windows 2000, and Windows Server 2003. It should be used before you create a VolumeCopy on Windows NT, Windows 2000, and Windows Server 2003.

Running the SMrepassist utility ensures that all the memory-resident data for filesystems on the target logical drive is flushed. If you are creating a VolumeCopy on Windows NT, you also use this utility after you map the VolumeCopy target logical drive to the same Windows NT server that the VolumeCopy source logical drive is mapped to. This resolves the duplicate disk signatures and system partition table information.

Important: You cannot map the VolumeCopy target logical drive to the same Windows 2000 or Windows Server 2003 servers that the VolumeCopy source logical drive is mapped to. You must use another server, or unmap the VolumeCopy source logical drive from the server.

The command to run this utility is:

```
SMrepassist -f [filesystem-identifier] | -r [filesystem-identifier]- list
```

- where `-f` flushes all the memory-resident data for the file system indicated by `[filesystem-identifier]`
- where `[filesystem-identifier]` specifies a unique file system in the following syntax:

  `drive-letter: [mount-point-path]`

  The file system might include only a drive letter, or a drive letter plus a mount point
- where `-r` (Windows NT only) resolves any duplicate signatures and partition table information. You must write a unique boot block signature to each logical drive that has a duplicate signature. Ensure that the driver re-reads the partition table for the logical drive to avoid a restart of the operating system.

  The `-r` option by itself causes the utility to find and resolve all FlashCopy logical drive and VolumeCopies on the storage array having duplicate signatures. The utility will only modify the signature on a FlashCopy logical drive or a VolumeCopy, not the base logical drive or standard logical drive, even where there are more than two logical drives that share a common signature.

An error message is provided in the command line and the logical drives are listed as a logical drive set when the utility cannot distinguish between the following logical drives:

- Base logical drive and FlashCopy logical drive (for example, if the snapshot logical drive has been removed)
- Standard logical drive and VolumeCopy (for example, if the VolumeCopy has been removed)

Locating associated logical drives

The Go To option can be used to quickly jump to an associated source logical drive or target logical drive displayed in the Logical view of the Subsystem Management Window.

Important: The Go To option is available only if the VolumeCopy feature has been enabled, or if VolumeCopy copies currently exist on the storage array. It is not accessible using the Mappings view of the Subsystem Management Window.

To locate an associated source logical drive or target logical drive, complete the following steps:

1. Select a source logical drive or target logical drive in the Logical view of the Subsystem Management window.
2. Perform one of the following actions, based on the logical drive type that you have selected:

   Source logical drive
   > Click **View → Go To → Source Logical Drive**.
   >
   > The selection jumps to the associated source logical drive in the Logical view of the Subsystem Management window.

   Target logical drive
   > Click **View →Go To →Target Logical Drive**.

The selection jumps to the associated target logical drive in the Logical view of the Subsystem Management window.

Chapter 4. Managing VolumeCopy

After you create a VolumeCopy with the Create Copy wizard, you can monitor the VolumeCopy operation through the Copy Manager. You can perform the following tasks from the Copy Manager:

- Re-copy, stop, or remove a VolumeCopy
- Modify the attributes of a logical drive, including the copy priority and the target logical drive read-only attribute
- View the status of a VolumeCopy operation
- Determine what logical drives are involved in a VolumeCopy operation

  You can also use the Storage Subsystem Profile to determine what logical drives are involved in a VolumeCopy operation.

Copy Manager displays information for all of the logical drive copies on the storage subsystem. This information includes the following items:

- The source logical drive
- The target logical drive
- The status of the VolumeCopy operation
- A timestamp for any completed copies
- The VolumeCopy priority assigned to the VolumeCopy

If a target logical drive is read-only to hosts, a **lock** icon is displayed in the Target Logical Drive column.

Perform the following steps to access and use the Copy Manager:

1. Click **Select Logical Drive → Copy → Copy Manager**.

   The Copy Manager window opens.
2. Click on the VolumeCopy pair or press Enter to select the VolumeCopy pair in the table.
3. Select an option from the pull-down menu.

Restrictions

The following restrictions apply to the source logical drive, target logical drive, and the storage subsystem:

- The source logical drive is available for read I/O activity only while a VolumeCopy operation has a status of `In Progress` or `Pending`. Write requests are allowed after the VolumeCopy operation is completed.

  Before you start the VolumeCopy operation, create a FlashCopy of the logical drive that you want to copy, and then use the FlashCopy as the source logical drive of the VolumeCopy pair.
- A logical drive can be used as a target logical drive in only *one* VolumeCopy operation at a time.
- The maximum number of VolumeCopies that are allowed per storage subsystem depends on the number of target logical drives that are available on your storage subsystem.
- A storage subsystem can have up to eight logical drive copies running at any given time.
- The target logical drive capacity must be equal to or greater than the source logical drive capacity.

- The target logical drive capacity must be equal to or greater than the usable capacity of the original source logical drive.
- A target logical drive can be a standard logical drive, a base logical drive of a disabled or failed FlashCopy logical drive, or a Remote Mirror primary logical drive.

> **Note:** You must disable all FlashCopy logical drives that are associated with the base logical drive before you can select it as a target logical drive. Otherwise, the base logical drive cannot be used as a target logical drive.

Logical drives that have the following statuses cannot be used as a source logical drive or target logical drive:

- A logical drive that is reserved by the host
- A logical drive that is in a modification operation
- A logical drive with a status of `Failed` or `Degraded`

> **Note:** A logical drive can be defined as the source logical drive of multiple VolumeCopy logical drive pairs even when the status of the VolumeCopy logical drive pair is `In Progress` or `Failed`. After a logical drive is defined as a target logical drive in a VolumeCopy logical drive pair, it is not available to participate in any other VolumeCopy logical drive pairs as a target logical drive regardless of the VolumeCopy logical drive pair status. After a VolumeCopy operation is completed, the logical drive, which is defined as a target logical drive in a VolumeCopy logical drive pair, is available to participate in any other VolumeCopy logical drive pairs as the source logical drive role only.

Copy status

The progress of the VolumeCopy operation displays in the status bar at the bottom-right of the Copy Manager. The status bar shows the estimated time remaining for the VolumeCopy operation to complete. You can view the progress of a VolumeCopy operation in the Copy Manager only when a VolumeCopy operation has a status of `In Progress`.

There are three possible copy statuses:

Copy Pending
> The `Copy Pending` status displays in the Copy Manager when a VolumeCopy operation has been created, but system resources do not allow it to start. For example, if there are already eight logical drive copies with a status of `In Progress`, any subsequent VolumeCopy that you create will have a status of `Pending` until one of the other eight logical drive copies has completed. In addition, a modification operation on another logical drive in the array might need to complete before the VolumeCopy operation can begin.
>
> While in the `Copy Pending` status, the host has read-only access to the source logical drive, and read and write requests to the target logical drive do not take place until the VolumeCopy operation has completed.

Copy In Progress
> The `Copy In Progress` status displays in the Copy Manager while data on the source logical drive is being read and then written to the target logical drive. While in the `Copy In Progress` status, the host has read-only access

to the source logical drive, and read and write requests to the target logical drive do not take place until the VolumeCopy operation has completed.

Copy Failed

The `Copy Failed` status displays in the Copy Manager when an error occurs while the VolumeCopy is being created. A status of `Copy Failed` can occur because of a read error from the source logical drive, a write error to the target logical drive, or a failure on the storage subsystem that affects the source logical drive or target logical drive (such as a Remote Mirror role reversal). A critical event is logged in the Major Event Log (MEL) and a **Needs-Attention** icon displays.

While a VolumeCopy operation has the `Copy Failed` status, the host has read-only access to the source logical drive, and read and write requests to the target logical drive will not take place until the failure is fixed.

When a VolumeCopy operation fails, you must use the Stop Copy option in the Copy Manager to stop the operation and use the Recovery Guru to fix the problem.

You can use the Re-Copy option to restart the VolumeCopy operation from the beginning.

Notes:

1. If there are eight logical drive copies with a status of `In Progress`, any subsequent VolumeCopy operation will have a status of `Pending` until one of the eight logical drive copies completes.

2. If a modification operation is running on a source logical drive or target logical drive, and the VolumeCopy operation has a status of `In Progress`, `Pending`, or `Failed`, then the VolumeCopy operation will not take place.

3. If a modification operation is running on a source logical drive or target logical drive after a VolumeCopy has been created, then the modification operation must complete before the VolumeCopy operation can start. If a VolumeCopy operation has a status of `In Progress`, then any modification operation will not take place.

Viewing VolumeCopy properties

Use the Logical Drive Properties window, shown in Figure 23 on page 76, to view the following information about a selected source logical drive or target logical drive:

- The role of the logical drive: either source or target
- The copy status: `Pending`, `In Progress`, `Completed`, `Stopped`, `Failed`
- The copy priority: `Lowest`, `Low`, `Medium`, `High`, `Highest`
- The start timestamp: in the format MM/DD/YY HH/MM/SS
- Completion timestamp: in the format MM/DD/YY HH/MM/SS
- The read-only attribute: `Enabled` or `Disabled` (only if a target logical drive is selected)
- Source or target logical drive ID: WWN
- Source or target logical drive name

Note: You can only view the progress of a VolumeCopy operation with a status of `In Progress`.
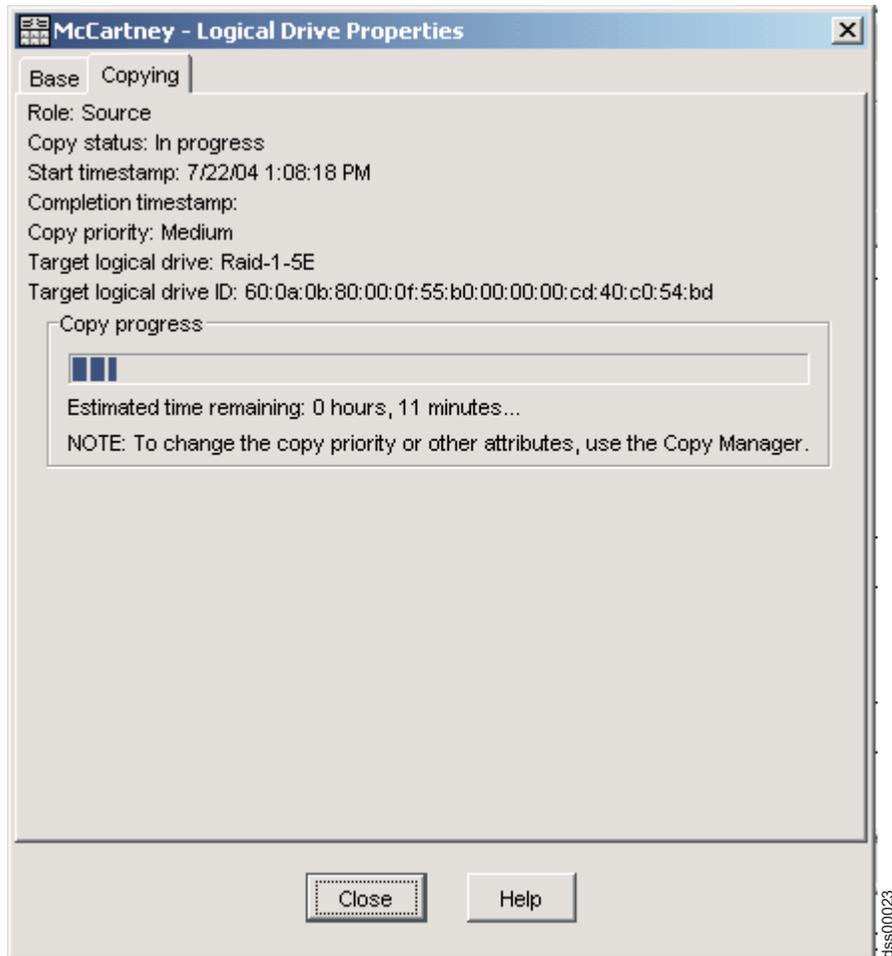
Figure 23. The Logical Drive Properties window

Perform the following steps to view the VolumeCopy properties:

1. Select the source logical drive or target logical drive in the Logical view.
2. Click **Logical Drive → Properties**.

   The Logical Drive Properties window opens.
3. Click the **Copying** tab.

   The **Copy Properties** tab displays.

   If a source logical drive has multiple target logical drives, then the details will be repeated for each target logical drive.
4. Click **Close** to close the window.

Changing copy priorities

You can change the copy priority to balance I/O activity with VolumeCopy operation activity on a storage subsystem. You can set the copy priority to a rate that will have the least impact on I/O activity. There are five copy priority rates available: lowest, low, medium, high, and highest. If the copy priority is set at the lowest rate, I/O activity is prioritized and the VolumeCopy operation will take longer. If the copy priority is set to the highest priority rate, the VolumeCopy operation is prioritized, but I/O activity for the storage subsystem might be affected.

You can change the copy priority for a VolumeCopy pair before the VolumeCopy operation begins, while the VolumeCopy operation has a status of `In Progress`, or after the VolumeCopy operation has completed (for a re-copy). Perform the following steps to change the copy priority:

1. Click **Select Logical Drive → Copy → Copy Manager**.

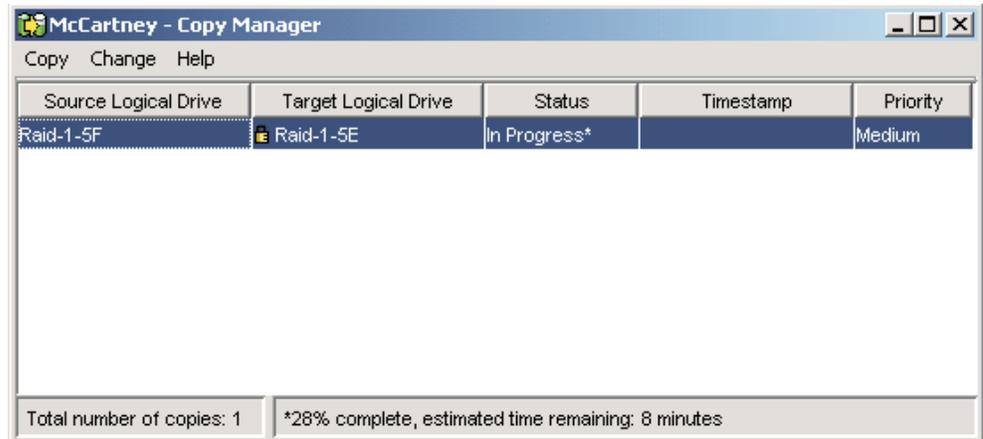   The Copy Manager window opens as shown in Figure 24.

Figure 24. Copy Manager window

2. Select one or more VolumeCopy pairs in the table. You can select more than one VolumeCopy pair by pressing Ctrl and the left mouse button.

3. Click **Change → Copy Priority**.

   The Change Copy Priority window opens.

4. In the **Copy Priority** field, use the slider bar to select the appropriate copy priority, depending on your system performance needs.

   For more information about the copy priority, see "Setting the copy priority" on page 64.

5. Click **OK**.

   The Change Copy Priority - Progress window opens.

6. Click **OK**.

   The copy priority for the selected VolumeCopy pair is changed.

Setting the target logical drive read-only attribute option

The target logical drive read-only attribute determines how read and write requests to the target logical drive are handled after a VolumeCopy operation is complete or if the VolumeCopy operation fails before it completes. After the VolumeCopy operation has completed, the target logical drive automatically becomes read-only to hosts, and write requests to the target logical drive do not take place. You might want to keep this attribute enabled in order to preserve the data on the target logical drive. The following situations are examples of when you might want to keep the read-only attribute enabled:

- If you are using the target logical drive for backup purposes
- If you are copying data from one array to a larger array for greater accessibility
- If you are using the data on the target logical drive to copy back to the base logical drive of a disabled or failed FlashCopy logical drive

If you decide not to preserve the data on the target logical drive after the VolumeCopy operation is completed, use the Copy Manager to disable the read-only attribute for the target logical drive.

Perform the following steps to enable the read-only attribute:
1. Click **Select Logical Drive → Copy → Copy Manager**.

    The Copy Manager window opens.
2. Select one or more VolumeCopy pairs in the table. You can select more than one copy pair by pressing Ctrl and the left mouse button.
3. Click **Change → Target Logical Drive Permissions → Enable Read-Only**.

    The read-only attribute is enabled on the target logical drive. Write requests to the target logical drive are rejected.

Perform the following steps to disable the read-only attribute:
1. Click **Select Logical Drive → Copy → Copy Manager**.

    The Copy Manager window opens.
2. Select one or more VolumeCopy pairs in the table. You can select more than one VolumeCopy pair by pressing Ctrl and the left mouse button.
3. Click **Change → Target Logical Drive Permissions → Disable Read-Only**.

    The read-only attribute is disabled on the target logical drive. Write requests to the target logical drive are permitted.

When the read-only attribute for a target logical drive is enabled, a **lock** icon displays in the Target Logical Drive column of the Copy Manager. The read-only attribute can be changed in the Copy Manager only after the VolumeCopy operation completes.

Re-copying the source logical drive in a VolumeCopy pair

When you re-copy the source logical drive in a VolumeCopy Pair, you create a new copy of the source logical drive data on an associated target logical drive. You can use Re-Copy to create a new copy from the beginning if the original VolumeCopy operation fails, was stopped, or has completed. You can also use Re-Copy for backup purposes; for instance, if the data on the source logical drive changes, you can use Re-Copy to duplicate any new data to the target logical drive.

Attention: Re-copying overwrites existing data on the target logical drive and makes the target logical drive read-only to hosts until you disable the read-only attribute in the Copy Manager.

Important: Note the following points before you re-copy logical drives:
*   If hosts have been mapped to the source logical drive, the data that is re-copied to the target logical drive might have changed since the previous VolumeCopy was created.
*   To use Re-Copy, select only one VolumeCopy in the Copy Manager.
*   See "Selecting the source logical drive" on page 60 and "Selecting the target logical drive" on page 61 for information about what types of logical drives you can use as source and target logical drives.

Perform the following steps to create a new VolumeCopy of the data on a selected VolumeCopy pair:
1. Stop all I/O operations to the source logical drive and target logical drive.

2. Unmount any filesystems on the source logical drive and target logical drive.
3. Click **Select Logical Drive → Copy → Copy Manager**.

   The Copy Manager window opens.
4. Click on the VolumeCopy pair or press Enter to select the VolumeCopy pair in the table.
5. Click **Copy → Re-Copy**.

   The Re-Copy window opens.
6. Set the copy priority.

   See "Setting the copy priority" on page 64 for more information.
7. Type `Yes` and click **OK**.

   The VolumeCopy operation begins.

   Note: You can view the progress of a VolumeCopy operation in the Copy Manager only when a VolumeCopy operation has a status of `In Progress`.

Stopping a VolumeCopy operation

You can stop a VolumeCopy operation with a status of `Pending`, `In Progress`, or `Failed`. If you decide not to use a particular logical drive as a source logical drive or target logical drive, you can stop the VolumeCopy operation before it completes. Then after you delete the VolumeCopy pair definition, the logical drives can be used in a new VolumeCopy pair.

Note: If you stop a VolumeCopy operation with a status of `Failed`, the `Needs-Attention` condition on a storage subsystem is cleared.

Important: Note the following points before you stop a VolumeCopy operation:
- If the copying process was stopped prematurely, there is no guarantee that the target logical drive will be in a usable state.
- Select only one copy pair in the Copy Manager.
- When the VolumeCopy operation is stopped, all mapped hosts will have write access to the source logical drive. If data is written to the source logical drive, the data on the target logical drive will no longer match the data on the source logical drive.

Perform the following steps to stop a VolumeCopy operation:
1. Click **Select Logical Drive → Copy → Copy Manager** .

   The Copy Manager window opens.
2. Click on the VolumeCopy pair or press Enter to select the VolumeCopy pair in the table.
3. Click **Copy → Stop**.

   The Stop Copy window opens.
4. Click **Yes**.

   The VolumeCopy operation stops.

Removing copy pairs

You can remove one or more VolumeCopies from the Copy Manager. Any VolumeCopy copy-related information for the source and target logical drive is removed from the Logical Drive Properties and Storage Subsystem Profile windows. After you remove the VolumeCopy, you can use the source logical drive and target logical drive in a new VolumeCopy. When you remove the VolumeCopy, the read-only attribute for the target logical drive is also removed.

After the VolumeCopy is removed from the Copy Manager, you can select the target logical drive as a source logical drive or target logical drive for a new VolumeCopy.

If you remove a VolumeCopy, the source logical drive and target logical drive are no longer displayed in the Copy Manager.

Important: Note the following points before you remove VolumeCopy pairs:
- This action does not delete the data on the source logical drive or target logical drive.
- If the VolumeCopy operation has a status of `In Progress`, it must be stopped before you can remove the VolumeCopy pair from the Copy Manager.

Perform the following steps to remove VolumeCopy pairs from the Copy Manager:

1. Click **Select Logical Drive → VolumeCopy → Copy Manager**.

   The Copy Manager window opens.
2. Select one or more VolumeCopy pairs in the table. You can select more than one VolumeCopy pair by pressing Ctrl and using the left mouse button to select multiple VolumeCopy pairs.
3. Click **Copy → Remove Copy Pairs**.

   The Remove Copy Pairs window opens.
4. Click **Yes** to confirm that you want to continue with the VolumeCopy pair removal.

   The VolumeCopy pair is removed.

VolumeCopy and other premium features

This section describes how VolumeCopy can be used with other premium features that are available with DS4000 Storage Manager. This section covers Storage Partitioning, FlashCopy, and the Remote Mirroring Option. Although Storage Partitioning is not covered in this guide, it is a premium feature that is offered with DS4000 Storage Manager. For more information about Storage Partitioning, see your operating system installation and user's guide or see the DS4000 Storage Manager online help.

Storage Partitioning and VolumeCopy

Note: Storage Partitioning is not a copy services premium feature. This guide does not describe how to enable and use the storage partitioning feature. For more information about Storage Partitioning, see the *IBM DS4000 Storage Manager Version 9 Installation and Support Guide* for your specific operating system.

Storage Partitioning is a feature that enables hosts to share access to logical drives in a storage subsystem. A storage partition is created when you define a collection of hosts (a host group) or a single host and then define a logical drive-to-LUN mapping.

This mapping allows you to define what host group or host will have access to a particular logical drive in the storage subsystem.

After a VolumeCopy has been created, the target logical drive automatically becomes read-only to hosts to ensure that the data is preserved. Hosts that have been mapped to a target logical drive do not have write access to the logical drive, and any attempt to write to the read-only target logical drive results in a host I/O error.

If you want hosts to have write access to the data on the target logical drive, use the Copy Manager to disable the read-only attribute for the target logical drive. For more information about changing the target logical drive read-only attribute, see "Setting the target logical drive read-only attribute option" on page 77.

FlashCopy and VolumeCopy

A FlashCopy logical drive is a point-in-time image of a standard logical drive and is typically created so that an application, such as a backup application, can access the FlashCopy logical drive and read the data while the base logical drive remains online and accessible to hosts.

Always use a FlashCopy logical drive as the source logical drive for a VolumeCopy.

Important: If you choose the base logical drive of a FlashCopy logical drive as your target logical drive, you must disable all FlashCopy logical drives that are associated with the base logical drive before you can select it as a target logical drive.

When you create a FlashCopy logical drive, a FlashCopy repository logical drive is automatically created. The FlashCopy repository logical drive stores information about the data that has changed since the FlashCopy logical drive was created. FlashCopy repository logical drives cannot be selected as source logical drives or target logical drives in a VolumeCopy pair.

FlashCopy can be used with VolumeCopy to back up data on the same storage array, and to restore the data on the FlashCopy logical drive back to its original base logical drive.

The Remote Mirror Option and VolumeCopy

The Remote Mirror Option is used for online, real-time replication of data between storage subsystems over a remote distance. In the event of a disaster or a catastrophic failure of one storage subsystem, you can promote a second storage subsystem to take over responsibility for computing services.

When you create a remote mirror, a mirrored logical drive pair is created, consisting of a primary logical drive at the primary storage subsystem and a secondary logical drive at a secondary, remotely located storage subsystem. The mirroring process and I/O completion notification to the host is different, depending on whether the write mode selected is synchronous or asynchronous. The description below is for mirroring with synchronous write mode selected. See "Synchronous write mode

(Metro Mirroring)" on page 96 and "Asynchronous write mode (Global Copy and Global Mirroring)" on page 97 for more information on the differences between the two modes.

The primary logical drive is the logical drive that accepts host I/O and stores data. When the mirror relationship is initially created, data from the primary logical drive is copied in its entirety to the secondary logical drive. This process is known as a full take synchronization and is directed by the controller owner of the primary logical drive. During a full synchronization, the primary logical drive remains fully accessible for all normal I/O activity.

The controller owner of the primary logical drive initiates remote writes to the secondary logical drive to keep the data on the two logical drive synchronized. Whenever the data on the primary logical drive and the secondary logical drive becomes unsynchronized, the controller owner of the primary logical drive initiates a full synchronization.

The secondary logical drive maintains a mirror of the data on its associated primary logical drive. The controller owner of the secondary logical drive receives remote writes from the primary logical drive controller owner. It will accept host read requests, but all host write requests will be blocked by the controller.

Note: The Host OS file I/O caching may briefly give the impression that one can write to the secondary logical drive. However, these attempted writes will be rejected when the Host OS tries to flush them from server cache memory to the logical drive.

The secondary logical drive remains unavailable (except for read requests in servers that can mount the secondary logical drive as read-only) to host applications while mirroring is in progress. In the event of a disaster or catastrophic failure at the primary site, you can perform a role reversal to promote the secondary logical drive to a primary role. Hosts are then able to access the newly promoted logical drive and business operations can continue.

A primary logical drive in a remote mirror relationship can be selected as the source logical drive for a VolumeCopy. However, a secondary logical drive in a remote mirror relationship cannot be selected as a source logical drive or target logical drive and is not available in the Create Copy wizard when you create a VolumeCopy. If a copy of a secondary logical drive is required, you can perform a role reversal to change the secondary logical drive to a primary logical drive. For more information about remote mirror role reversals, see "Role reversals" on page 106.

Note: Another method you can use to produce a copy of the secondary logical drive is to create a FlashCopy of the secondary logical drive, then create a VolumeCopy of the FlashCopy logical drive. This method eliminates the need to perform a role reversal on the secondary logical drive. This is the recommended method.

If a primary logical drive in a remote mirror is selected as the source logical drive for a VolumeCopy, any VolumeCopies that have a status of `In Progress` or `Pending` when a role reversal takes place fail, and cannot be started again until the primary logical drive is demoted back to its original remote mirror secondary logical drive role.

For more information about the Remote Mirror Option, see Chapter 6, "Overview of the Enhanced Remote Mirroring option," on page 91 or the Subsystem Management window online help.

Chapter 5. Troubleshooting VolumeCopy

This chapter provides information about troubleshooting some of the more common problems encountered when you use the VolumeCopy feature. The troubleshooting topics that are included are general VolumeCopy problems and premium feature troubleshooting topics. Locate the section that is directly related to your problem, or consult the section that describes general troubleshooting techniques. If your problem is not discussed in any of the sections in this chapter, contact technical support.

General troubleshooting

Table 4 describes some of the typical problems you might encounter when you use the VolumeCopy feature. The information in this section is presented in sequence, from the time the feature is enabled to problems that you might encounter when you use the VolumeCopy feature.

Information about the probable cause and recommended resolution for each problem are provided. If your problem is not addressed in this chapter, contact technical support.

Table 4. General troubleshooting for the VolumeCopy feature

Problem	Cause	Resolution
The VolumeCopy menu options in the Subsystem Management window are greyed out and unavailable	The VolumeCopy feature is not enabled.	Enable the VolumeCopy feature. You must use a Feature Key File to enable premium features. If one has not been supplied, contact your storage supplier. For step-by-step instructions about enabling the VolumeCopy feature, see "Enabling premium features" on page 8 or the Subsystem Management Window online help.
The VolumeCopy icon in the premium status area is greyed out with a red line	The VolumeCopy feature is not enabled.	Enable the VolumeCopy feature. You must use a Feature Key File to enable premium features. If one has not been supplied, contact your storage supplier. For step-by-step instructions about enabling the VolumeCopy feature, see "Enabling premium features" on page 8 or the Subsystem Management Window online help.
The Create Copy option is not available after selecting a source logical drive in the Logical view	The logical drive that you have chosen to be the source logical drive for the VolumeCopy is not a valid source logical drive. See "Selecting the source logical drive" on page 60 for more informations on source logical drives.	Select a valid source logical drive, which can be one of the following: • A standard logical drive • A FlashCopy logical drive • A base logical drive of a FlashCopy logical drive • A primary logical drive that is participating in a Remote Mirror.

Table 4. General troubleshooting for the VolumeCopy feature (continued)

Problem	Cause	Resolution
The source logical drive or target logical drive is displayed as being a missing logical drive	A physical drive on which the VolumeCopy depends (such as a source logical drive or target logical drive) has been removed, and the logical drive is now displayed under the Missing Logical Drive node in the Logical view of the Subsystem Management window.	If logical drives are missing because of a power loss to the drive trays or because drives have accidentally been removed, you can recover these logical drive by completing the following steps: 1. Re-insert the drives into the drive tray. 2. Ensure that the power supplies for the drive tray are properly connected to an operating power source and have an Optimal status. **Important:** Deleting a missing volume is a permanent action. Any associated logical drives or logical drive-to-LUN mappings will also be deleted. For more information about troubleshooting missing volumes, refer to the Recovery Guru or contact technical support. If the missing logical drive is no longer required, it can be deleted.
The controller owner for the source logical drive or target logical drive changes after the VolumeCopy operation has completed	When the VolumeCopy operation started, the preferred controller did not have ownership of both the source logical drive and target logical drive.	During a VolumeCopy operation, the same controller must own both the source logical drive and the target logical drive. If both logical drives do not have the same preferred controller when the VolumeCopy operation starts, the ownership of the target logical drive automatically transfers to the preferred controller of the source logical drive. When the VolumeCopy operation completes or is stopped, ownership of the target logical drive is restored to its preferred controller. If ownership of the source logical drive changes during the VolumeCopy operation, ownership of the target logical drive also changes.
A VolumeCopy that includes a source logical drive that is participating in a remote mirror has a status of `In Progress`, `Pending`, or `Completed`, but has failed	In response to a catastrophic failure at the primary storage subsystem, a role reversal has occurred. The secondary logical drive in the mirrored pair was promoted to the primary volume role, while the primary volume was demoted to the secondary volume role.	After the preferred controller of the primary logical drive can be contacted, a role reversal will automatically take place and you can then restart the VolumeCopy operation. For more information about role reversals, see "Role reversals" on page 106.

Table 4. General troubleshooting for the VolumeCopy feature (continued)

Problem	Cause	Resolution
The error message indicates that the VolumeCopy feature is out of compliance	The VolumeCopy feature is out of compliance. This normally occurs if a logical drive group with existing VolumeCopies has been moved into a storage subsystem where the feature is not authorized, or if you have disabled the feature on a storage subsystem where the feature is authorized, and you have existing VolumeCopies present.	• If the VolumeCopy feature is not authorized for this storage subsystem and you want to authorize it, or the VolumeCopy feature is authorized for this storage subsystem but you have disabled it, complete the following steps to clear the error: 1. Obtain a new Feature Key File for this feature, or retrieve the existing Feature Enable Identifier by clicking **Storage Subsystem → Premium Features → List** in the Subsystem Management window. 2. Enable the VolumeCopy feature. For step-by-step instructions, see "Enabling premium features" on page 8 or the Subsystem Management window online help. • If the VolumeCopy feature is not authorized for this storage subsystem and you do not want to authorize it, disable the VolumeCopy feature by clicking **Storage Subsystem → Premium Features → Disable** in the Subsystem Management window. For more information about disabling premium features, see to the Subsystem Management window online help.

Table 4. General troubleshooting for the VolumeCopy feature (continued)

Problem	Cause	Resolution
The error message indicates that the selected source logical drive has a reservation placed on it	Logical drives that are configured with a legacy or persistent reservation cannot be selected as a source logical drive or a target logical drive for a VolumeCopy.	Clear the reservation for the selected logical drive, and then recreate the VolumeCopy. 1. Click **Advanced → Persistent Reservations** to open the Persistent Reservations window. Ensure that the **View Associated Registrations** check box is deselected in the upper left corner of the Persistent Reservations window. 2. Click one or more desired logical drives. To select all logical drives, click **Select All**. The selected logical drives or all logical drives are highlighted, depending on your selection. 3. Click **Clear**. The Clear Registrations/Reservations window opens. 4. Type Yes in the confirmation field. The **OK** button is enabled. 5. Click **OK**, or click **Cancel** to return to the main Persistent Reservations window without clearing any reservations. The reservations and registrations that are associated with the logical drives that you highlighted in the upper pane are cleared.

VolumeCopy critical events

Critical major event Log (MEL) events are generated when an error occurs that can affect data availability or that results in a degraded mode of operation. The storage management software responds by alerting the appropriate administrators by e-mail, SNMP trap, or other configured mechanisms.

Because administrative action is required to correct the problem, the storage subsystem generally enters a Needs Attention status. Therefore, the appropriate indications are presented through the storage management software and an associated Recovery Guru procedure displays when requested.

Table 5 on page 89 provides a description of critical MEL events, with a brief explanation of what caused the event, and the recommended resolution. If your critical MEL event is not included in this section, contact technical support.

Table 5. VolumeCopy critical events

Problem	Cause	Resolution
Event 6600 - VolumeCopy Operation Failed	This event is logged when a VolumeCopy with a status of In `Progress` or `Pending` fails. A `Needs Attention` status is also reported for the storage subsystem. This failure can be caused by a read error on the source logical drive, a write error on the target logical drive, or because of a failure that occurred on the storage subsystem that affects the source logical drive or target logical drive.	For specific recovery procedures, see the Recovery Guru.

Chapter 6. Overview of the Enhanced Remote Mirroring option

This chapter introduces the basic concepts of the Enhanced Remote Mirroring option, describes what a remote mirror is, how information is replicated between storage subsystems, the software and hardware required, and the preferred system configurations.

Note: Enhanced Remote Mirroring, Remote Mirror, and Remote Mirroring are used interchangeably throughout this document, the online client, and online help system to refer to remote mirroring functionality.

Basic concepts of the Enhanced Remote Mirroring option

The Remote Mirror Option is a premium feature that comes with the IBM DS4000 Storage Manager software and is enabled by purchasing a premium feature key. The Remote Mirror option is used for online, real-time replication of data between storage subsystems over a remote distance. In the event of a disaster or unrecoverable error at one storage subsystem, the remote mirror option enables you to promote a second storage subsystem to take over responsibility for normal I/O operations. The Enhanced Remote Mirroring provides an enhancement of the existing 10 km maximum distance synchronous remote mirror option.

The maximum number of storage subsystems that can participate in a remote mirror configuration is two. The two storage subsystems are called *primary* and *secondary* storage subsystems or *local* and *remote* storage subsystems. These names are used interchangeably to describe remote mirror setups or concepts. The names do not refer to the location of storage subsystems or to the role that storage subsystems have in a remote mirror relationship.

Primary and secondary logical drives on a remote mirror setup

This section introduces you to primary and secondary logical drives, and describes how they interact to replicate data between storage subsystems using the Remote Mirror Option. When you create a remote mirror, a mirrored logical drive pair is defined and consists of a primary logical drive at the primary storage subsystem, and a secondary logical drive at a secondary storage subsystem. A standard logical drive might only be defined in one mirrored logical drive pair. The maximum number of supported mirrored logical drive pairs is determined by the storage subsystem model.

The primary and secondary role in a remote mirror setup is implemented at the logical drive level instead of at the storage subsystem level. All logical drives that participate in a remote mirror relationship on a storage subsystem can be in either a primary or secondary role only. The storage subsystem can also have a combination of logical drives in a primary role and logical drives in a secondary role. Whether the logical drive is in a primary or secondary role, it counts towards the maximum number of mirror logical drive pairs that can be defined in a storage subsystem.

There are no requirements for having a certain number of logical drives be of a certain role in a remote mirror relationship for a given storage subsystem. For example, a storage subsystem with a maximum of 16 remote mirror relationship pairs might have logical drives in any one of the remote mirror relationship combinations shown in Table 6 on page 92.

91

Table 6. Remote Mirror drives in primary and secondary roles

Remote mirror drives in a primary role	Remote mirror drives in a secondary role	Description
16	0	This local storage subsystem has data in 16 logical drives mirrored in 16 logical drives in a separate (remote) storage subsystem.
8	8	This local storage subsystem has data in eight logical drives mirrored in eight logical drives in a remote storage subsystem. It also has eight logical drives that are used to store the mirrored data from eight logical drives in a remote storage subsystem.
4	12	There are four logical drives that are used to store the mirrored data from four logical drives in a remote storage subsystem. It also has 12 logical drives that are used to store the mirrored data from 12 logical drives in a remote storage subsystem.
0	16	This local storage subsystem has 16 logical drives that are used to store the mirrored data from 16 logical drives in a remote storage subsystem.

With controller firmware 05.30.xx.xx. and higher, there is a limit to how many logical drives that you can create in a single storage subsystem. When Remote Mirror Option is enabled, the total number of logical drives that are supported for each storage subsystem is reduced from the number of logical drives that you would have without the Remote Mirror Option enabled. The reduced maximum number of logical drives that a DS4000 Storage Subsystem can support with firmware version 05.30.xx.xx and higher depends on the model of the DS4000 Storage Subsystem. See Table 7 for more information.

Table 7. Logical drives using the Remote Mirror option for firmware version 6.10.xx.xx and higher

Model type	Maximum logical drives	Maximum logical drives per storage mapping partition	Maximum FlashCopy logical drives
1724 Standard/ Base option	1024 (See notes 4 and 6)	256	511 (See note 2)
1722 Turbo option	1024 (See notes 4 and 6)	32 or 256 (See note 5)	511 (See note 2)
1742 - all models	2048 (See notes 1, 4, and 6)	32 or 256 (See note 5)	1023 (See note 2)
1815 - all models	2048 (See notes 1, 4, and 6)	256	1023 (See note 2)

Notes:

1. When using firmware version 5.xx.xx and higher, the firmware reserves one logical drive for the system to use.
2. There is a maximum of four FlashCopy logical drives for each standard logical drive.
3. There is a maximum of eight remote mirror pairs for machine type 3552, all models, and 1742, all models, with Remote Mirroring premium feature option.

4. With the Enhanced Remote Mirroring premium, feature, there is a maximum of 32 remote mirror pairs for machine type 1724 standard/base model, 1722-Turbo option model, and 64 remote mirror pairs for machine type 1742, all models, and 1815, all models.

5. The host-agent management method uses a special logical drive, called an *access logical drive*, to communicate with the controllers on the storage subsystem. The access logical drive uses one of the available LUNs. Therefore, managing storage subsystems with the host-agent software limits you to one fewer LUN than the maximum number that is supported by the operating system and the host adapter.

   For controller firmware 05.4x.xx.xx and higher the maximum number of logical drives per storage mapping partition is 256. However, depending on the operating system limitations, the actual number of supported LUNs logical drives per storage mapping partition is less than 256.

6. For firmware version 05.3x.xx.xx, the maximum number of logical drives includes the FlashCopy repository logical drives and the Remote Mirror repository logical drives, in addition to the standard data logical drives. If the Remote Mirror option is enabled, two logical drives are reserved for the system to use.

7. Machine type 3552 is not supported with the new Enhanced Remote Mirroring option. None of the new remote mirroring features are applicable for this machine type. It is supported with the previous 10 km maximum distance synchronous remote mirror option only.

8. There is no Remote Mirror support for FAStT200, all models, DS4100 single controller models, or DS4300 base/standard and single controller unit.

The primary logical drive is the drive that accepts host computer I/O and stores program data. When you first create the mirror relationship, data from the primary logical drive is copied (becomes a mirror image) in its entirety to the secondary logical drive. This process is known as a *full synchronization* and is directed by the controller owner of the primary logical drive. During a full synchronization, the primary logical drive remains fully accessible for all normal I/O operations.

When a write request is made to the primary logical drive, the controller owner of the primary logical drive also initiates a remote write request to the secondary logical drive. The timing of the write I/O completion indication that is sent back to the host depends on the write mode option that is selected. Synchronous write mode requires the primary-side controller to wait for the acknowledgment of the write operation from the secondary-side controller before returning the write I/O request completion to the host. Asynchronous write mode, which is a new Remote Mirror feature, allows the primary-side controller to return the write the I/O request completion to the host server before data has been successfully written by the secondary-side controller. See "Write options" on page 96 for more information.
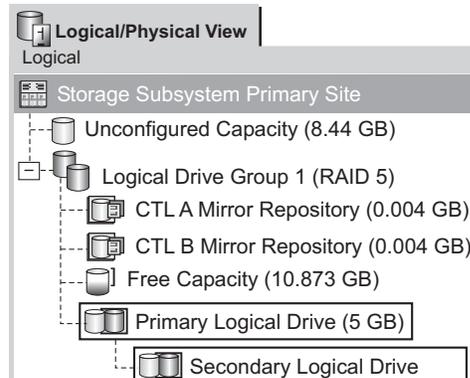
The secondary logical drive is used to store data that is copied from its associated primary logical drive. The controller owner of the secondary logical drive receives remote writes from the controller owner of the primary logical drive and will not accept host write requests. The Enhanced Remote Mirror option allows the host server to issue read requests to the secondary logical drive.

Note: The host server must have the ability to mount the file system as read-only in order to properly mount and issue read requests to the data in the secondary logical drive.

The secondary logical drive is normally unavailable to host computer programs while mirroring is performed. In the event of a disaster or unrecoverable error of the primary storage subsystem, a role reversal is performed to promote the secondary logical drive to the primary logical drive. Host computers will then be able to access the newly-promoted logical drive and normal operations can continue.
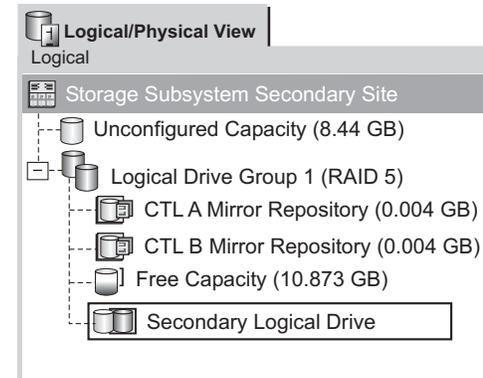
Figure 25 shows the primary and secondary logical drives displayed in the Subsystem Management window for the primary storage subsystem and the secondary storage subsystem.

Primary storage subsystem   Secondary storage subsystem

Both the primary and secondary logical drives are displayed in the Subsystem Management window for the storage subsystem.

Only the secondary logical drive is displayed in the Subsystem Management window for the secondary storage subsystem.

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Figure 25. Primary and secondary logical drives displayed in the Subsystem Management window

Mirror repository logical drives

A mirror repository logical drive is a special logical drive in the storage subsystem. It is created as a resource for the controller owner of the primary logical drive in a remote logical drive mirror. The controller stores mirrored information on this logical drive, including information about remote write requests that are not yet written to the secondary logical drive. The controller can use this information to recover from controller resets or if the storage subsystems are accidentally turned off.

When you activate the Remote Mirror Option on the storage subsystem, two mirror repository logical drives are created, one for each controller in the storage subsystem. An individual mirror repository logical drive is not needed for each mirror logical drive pair.

When you create the mirror repository logical drives, you specify their location. You can either use existing free capacity (shown in Figure 26 on page 95) or you can create an array for the logical drives from unconfigured capacity and then specify the RAID level.

Because of the critical nature of the data that is stored, the RAID level of mirror repository logical drives must be non-zero. The required size of each logical drive is 128 MB for each mirror repository logical drive (256 MB total). If you are upgrading

from the previous version of Remote Mirror, you must upgrade the size of the repository logical drive from 4M to 128M (see "Upgrading mirror repository logical drives" on page 135) in order to support a maximum of 64 Remote Mirror pairs. A maximum of only 32 Remote Mirror pairs is supported with the 4M repository logical drive.

Recommendation: For each mirrored pair that you create, leave a minimum of 0.25 GB free capacity in the same array as the mirror repository logical drives. If you someday deactivate the mirrored pair, this will ensure that you have enough capacity to reestablish the mirrored pair from the deactivated state. Otherwise, if there is no free capacity available on the storage subsystem, you might not be able to reestablish the mirrored pair.

Figure 26 shows mirror repository logical drives displayed in the Subsystem Management window for the primary storage subsystem.

Mirror Repository logical drives
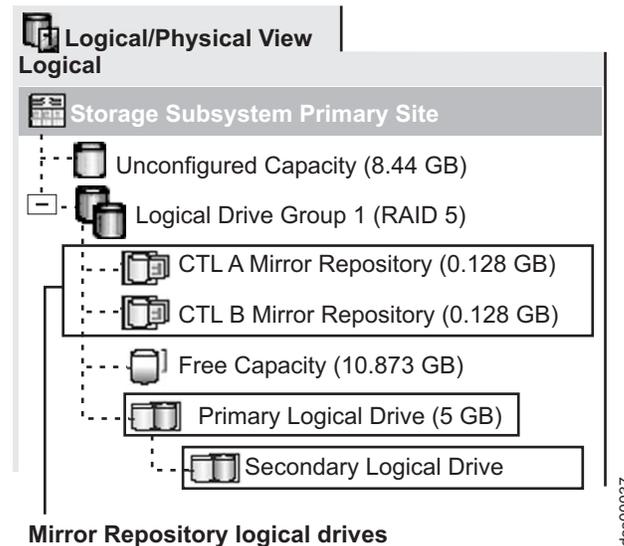
Figure 26. Mirror repository logical drives displayed in the Subsystem Management window

Mirror relationships

Before you define a mirror relationship, the Remote Mirror Option must be enabled on both the primary and secondary storage subsystems. A secondary standard logical drive candidate must be created on the secondary storage subsystem if one does not already exist. It must be a standard logical drive and be at least the same size or larger than the primary logical drive.

When secondary logical drive candidates are available, you can define a mirror relationship in the storage management software by identifying the storage subsystem that contains the primary logical drive and the storage subsystem that contains the secondary logical drive.

When you set up the mirror relationship, a full synchronization occurs as data from the primary logical drive is copied in its entirety to the secondary logical drive. For more information about establishing mirror relationships, see"Creating mirror relationships" on page 137.

Data replication

This section describes how data is replicated between storage subsystems that are participating in remote logical drive mirroring, and the actions that are taken by the controller owner of the primary logical drive if a link interruption occurs between storage subsystems. Data replication between the primary logical drive and the secondary logical drive is managed by the controllers and is transparent to host computers and programs.

Note: When a read request is received from a host computer, the controller owner of either the primary or secondary logical drive manages the request, depending on whether the read is issued to the primary or secondary logical drive, respectively. No communication takes place between the primary and secondary storage subsystems.

Write options

When the controller owner of the primary logical drive receives a write request from a host computer, the controller first logs information about the write request to its mirror repository logical drive, and then writes the data to the primary logical drive. The controller then initiates a remote write operation to copy the affected data blocks to the secondary logical drive at the secondary storage subsystem.

There are two write mode options that affect the timing that the I/O completion indication is sent back to the host:

- "Synchronous write mode (Metro Mirroring)"
- "Asynchronous write mode (Global Copy and Global Mirroring)" on page 97

Synchronous write mode (Metro Mirroring)

When synchronous write mode (also known as Metro Mirroring) is selected, any host write requests are written to the primary logical drive and then copied to the secondary logical drive. After the host write request has been written to the primary logical drive and the data is successfully copied to the secondary logical drive, the controller removes the log record on the mirror repository logical drive and sends an I/O completion indication back to the host computer.

In the event of a communication failure, synchronous write mode offers the best chance of full data recovery from the secondary logical drive. In synchronous write mode, host I/O performance is slower than it is in asynchronous write mode.

Synchronous write mode is selected by default and is the recommended write mode when the maximum distance between the DS4000 Storage Subsystems in an Enhanced Remote Mirroring configuration is less than 10 km.

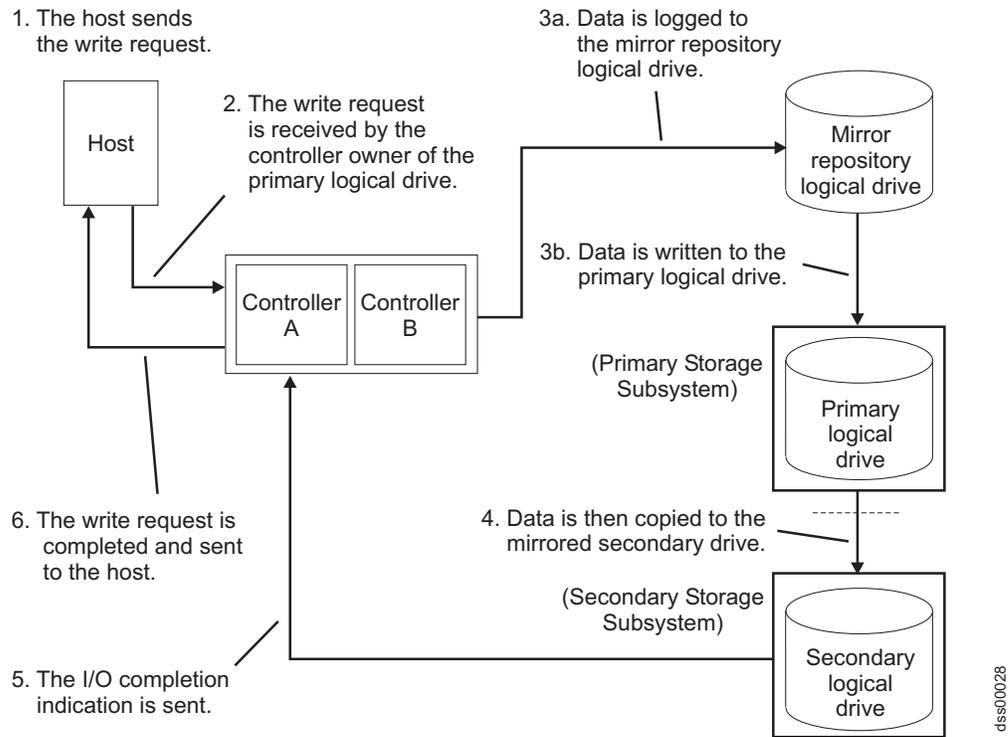Figure 27 on page 97 shows the data replication process for synchronous write mode (Metro Mirroring).

Figure 27. Data replication between primary and secondary storage subsystems: Synchronous write mode (Metro Mirroring)

Asynchronous write mode (Global Copy and Global Mirroring)

When asynchronous write mode is selected, host write requests are written to the primary logical drive, and the controller then sends an I/O completion indication back to the host system regardless of when the data was successfully copied to the secondary logical drive.

There are two types of mirroring that use asynchronous write mode: Global Copy and Global Mirroring. See "Write consistency groups" on page 98 for a description of each type.

Note: Remote mirroring using synchronous write mode is referred to as Metro Mirroring.

Asynchronous write mode offers faster host I/O performance than synchronous write mode, but does not guarantee that the copy has been successfully completed before processing the next write request. This is the recommended mode when the maximum distance between the DS4000 Storage Subsystems in an Enhanced Remote Mirroring configuration is more than 10 km.

Figure 28 on page 98 shows the data replication process for asynchronous write mode.
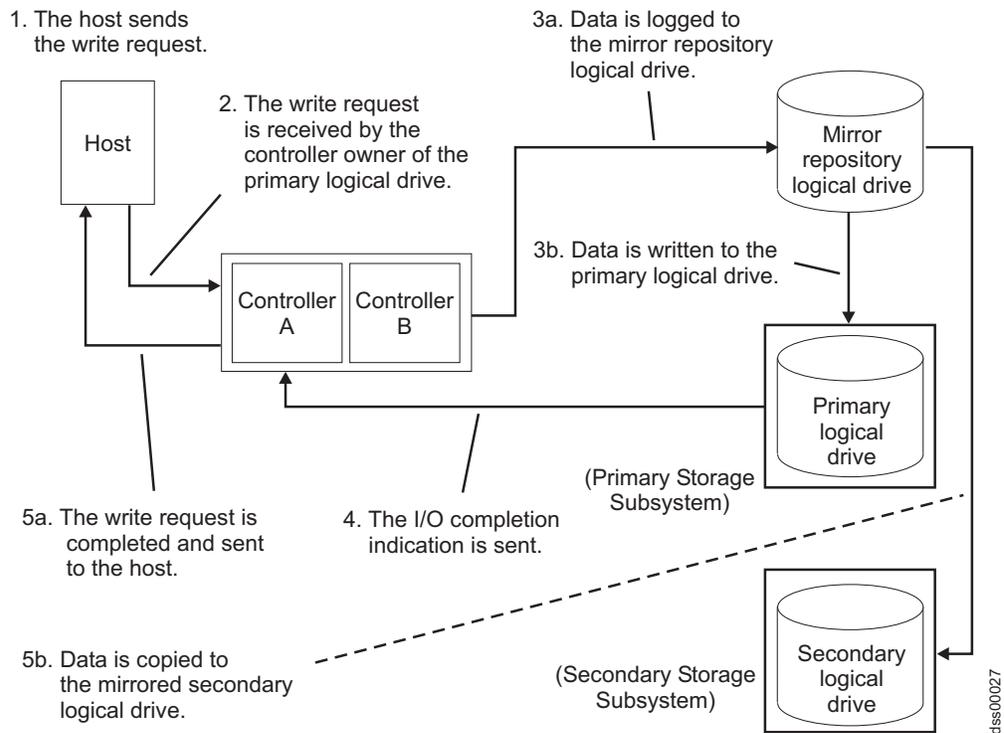
1. The host sends the write request.

2. The write request is received by the controller owner of the primary logical drive.

3a. Data is logged to the mirror repository logical drive.

3b. Data is written to the primary logical drive.

5a. The write request is completed and sent to the host.

4. The I/O completion indication is sent.

5b. Data is copied to the mirrored secondary logical drive.

Figure 28. Data replication between primary and secondary storage subsystems: Asynchronous write mode (Global Copy/Global Mirroring)

Write Consistency

Write consistency, a configuration option available for any primary or secondary logical drives in a remote mirror relationship using asynchronous write mode, preserves write orders.

In asynchronous write mode, write requests are not guaranteed to be completed in the same order on the secondary logical drive as they are on the primary logical drive. If the order of write requests is not retained, data on the secondary logical drive may become inconsistent with the data on the primary logical drive. This can jeopardize any attempt to recover data if a disaster occurs on the primary storage subsystem.

You can avoid this by selecting the write consistency option for multiple mirror relationships on the same storage subsystem. When you select write consistency, the order in which the data is synchronized is preserved. For example: In a remote mirror pair, the write for Mirror 1 is always performed before the write for Mirror 2.

Note: Selecting write consistency for a single mirror relationship does not change the process in which data is replicated. More than one mirror relationship must reside on the primary storage subsystem for the replication process to change.

Write consistency groups

When multiple mirror relationships on a single storage subsystem have been configured to use asynchronous write mode and to preserve write consistency, they are considered to be an interdependent group known as a *write consistency group*.

In a write consistency group, all mirror relationships maintain the same order when sending writes from the primary logical drives to their corresponding secondary logical drives.

The data on the secondary, remote storage subsystem cannot be considered fully synchronized until all remote mirrors in the write consistency group are synchronized. If one mirror relationship in a write consistency group becomes unsynchronized, all of the mirror relationships in the write consistency group will become unsynchronized. In this case, write activity to the remote, secondary storage subsystem is prevented, in order to protect the consistency of the remote data set.

Note: Care must be taken in selecting the number of logical drives that are in a write consistency group to minimize the impact when multiple simultaneous remote writes becomes single-thread because of write consistency requirement.

Example of a write consistency group: On a campus site, the Remote Mirror Option has been configured between two storage subsystems. At the primary site, the primary storage subsystem has three defined mirror relationships (RMO-A, RMO-B, and RMO-C), with each mirror relationship configured to copy data to the secondary storage subsystem.

All three mirror relationships have been configured to use the Asynchronous write mode and to preserve write order. If the mirrored pair RMO-A becomes unsynchronized due to a link interruption, the controller will automatically transition RMO-B and RMO-C into an `Unsynchronized` state until communication can be resumed.

Global Copy and Global Mirroring: There are two types of asynchronous mirroring:

Global Copy
> Refers to a remote logical drive mirror pair that is set up using asynchronous write mode *without* the write consistency group option. This is also referred to as "Asynchronous Mirroring without Consistency Group."

> Global Copy does not ensure that write requests to multiple primary logical drives are carried out in the same order on the secondary logical drives as they are on the primary logical drives. If it is critical that writes to the primary logical drives are carried out in the same order in the appropriate secondary logical drives, use Global Mirroring instead of Global Copy.

Global Mirroring
> Refers to a remote logical drive mirror pair that is set up using asynchronous write mode *with* the write consistency group option. This is also referred to as "Asynchronous Mirroring with Consistency Group."

> Global Mirroring ensures that write requests to multiple primary logical drives are carried out in the same order on the secondary logical drives as they are on the primary logical drives, preventing data on the secondary logical drives from becoming inconsistent with the data on the primary logical drives.

Resynchronization methods

Data replication between the primary logical drive and secondary logical drive in a mirror relationship is managed by the controllers, and is transparent to host machines and applications. When the controller owner of the primary logical drive

receives a write request from a host, the controller persistently logs information about the write to a mirror repository logical drive, then writes the data to the primary logical drive. The controller then initiates a write operation to copy the affected data to the secondary logical drive on the secondary storage subsystem.

If a link interruption or logical drive error prevents communication with the secondary storage subsystem, the controller owner of the primary logical drive transitions the mirrored pair into an `Unsynchronized` state and sends an I/O completion to the host that sent the write request. The host can continue to issue write requests to the primary logical drive, but remote writes to the secondary logical drive do not take place. These write requests are persistently logged in the primary-side remote mirror repository logical drive, instead.

When connectivity is restored between the controller owner of the primary logical drive and the controller owner of the secondary logical drive, resynchronization takes place. To minimize the resynchronization effort, the Enhanced Remote Mirroring option will copy only the blocks of data that were changed on the primary logical drive during the link interruption to the secondary logical drive.

If the remote mirror logical drive pair becomes unsynchronized due to the lost of mirror repository logical drives, full synchronization will be required when the mirror repository logical drives is restored.

Attention: Multiple communication disruptions and restore cycles that occur between the primary and secondary storage subsystems during resynchronization can result in a mix of new and old data on the secondary logical drive. If this happens, the data is unusable in a disaster recovery situation. Manual Resynchronization is the recommended setting.

This section describes the two resynchronization methods that you can use:
- "Manual resynchronization"
- "Automatic resynchronization" on page 101

Important: Manual resynchronization is the recommended setting for all mirror relationships in a write consistency group. If automatic resynchronization is selected for a mirror relationship in a write consistency group, resynchronizations will start as soon as communication is reestablished, which does not preserve consistency in the write consistency group.

Manual resynchronization

When you select manual resynchronization and a communication failure occurs between the primary and secondary storage subsystems, resynchronization of the data on the primary logical drive and secondary logical drive can be started manually after communication has been restored to the unsynchronized mirrored pair.

Important: Only the blocks of data that were changed on the primary logical drive during the link interruption are copied to the secondary logical drive.

Selecting the manual resynchronization option allows you to manage the resynchronization process in a way that provides the best opportunity for recovering data. When this option is selected and a communication failure occurs between the primary and secondary logical drives, the mirror relationship transitions to an `Unsynchronized` state. Any write requests to the primary logical drive are logged and the storage subsystem is placed in a `Needs Attention` state.

After the controller owner of the primary logical drive detects that communication has been restored, the mirror relationship will remain in an `Unsynchronized` state until you select **Logical Drive—> Remote Mirror Option—> Resume** in the Subsystem Management window.

Automatic resynchronization

When the automatic resynchronization option is selected and a communication failure occurs between the primary and secondary storage subsystems, the controller owner of the primary logical drive will start resynchronizing the primary and secondary logical drives immediately after detecting that communication has been restored.

Important: Only the blocks of data that have changed on the primary logical drive during the link interruption are copied to the secondary logical drive.

Link interruptions or secondary logical drive errors

In the course of processing write requests, a primary controller might be able to write only to the primary logical drive while a link interruption prevents communication with the remote secondary controller.

After a link interruption, the remote write operation cannot complete to the secondary logical drive and the primary and secondary logical drives are no longer correctly mirrored. The primary controller transitions the mirrored pair into an `Unsynchronized` state and sends an I/O completion message to the primary host computer, as shown in Figure 29. The primary host computer can continue to write to the primary logical drive but remote write operations do not take place.

Primary Storage Subsystem   Secondary Storage Subsystem
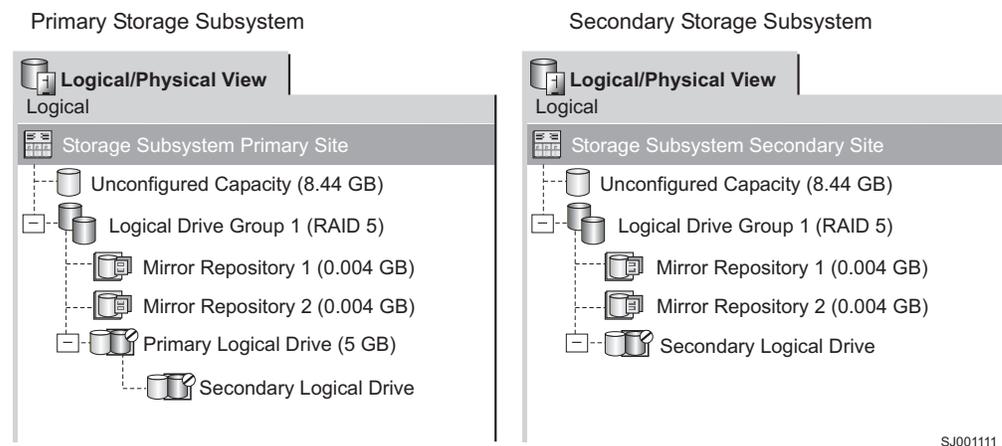
Figure 29. Mirrored logical drive pair showing Unsynchronized status

When connectivity is restored between the controller owner of the primary logical drive and the controller owner of the secondary logical drive, a resynchronization either happens automatically or must be started manually, depending on which method you chose when you set up the mirror relationship. During the resynchronization, only the blocks of data that were changed on the primary logical drive during the link interruption are copied to the secondary logical drive.

After the resynchronization begins, the mirrored pair transitions from an `Unsynchronized` state to a `Synchronization-in-Progress` state, as shown in Figure 30 on page 102.
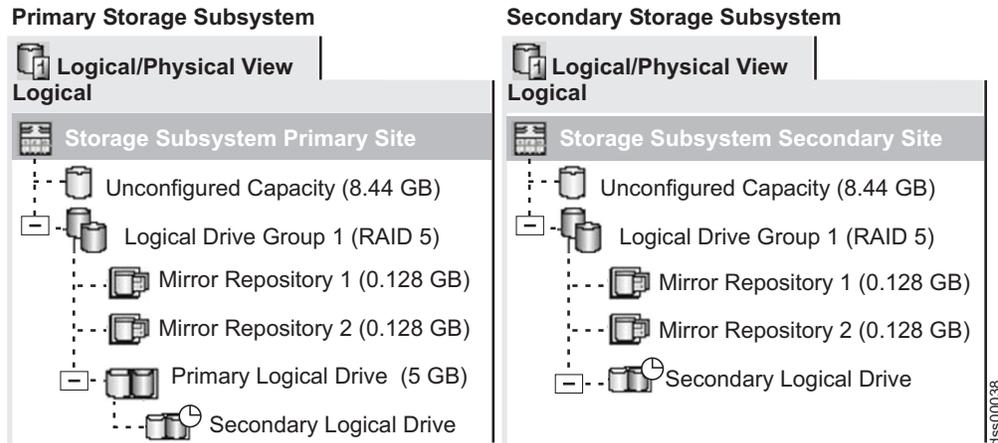
Figure 30. Mirrored logical drive pair showing Synchronization-in-Progress status

The primary controller places the mirrored pair in an `Unsynchronized` state when a logical drive error on the secondary storage subsystem prevents a remote write operation from completing. For example, an offline or failed secondary logical drive can cause the remote mirror to be placed in an `Unsynchronized` state. When the secondary logical drive is placed online or is recovered to an `Optimal` state, a manual or automatic resynchronization is required, and the mirrored pair transitions to a `Synchronization-in-Progress` state.

For more information about Remote Mirror Option status, see Chapter 8, "Using the Enhanced Remote Mirroring option," on page 135.

Connectivity and I/O

The Remote Mirror option requires a dedicated host port for mirroring data between storage subsystems. This section describes three configurations that you can use to connect storage subsystems for remote logical drive mirroring, controller ownership of logical drives within storage subsystems, the maximum storage subsystem distance permitted, and some general performance considerations. If these configurations do not meet your remote mirror configuration requirement, contact your IBM technical-support representative.

The Remote Mirror Option is supported on DS4000 Storage Subsystems that have at least two Fibre Channel host ports per controller (machine types 3552 and 1742, and 1722). When the Remote Mirror Option is activated, one Fibre Channel host-side I/O port on each controller is dedicated only to mirroring operations. For example, in the primary storage subsystem, controller host ports A2 and B2 are dedicated to mirroring operations. In the secondary storage subsystem, controller host ports A2 and B2 are also dedicated to mirroring operations. See Figure 31 on page 103 for the location of the controller host ports for machine types 3552 and 1742.
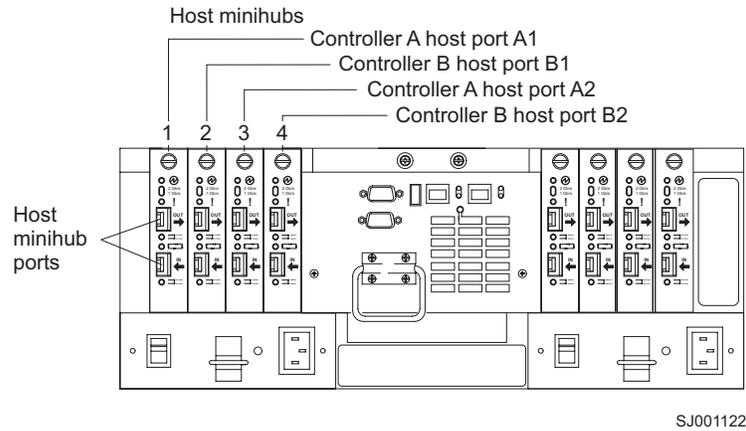
Host minihubs
Controller A host port A1
Controller B host port B1
Controller A host port A2
Controller B host port B2

1 2 3 4

Host
minihub
ports

SJ001122

Figure 31. Controller A and Controller B host ports, machine type 3552 and 1742

See Figure 32 for the location of controller host ports for machine type 1722.
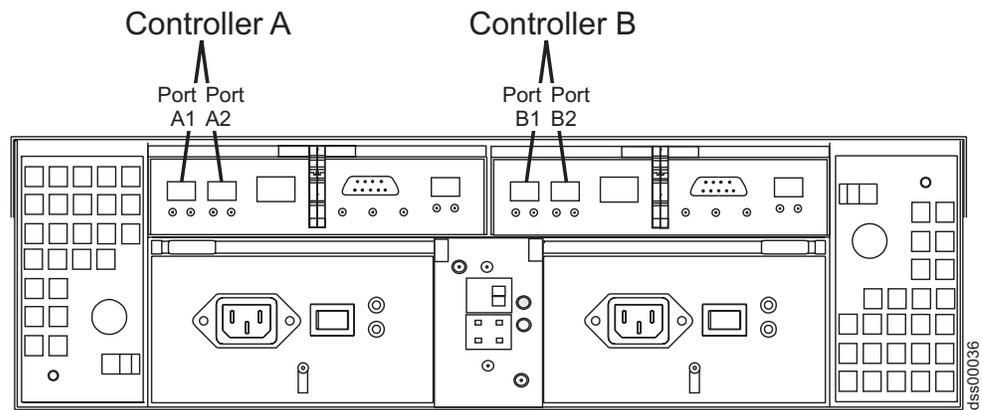
Controller A   Controller B

Port Port   Port Port
A1   A2   B1   B2

dss00036

Figure 32. Controller A and Controller B host ports, machine type 1722

For the machine type 1815, controller host ports A4 and B4 are dedicated for mirroring options when the Enhanced Remote Mirroring premium feature is enabled. See Figure 33 on page 104 for the location of controller host ports for machine type 1815.

Host port A4

Controller A

Controller B
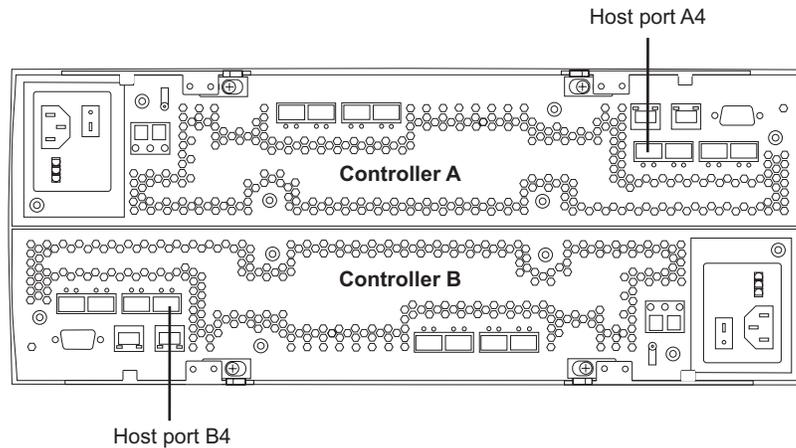
Host port B4

Figure 33. Controller A and Controller B host ports, machine type 1815

For machine types 3552 and 1742, each of the controller host ports is connected to a minihub. Each minihub has two small form-factor pluggable (SFP) or gigabit interface converter (GBIC) port slots. If the first minihub SFP or GBIC port slot is connected to a Fibre Channel switch port as part of remote mirror setup, the second minihub port must not be occupied.

Host-initiated I/O operations are refused by the dedicated port. Requests that are received on this dedicated port are only accepted from a controller that is participating in the remote mirror relationship.

Controller ports that are dedicated to the remote logical drive mirror must be attached to a Fibre Channel fabric environment with support for the Directory Service and Name Service interfaces.

Logical drive ownership

The controller owner of the primary logical drive attempts to communicate with only its mirrored controller in the secondary storage subsystem. As shown in Figure 34 on page 105, controller A in the primary storage subsystem attempts to communicate with controller A in the secondary storage subsystem.

The controller (A or B) that owns the primary logical drive determines the controller owner of the secondary logical drive. Regardless of the secondary logical drive controller ownership, if the primary logical drive is owned by controller A on the primary storage subsystem, the secondary logical drive is then owned by controller A on the secondary storage subsystem. If primary controller A cannot communicate with secondary controller A, no controller ownership changes take place and the remote mirror link is broken for that mirror logical drive pair. When primary controller A can communicate with secondary controller A, the next I/O request to the primary logical drive results in a secondary drive ownership change.
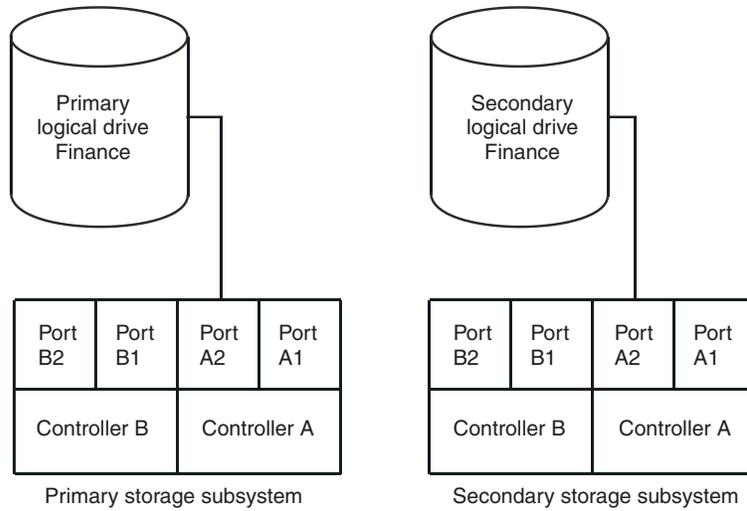
Figure 34. Controller A shown as the controller owner

When an I/O path error causes a logical drive ownership change on the primary storage subsystem, or if the storage administrator changes the controller owner of the primary logical drive, the next remote write request that is processed automatically starts an ownership change on the secondary storage subsystem.

As shown in Figure 35, if a primary logical drive is owned by controller A and the controller owner is changed to controller B, the next remote write operation changes the controller owner of the secondary logical drive from controller A to controller B.
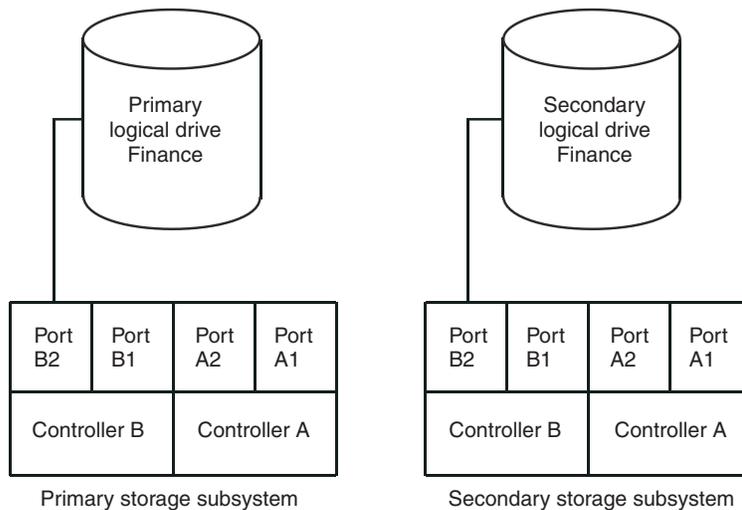
Figure 35. Controller B shown as controller owner

Because controller ownership changes on the secondary storage subsystem are controlled by the primary controller, they do not require any special intervention and you cannot manually change them.

Primary and secondary storage subsystem connection distance

The maximum connection distance that is permitted between storage subsystems that are participating in a mirror relationship is governed by the distance limits of the Fibre Channel interswitch links (ISL). With the previous Remote Mirror option using standard single mode fiber technology, the maximum link distance was 10 km (6.25 mi) between storage subsystems. In addition, the ISL link must be a standard Fibre Channel connection using single mode Fibre Channel cables between two longwave GBICs or SFPs that are inserted into the Fibre Channel switch port slots. With the Enhanced Remote Mirroring option, link distances between storage subsystems of more than 5150 km (3200 mi) can be achieved.

Role reversals

A role reversal is the act of promoting the secondary logical drive to be the primary logical drive of the mirrored logical drive pair, and demoting the primary logical drive to the secondary logical drive role.

In the event of a disaster at the storage subsystem that contains the primary logical drive, you can fail over to the secondary site by performing a role reversal to promote the secondary logical drive to the primary logical drive role. This allows business operations to continue and hosts to continue accessing data.

You can use one of the following methods to perform a role reversal:

- Click **Volume → Remote Mirroring → Change → Role to Primary** to change a secondary logical drive to a primary logical drive.

  This option promotes the selected secondary logical drive to become the primary logical drive of the mirrored pair, and can be used when a catastrophic failure has occurred. For step-by-step instructions, see the Subsystem Management window online help.

- Click **Volume → Remote Mirroring → Change → Role to Secondary** to change a primary logical drive to a secondary logical drive.

  This option demotes the selected primary logical drive to the secondary logical drive role, and can be used during normal operating conditions. For step-by-step instructions, see the Subsystem Management Window online help.

If the primary storage array is recovered but is unreachable due to a link failure, a forced promotion of the secondary logical drive results in both the primary and secondary logical drives viewing themselves in the primary logical drive role (dual-primary condition). If this occurs, the logical drive copy in which the primary logical drive is participating will be unaffected by the role change.

General performance considerations

Note the following general performance considerations when you create remote mirrors:

- The controller owner of a primary logical drive performs a full synchronization in the background while processing local I/O write operations to the primary logical drive and associated remote write operations to the secondary logical drive. Because a full synchronization diverts controller processing resources from I/O activity, this can impact performance to the host computer program.

  To reduce the performance impact, you can set the synchronization priority to establish how the controller owner prioritizes a full synchronization relative to other I/O activity. The following are some basic guidelines for setting the synchronization rate:

- A full synchronization at the lowest synchronization priority rate takes approximately eight times as long as a full synchronization at the highest priority synchronization rate.

- A full synchronization at the low synchronization priority rate takes approximately six times as long as a full synchronization at the highest priority synchronization rate.

- A full synchronization at the medium synchronization priority rate takes approximately three and a half times as long as a full synchronization at the highest priority synchronization rate.

- A full synchronization at the high synchronization priority rate takes approximately twice as long as a full synchronization at the highest priority synchronization rate.

  For more information about setting the synchronization priority, see Chapter 8, "Using the Enhanced Remote Mirroring option," on page 135.

- When the mirror logical drive pair is in the `Synchronization-in-Progress` state, all host computer write data is copied to the remote system in processing the I/O. Controller I/O bandwidth and I/O latency affect host computer write performance. Host read performance is not affected by the mirror relationship.

- The overall system performance is impacted when data is copied from the primary logical drive to the secondary logical drive and when the number of write operations that are permitted at one time are limited.

Using other premium features with the Remote Mirror Option

This section describes how you can use the Remote Mirror Option with Storage Partitioning and FlashCopy.

For information about using the Remote Mirror Option with VolumeCopy, see "The Remote Mirror Option and VolumeCopy" on page 81.

Storage Partitioning and the Remote Mirror Option

Storage Partitioning is a premium feature which enables host computers to share access to logical drives in a storage subsystem. A storage partition is created when you define a collection of host computers (a host group) or a single host computer and then define a logical drive to logical unit number (LUN) map. This map enables you to define what host group or host computer has access to a particular logical drive in your storage subsystem.

Note: Storage partitioning is not a copy services premium feature. This guide does not describe how to enable and use the Storage Partitioning feature. For more information about storage partitioning, see the *IBM DS4000 Storage Manager Version 9 Installation and Support Guide* for your specific operating system.

Figure 36 on page 108 shows the Mappings view of the Subsystem Management window, where primary logical drive `Accounting` is included in a partition that is accessible by host group `Campus East`, and secondary logical drive `Accounting 2` is included in a partition that is accessible by host group `Campus West`.
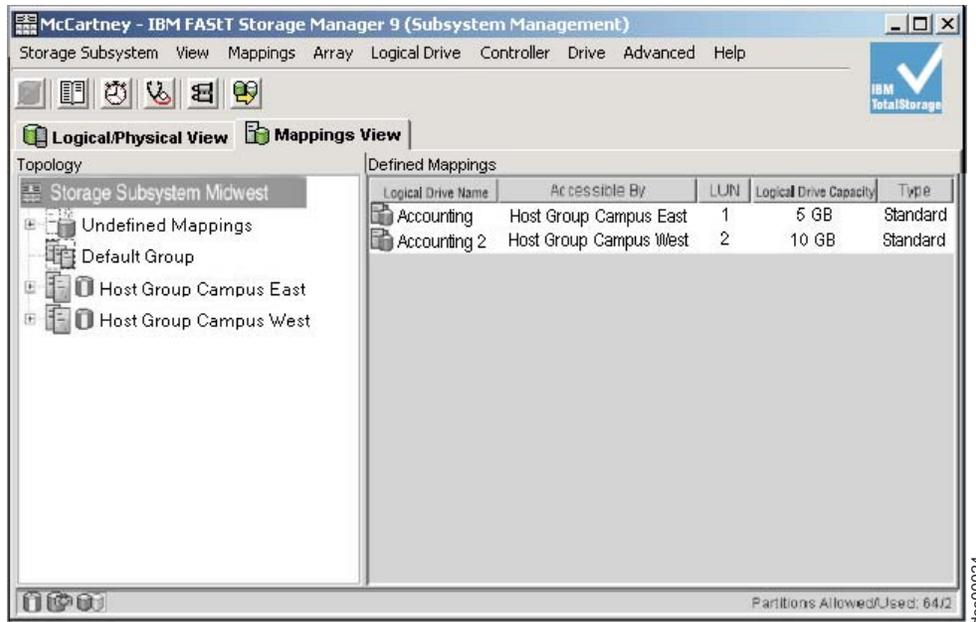
Figure 36. Mappings view of the Subsystem Management window showing storage partitioning

The storage partition definitions for the primary and secondary storage subsystems are independent of each other. If the storage partition definitions are put in place while the logical drive is in the secondary role, the storage partition reduces the administrative effort that is associated with storage subsystem recovery if it becomes necessary to promote the secondary logical drive to the primary role. However, depending on the host operating system and application, the secondary logical drive might not be assigned to the same host that the primary logical drive is mapped to. For more information about defining storage partitions, see the Subsystem Management window online help.

Storage partition definitions can be performed using the **Create** command in the Storage Manager Script window or the CLI. For more information, see the Enterprise Management window online help.

FlashCopy and the Remote Mirror Option

FlashCopy is a premium feature that comes with the IBM DS4000 Storage Manager software. You can enable this premium feature by purchasing the FlashCopy option. A FlashCopy logical drive is a point-in-time (real-time) image of a logical drive and is created so that a program, such as a backup program, can access the FlashCopy logical drive and read the data while the base logical drive remains online and is accessible to host computers.

When FlashCopy is enabled, you can have FlashCopy logical drives that are based on the primary or secondary logical drive of a mirrored logical drive pair.

The logical drive for which the point-in-time image is created is known as the base logical drive and must be a standard logical drive in the storage subsystem. For remote logical drive mirroring, only the base logical drive of a FlashCopy logical drive is permitted to be a candidate for the primary logical drive in a mirror relationship. Figure 37 on page 109 shows the primary logical drive (also the base

logical drive for the FlashCopy logical drive), the secondary logical drive, and the FlashCopy repository logical drive in the Subsystem Management window for the primary storage subsystem.

Important: The base logical drive of a FlashCopy logical drive cannot be a candidate for the secondary logical drive role in a mirror relationship. Otherwise, the FlashCopy logical drive fails when the remote mirror relationship is created.
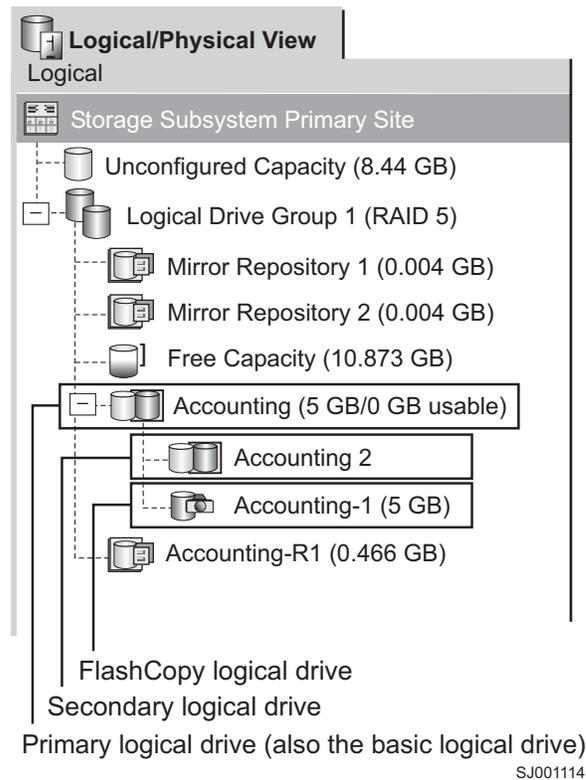

Logical/Physical View

Logical

Storage Subsystem Primary Site

Unconfigured Capacity (8.44 GB)

Logical Drive Group 1 (RAID 5)

Mirror Repository 1 (0.004 GB)

Mirror Repository 2 (0.004 GB)

Free Capacity (10.873 GB)

Accounting (5 GB/0 GB usable)

Accounting 2

Accounting-1 (5 GB)

Accounting-R1 (0.466 GB)

FlashCopy logical drive

Secondary logical drive

Primary logical drive (also the basic logical drive)

SJ001114

Figure 37. FlashCopy logical drive included in a mirror relationship

Dynamic Volume Expansion

Dynamic Volume Expansion (DVE) is a modification operation that you can use to increase the capacity of a standard logical drive or a FlashCopy repository logical drive. To increase the capacity, a DVE operation uses the free capacity that is available on the logical drive group of the logical drive.

The operation is considered to be ″dynamic″ because you can continuously access data on logical drive groups, logical drives, and disk drives during the operation.

You can perform a DVE operation on a primary or secondary logical drive in a remote mirror relationship. However, keep in mind that although Storage Manager indicates that the logical drive has increased in capacity, its usable capacity becomes the smaller of the two logical drives.

You cannot perform a DVE operation on a mirror repository logical drive. If the mirror repository logical drive exists from a previous release of Storage Manager and needs to be upgraded, see "Upgrading mirror repository logical drives" on page 135

Chapter 7. Installing hardware and software for the Enhanced Remote Mirroring option

This chapter contains the information that you need to install the hardware and software to run the Remote Mirror Option. The first section contains the steps that you must complete before you install the hardware and software. Next, hardware installation procedures are presented, followed by software installation procedures. Complete the procedures in this chapter sequentially, from beginning to end.

Pre-installation considerations

This section provides the following information that you must review and complete before you begin the hardware or software installation procedures:

- Site preparation
- Hardware requirements
- Software requirements
- Host operating systems
- Switch zoning overview

Site preparation

The Remote Mirror Option uses Fibre Channel switches to create a fabric environment for data replication. These Fibre Channel switches require only minimal additional site preparation beyond basic storage subsystem operation.

For basic site preparation considerations including the use of Fibre Channel cables and connections, see the *IBM DS4000 Storage Manager Version 9 Installation and Support Guide* for your specific operating system.

For additional site preparation considerations concerning the Fibre Channel switches, including power requirements and physical dimensions and requirements, see the documentation that comes with the fabric switch.

Hardware requirements

The following list contains the minimum hardware requirements for configuring your system to use the Enhanced Remote Mirror Option. The list includes the components that are supplementary to the standard requirements of a basic storage subsystem environment. For more information, see the *IBM DS4000 Storage Manager Version 9 Installation and Support Guide* for your specific operating system.

Note: Enhanced Remote Mirroring is not supported on IBM FAStT500 Fibre Channel Storage Subsystems. However, you can use the previous, synchronous-mode-only Remote Mirroring on FAStT500 storage servers with Storage Manager firmware version 5.20.xx.xx or higher. If you have a FAStT500 storage subsystem, see the following edition of the *Copy Services Guide* for information about using Remote Mirroring:

IBM TotalStorage FAStT Storage Manager Copy Services Guide (GC26-7561-00)

- **IBM TotalStorage DS4000 Storage Subsystems**

Enhanced Remote Mirroring is currently supported on DS4100, DS4300, DS4400, DS4500, DS4800 Storage Subsystems. For information about other storage subsystems that might be supported in the future, contact your IBM service representative.

It is possible to have different storage subsystems in each of the two nodes of the Remote Mirror Option. For example, the local storage subsystem can be the IBM DS4400 Storage Subsystem and the remote storage subsystem can be the IBM DS4500 Storage Subsystem and vice-versa.

However, because the IBM DS4400 and IBM DS4500 Storage Subsystems are different sets of hardware with different performance characteristics, the storage subsystem and its associated drives and storage expansion enclosures in each of the nodes of the remote mirror setup must be the same for optimal and reliable performance.

- **Fibre-channel switches**

  Use these devices to connect multiple host computers with multiple storage subsystems in a controlled environment. You can connect multiple Fibre Channel switches over long distances to create a fabric environment.

  For a list of certified Fibre Channel switches to use with the Remote Mirror Option, see the DS4000 Storage Manager readme file for your host operating system.

- **Short or medium range Fibre Channel cables**

  Use these cables to connect the host computers and storage subsystems to the Fibre Channel switches.

- **Long range Fibre Channel cables**

  Use these cables to connect between Fibre Channel switches to complete long-distance fabrics.

- **Fibre-channel host bus adapters (HBAs)**

  For a list of certified HBAs to use with the Remote Mirror Option, see the DS4000 Storage Manager readme file for your host operating system.

- **Ethernet switches and network**

  Use these devices to connect the DS4000 Storage Subsystems to the DS4000 Storage Subsystem management station. In order to create remote mirror logical drive pairs, the management station must have either in-band or out-of-band management connections to both DS4000 Storage Subsystems where the logical drives reside.

Software requirements

When configuring your host computer to use the new Enhanced Remote Mirroring option, be sure that the following minimum software requirements are met:

- IBM DS4000 Storage Manager Version 9.x or later
- Controller firmware version 6.10.xx.xx or higher for DS4300 Turbo Option, DS4400, and DS4500
- Controller firmware version 6.12.xx.xx or higher for DS4100
- Controller firmware version 6.14.xx.xx or higher for DS4800
- IBM Remote Mirror Premium Feature Key (one for each storage subsystem)

When configuring your host computer to use the previous, synchronous-mode-only version of Remote Mirror Option, be sure that the following minimum software requirements are met:

- IBM DS4000 Storage Manager Version 8.4x.xx

- Controller firmware version 5.20.xx.xx or higher for FAStT500 and DS4400. Controller firmware version 5.30.xx.xx or higher for DS4500.
- IBM Remote Mirror Premium Feature Key (one for each storage subsystem)

Host operating systems

Host computers that access mirrored logical drives must have one of the following operating systems installed to use the Remote Mirror Option. (For the most up-to-date information, check the most recent DS4000 Storage Manager readme file for the appropriate host operating system. See "Who should read this document" on page xi for instructions that describe how to find the readme file online.)

- Microsoft Windows NT 4.0 Server Edition (earlier Remote Mirror Option only)
- Microsoft Windows 2000
- Microsoft Windows Server 2003
- Solaris Version 2.6, 2.7 (Solaris 7), 2.8 (Solaris 8), Solaris 9
- HP-UX Version 11.0 or later
- AIX Version 5.1, 5.2 or later
- Linux (Red Hat Advance Server 3.0 and 4.0, SLES 8 and 9)
- Linux on POWER-based operating systems (Red Hat Enterprise Linux 3 and 4, SLES 9)
- Novell NetWare Version 6.0 and 6.5

Switch zoning overview

This section describes how to create zones for Remote Mirroring. For host server zoning, see the *DS4000 Storage Manager Installation and Support Guide* for your host operating system, in addition to the installation and user's guide provided by the switch manufacturer.

To create switch zoning configurations for Remote Mirroring, use the management software that comes with the Fibre Channel switch.

The Enhanced Remote Mirroring option requires two dedicated controller host port connections for each storage subsystem that will participate in Enhanced Remote Mirroring. When the Enhanced Remote Mirroring option is activated on a storage subsystem, one of the host ports in each of the DS4000 controllers is dedicated for Remote Mirroring. You cannot use this port for other types of I/O to the DS4000 storage subsystem. In DS4000 storage subsystems that have a maximum of two host ports on each controller, the second host port of each controller is the port that is dedicated for Remote Mirroring operations. See the *DS4000 Storage Subsystem Installation, User's and Maintenance Guide* for your storage subsystem for information about Remote Mirroring dedicated ports.

You must create at least two zones – one zone that consists of the host ports in controller A of the Enhanced Remote Mirroring pair primary and secondary storage subsystems that are dedicated for mirroring operations, and similarly, one zone that consists of the host ports in controller B of the primary and secondary storage subsystems that are dedicated for mirroring operations. This configuration is required to ensure that one port on the controller is fully dedicated to remote mirroring operations. However, for best practices, IBM recommends that you also zone server HBA connections so that a single host bus adapter in a server can access only one controller per storage subsystem.

Important:

1. IBM recommends that you establish one-to-one zones between the DS4000 Storage Subsystems in the mirrored pair. The zoning and cabling procedures described in this section are for illustrative purposes only, and might not show one-to-one zoning. Adjust the procedures for your specific installation.

2. Do not zone the ISL port that connects (cascades) switches within a fabric environment.

3. Although the ports that are dedicated for remote mirroring operations are known as "host ports," in a remote mirror setup you do not connect them to a host server. Instead, you connect them to the other DS4000 Storage Subsystems in the mirrored pair.

When two or more Fibre Channel switches are cascaded together, each switch shares a common view of the storage area network (SAN) fabric. For example, if two 16-port Fibre Channel switches are physically connected (cascaded) with a Fibre Channel cable, the switch management software manages these two switches as if they are a single switch with 32 ports (0 - 31), rather than as two separate Fibre Channel switches with 16 ports each (0 - 15). Therefore, a zone that is created containing any of these ports exists on multiple cascaded Fibre Channel switches.

Note: This is usually, but not always the case, depending on the switch manufacturer. Some switch software might write over, rather than merge the switches.

In the top illustration in Figure 38 on page 115, the Fibre Channel switches are on the same network and cascaded. Therefore, there are two zones that span across two switches (Zone 1 and Zone 2). Zone 1 is the same zone on Switch 1A as Zone 1 on Switch 1B.

In the bottom illustration in Figure 38 on page 115, the Fibre Channel switches are on the same network, but are not cascaded. Therefore, in this configuration, there are four different zones — two zones on Switch 1 and two zones on Switch 2. The zones on Switch 1 are independent of the zones on Switch 2.

Host 1

HA1 HA2

Switch 1A   Fabric 1   Switch 1B
                   10 Km Max

0 2 4 6 8 10 12 14   16 18 20 22 24 26 28 30
   Zone 1   Zone 2   Zone 1   Zone 2
1 3 5 7 9 11 13 15   17 19 21 23 25 27 29 31

B1 B2
A1 A2

Host 1

HA1 HA2

Switch 1   Switch 2

0 2 4 6 8 10 12 14   0 2 4 6 8 10 12 14
   Zone 1   Zone 2   Zone A   Zone B
1 3 5 7 9 11 13 15   1 3 5 7 9 11 13 15

B1 B2
A1 A2
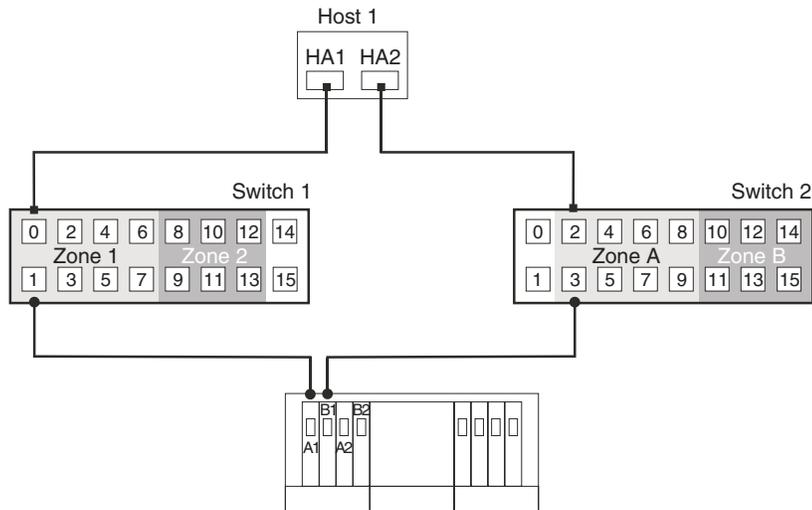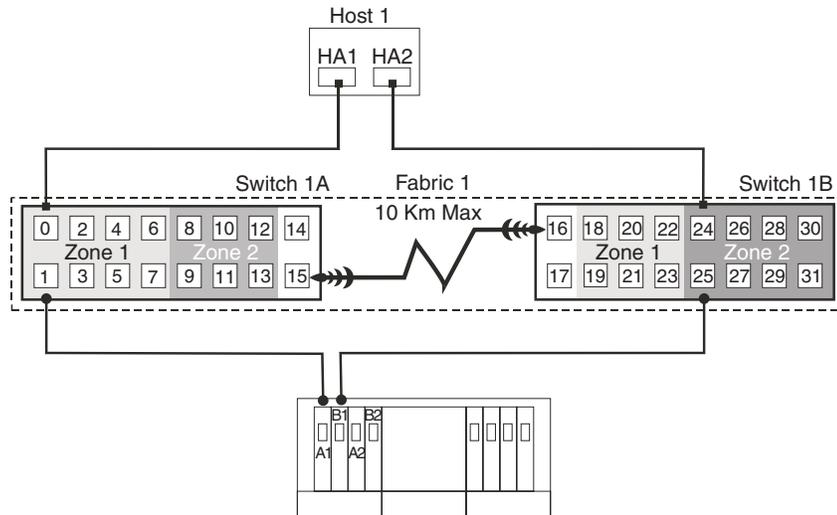
Figure 38. Switch zoning in cascaded (top) and noncascaded (bottom) Fibre Channel switches

For more information about Fibre Channel switch zoning or setting up a zone configuration, see the documentation that comes with the switch.

Installing the hardware

This section describes the procedures that are necessary to properly connect and configure one or more storage subsystems for use with the Remote Mirror Option.

For a checklist to ensure that all the required hardware components are configured properly, see "Hardware and software checklists" on page 132.

The three following Remote Mirroring configurations are examples of configurations that IBM supports. Contact your IBM representative or reseller if you have questions about the implementation of your Remote Mirroring requirements.

Highest Availability Campus configuration

This configuration has two Fibre Channel switches at both the primary and secondary sites to provide complete failover and redundancy in the Fibre Channel switches and fabrics, in addition to all storage subsystem components and host computers. Two Fibre Channel switches at each site also provide redundancy to the local site in addition to a fully redundant remote configuration. There is no single point of failure in the hardware components. Therefore, data synchronization can continue for any single switch failure. This simplifies the disaster recovery process.

Use Metro Mirroring (synchronous write mode) for distance less than 10 km and Global Mirroring for distance of greater than 10 km. Additional hardware and/or Fibre Channel switch licensing may be required to support distances greater than 10 km.

Important:

1. IBM recommends that you establish one-to-one zones between the DS4000 Storage Subsystems in the mirrored pair. The zoning and cabling procedures described in this section are for illustrative purposes only, and might not show one-to-one zoning. Adjust the procedures for your specific Highest Availability Campus installation.

2. The Highest Availability Campus configuration is the preferred configuration for the Remote Mirror Option.

Figure 39 on page 117 shows the Highest Availability Campus configuration after installation is complete.
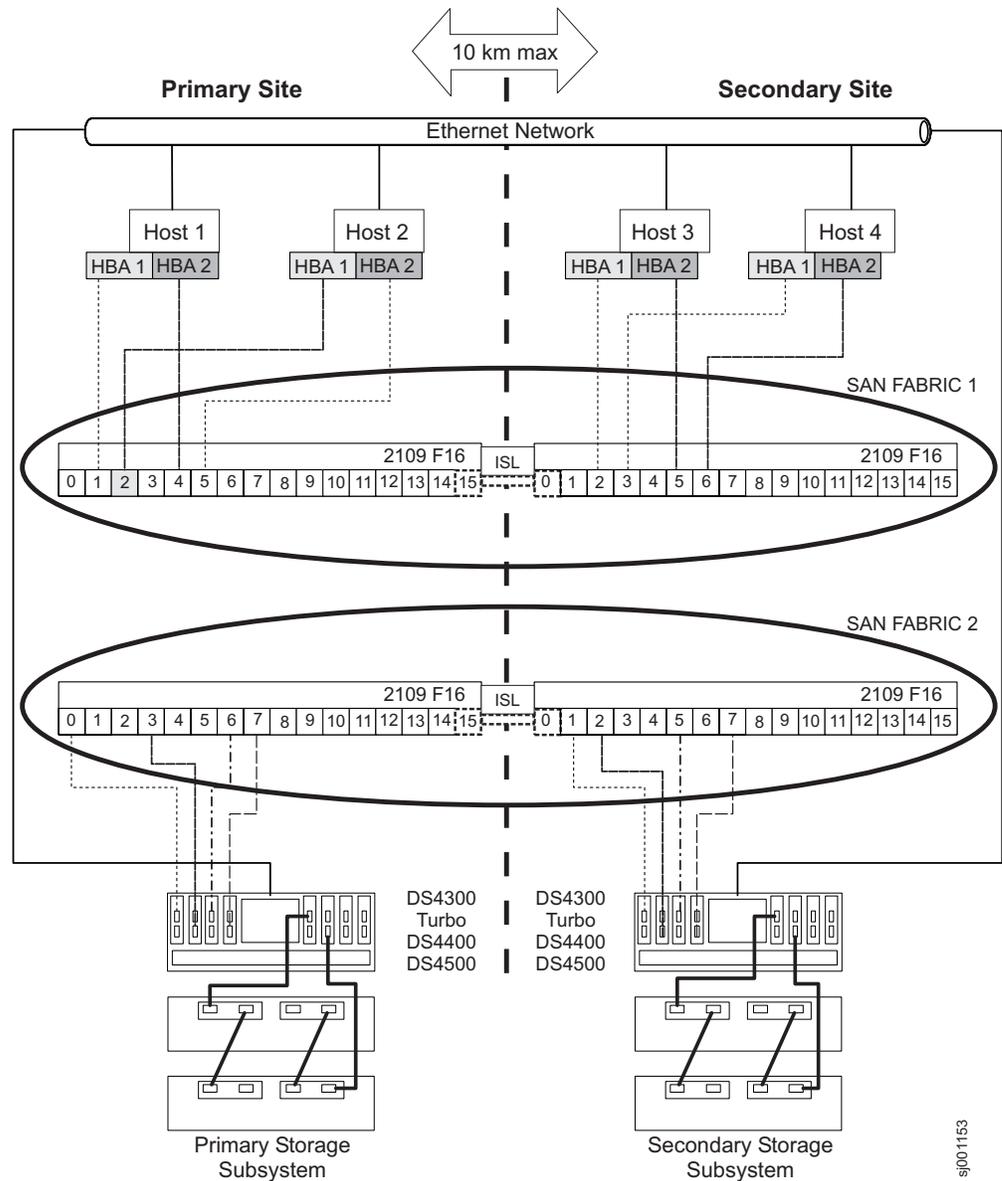
Figure 39. Highest Availability Campus configuration

Switch zoning for the Highest Availability Campus configuration

This configuration provides a separate zone for each reserved port for the Remote Mirroring Option.

You do not need to zone the Fibre Channel switches exactly as presented in this sample configuration. However, the following are requirements when zoning switches for the Highest Availability Campus configuration:

- The remote mirror host port connections cannot be zoned together. You must create two zones:
  - The first zone consists of the Remote Mirroring-dedicated host ports from Controllers A of the primary and secondary host subsystems.
  - The second zone consists of the Remote Mirroring-dedicated host ports from Controllers B of the primary and secondary host subsystems.

- The uplink port must not be zoned on any Fibre Channel switch.
- For best practices, IBM recommends that you zone server HBA connections so that a single host adapter can access only one controller per storage subsystem fabric.

Important: The Fibre Channel switches in Figure 39 on page 117 contain 16 ports each, which leaves many unused ports per switch. If you are performing switch zoning using the Fibre Channel host port number, instead of the WWNN of the SAN fabric logged-in ports, do not include Fibre Channel switch ports with no Fibre Channel connections in the zone definition. If you include these unused ports in your zones, unauthorized access to the SAN might result.

Figure 39 on page 117 shows how the four Fibre Channel switches are cabled for this Highest Availability Campus configuration. The zones are configured on the switch to allow one port per zone for a storage subsystem connection, and one HBA port per zone for each host. There are four zones in the following configuration example.
- Zone 1 and Zone 3 exist on Fabric 1 (switch 1A at the primary site, and switch 1B at the secondary site)
- Zone 2 and Zone 4 exist on Fabric 2 (switch 2A at the primary site, and switch 2B at the secondary site.

Before proceeding to the next section, ensure that all four Fibre Channel switches are properly zoned. For more information about zoning Fibre Channel switches, see "Switch zoning overview" on page 113.

Cabling examples for the Highest Availability Campus configuration

Table 8 and Table 9 show examples of the Fibre Channel cabling connections in the Highest Availability Campus configuration. Refer to the examples before you complete the procedure in "Setting up the Highest Availability Campus configuration" on page 120.

Important: IBM recommends that you establish one-to-one zones between the DS4000 Storage Subsystems in the mirrored pair. The examples shown in these tables are for illustrative purposes only, and do not show one-to-one zoning.

Table 8. Highest Availability Campus configuration connections (Primary site)

Primary site					
Switch 1A			**Switch 2A**		
Zone	**Port**	**Connection to and from:**	**Zone**	**Port**	**Connection to and from:**
1	0	Host 1, HBA 1 (HA1)	2	0	Host 2, HBA 2 (HB2)
	1	Controller port A1		1	Host 1, HBA 2 (HA2)
	2	Host 2, HBA 1 (HB1)		2	Controller port B1
	3	Additional host, HBA 1 (optional)		3	Additional host, HBA 2 (optional)
	4	Additional host, HBA 1 (optional)		4	Additional host, HBA 2 (optional)
	5	Additional host, HBA 1 (optional)		5	Additional host, HBA 2 (optional)
	6	Additional host, HBA 1 (optional)		6	Additional host, HBA 2 (optional)
	7	Additional host, HBA 1 (optional)		7	Additional host, HBA 2 (optional)
3	8	Unused	4	8	Controller port B2 (dedicated remote mirror port)
	9	Controller port A2 (dedicated remote mirror port)		9	Unused
	10	Unused		10	Unused
	11	Unused		11	Unused
	12	Unused		12	Unused
	13	Unused		13	Unused
N/A	14	Spare (can be added to either zone)	N/A	14	Spare (can be added to either zone)
N/A	15	Uplink with Switch 1B	N/A	15	Uplink with Switch 2B

Table 9. Highest Availability Campus configuration connections (Secondary site)

Secondary site					
Switch 1B			**Switch 2B**		
Zone	**Port**	**Connection from and to:**	**Zone**	**Port**	**Connection from and to:**
N/A	16	Uplink with Switch 2A	N/A	16	Uplink with Switch 1A
N/A	17	Spare (can be added to either zone)	N/A	17	Spare (can be added to either zone)

Table 9. Highest Availability Campus configuration connections (Secondary site) (continued)

Secondary site						
1	18	Host 3, HBA 1 (HC1)	2	18	Controller port B1
	19	Controller port A1		19	Host 4, HBA 2 (HD2)
	20	Host 4, HBA 1 (HD1)		20	Additional host, HBA 1 (optional)
	21	Additional host, HBA 1 (optional)		21	Host 4, HBA 2 (HD2)
	22	Additional host, HBA 1 (optional)		22	Additional host, HBA 1 (optional)
	23	Additional host, HBA 1 (optional)		23	Additional host, HBA 1 (optional)
3	24	Unused	4	24	Controller port B2 (dedicated remote mirror port)
	25	Controller port A2 (dedicated remote mirror port)		25	Unused
	26	Unused		26	Unused
	27	Unused		27	Unused
	28	Unused		28	Unused
	29	Unused		29	Unused
	30	Unused		30	Unused
	31	Unused		31	Unused

Setting up the Highest Availability Campus configuration

Complete the steps in this procedure to set up the Highest Availability Campus configuration for the Remote Mirror Option. Adjust the steps for your specific installation.

Before you begin: Note the following information:

* IBM recommends that you establish one-to-one zones between the DS4000 Storage Subsystems in the mirrored pair. The zoning and cabling procedures described in this section are for illustrative purposes only, and might not show one-to-one zoning. Adjust the procedures for your specific Highest Availability Campus installation.
* Refer to Figure 39 on page 117 as you complete the steps in this procedure.
* Begin the installation at the primary site. Repeat these steps for the secondary site when instructed to do so.
* All connections are completed using Fibre Channel cables of appropriate length.
* If you are adding the Remote Mirror Option hardware to an existing storage subsystem environment that stops I/O from all host computers, begin with step 1. If this is a new storage subsystem installation, begin with step 2.

1. Power down all storage subsystems, host computers, Fibre Channel switches, and all other hardware in the storage subsystem environment.

2. Ensure that the cabling between all storage subsystems and storage expansion enclosures is complete.

   Note: Depending on which site you are configuring, Switch 1 represents Switch 1A for the primary site and Switch 1B for the secondary site. Repeat the same configuration for Switch 2.

3. Connect the primary host bus adapter (Hx1) for each local host to an available port in Zone 1 of Switch 1.

Note: You can connect the cables to any port in the proper zone of the switch.

4. Connect the secondary host bus adapter (Hx2) for each host at this site to an available port in Zone 2 of Switch 2.

5. Connect controller port A1 of the storage subsystem to an available port in Zone 1 of Switch 1.

6. Connect controller port B1 of the storage subsystem to an available port in Zone 2 of Switch 2.

7. Connect controller port A2 of the storage subsystem to an available port in Zone 3 of Switch 1.

8. Connect controller port B2 of the storage subsystem to an available port in Zone 4 of Switch 2.

> **Note:** Controller ports A2 and B2 are reserved for mirror relationship synchronization when the Remote Mirror Option is activated. For more information, see "Connectivity and I/O" on page 102.

9. If the primary site cabling and the secondary site cabling is complete, go to step 10. Otherwise, repeat step 1 on page 120 through step 8 for the secondary site.

10. Complete the Fabric 1 environment for Switch 1 by connecting Switch 1A with Switch 1B. Connect each end of a long range Fibre Channel cable (that can support a distance up to 10 Km (6.25 mi)) to an unzoned port in each switch.

11. Repeat step 10 for Switch 2A and 2B to complete the Fabric 2 environment for Switch 2.

12. Cabling for this Highest Availability Campus configuration is complete. Repeat step 3 on page 120 through step 9 for any additional storage subsystems that use the Remote Mirror Option.

13. Power up all storage subsystems, host computers, Fibre Channel switches, and any other hardware at both sites that were powered down in step 1 on page 120.

14. Hardware installation is complete. The next step is to configure the storage management software to support mirror relationships. Go to "Installing the software" on page 129.

Campus configuration

The Campus configuration offers the same functionality as the Highest Availability Campus configuration, but contains only one switch at each site, rather than two. The configuration is still redundant for host bus adapters, controllers, and remote logical drive mirroring ports, but is a single point of failure for Fibre Channel switches. If a switch at either site fails, the Remote Mirror Option cannot function. For this reason, the Highest Availability Campus configuration is preferred for total environment redundancy. Figure 40 on page 122 shows the Campus configuration after installation is complete.

Use Metro Mirroring (synchronous write mode) for distance less than 10 km and Global Mirroring for distance of greater than 10 km. Additional hardware and/or Fibre Channel switch licensing may be required to support distances greater than 10 km.

Important: IBM recommends that you establish one-to-one zones between the DS4000 Storage Subsystems in the mirrored pair. The zoning and cabling procedures described in this section are for illustrative purposes only, and might not show one-to-one zoning. Adjust the procedures for your specific Campus installation.
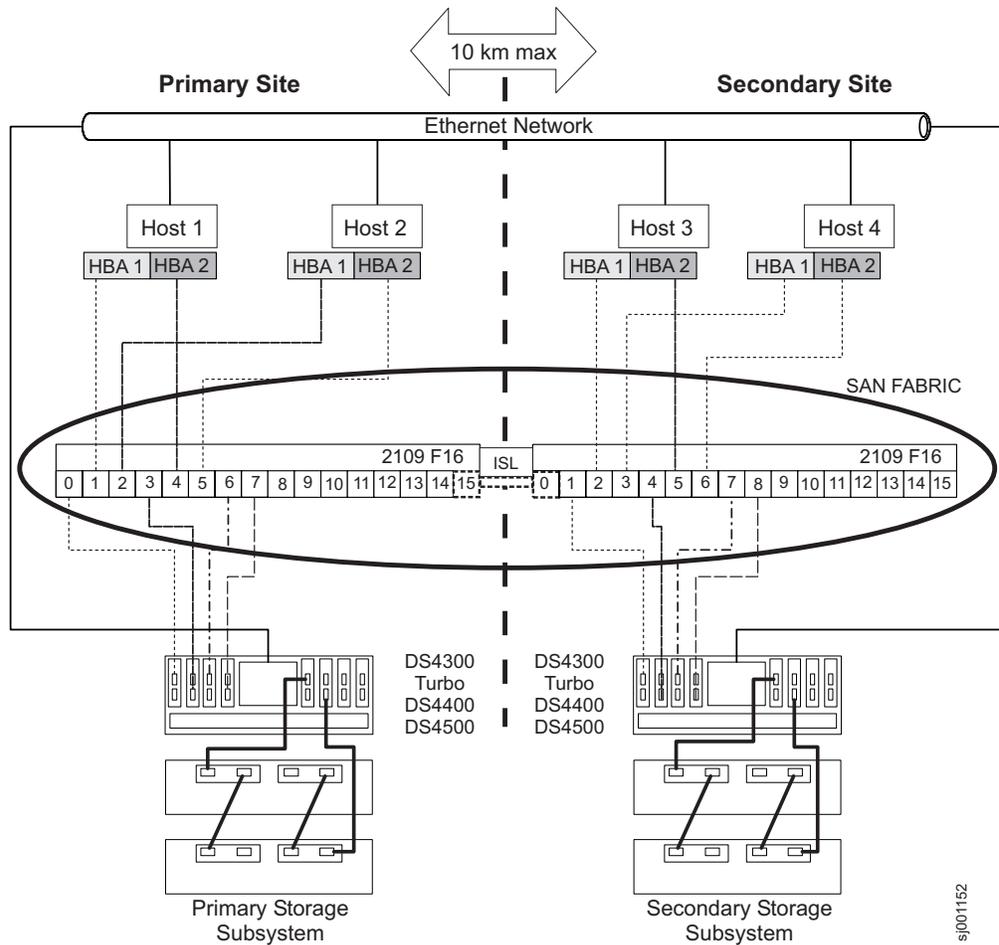
Figure 40. Campus configuration

Switch zoning for the Campus configuration

This configuration provides a separate zone for each reserved port for the Remote Mirroring Option.

For an example of how to zone the Fibre Channel switches, see "Switch zoning for the Highest Availability Campus configuration" on page 117. Remember that the Campus configuration uses two Fibre Channel switches and one 10Km (6.2 mi) ISL.

There are a total of four zones in this configuration.
* All zones exist on the Fabric 1 environment (Switch 1A at the primary site, and Switch 1B at the secondary site).
* Zone 3 and Zone 4 are reserved for the dedicated Remote Mirror Option connections.

Important: The Fibre Channel switches in Figure 40 contain 16 ports each, which leaves many unused ports per switch. If you are performing switch zoning using the Fibre Channel host port number, instead of the WWNN of the SAN fabric logged-in ports, do not include Fibre Channel switch ports with no Fibre Channel connections in the zone definition. If you include these unused ports in your zones, unauthorized access to the SAN might result.

Before proceeding to the next section, ensure that both Fibre Channel switches are properly zoned. For more information about zoning Fibre Channel switches, see "Switch zoning overview" on page 113.

Cabling examples for the Campus configuration

Table 10 and Table 11 show examples of the Fibre Channel cabling connections in the Campus configuration. Refer to the examples before you complete the procedure in "Setting up the Campus configuration" on page 124.

Important: IBM recommends that you establish one-to-one zones between the DS4000 Storage Subsystems in the mirrored pair. The examples shown in these tables are for illustrative purposes only, and do not show one-to-one zoning.

Table 10. Campus configuration connections (Primary site)

Primary site		
Switch 1A		
Zone	**Port**	**Connection to and from:**
1	0	Host 1, HBA 1
	1	Controller port A1
	2	Host 2, HBA 1
	3	Additional host, HBA 1 (optional)
	4	Additional host, HBA 1 (optional)
	5	Additional host, HBA 1 (optional)
2	6	Host 1, HBA 2
	7	Controller port B1
	8	Host 2, HBA 2
	9	Additional host, HBA 2 (optional)
	10	Additional host, HBA 2 (optional)
	11	Additional host, HBA 2 (optional)
3	12	Controller port A2 (dedicated remote mirror port)
4	13	Controller port B2 (dedicated remote mirror port)
N/A	14	Spare
N/A	15	Uplink with Switch 2

Table 11. Campus configuration connections (Secondary site)

Secondary site		
Switch 1B		
Zone	**Port**	**Connection to and from:**
1	16	Uplink with Switch 1
	17	Spare
	18	Host port, HBA 1
	19	Controller port A1
	20	Host 4, HBA 1
	21	Additional host, HBA 1 (optional)
	22	Additional host, HBA 1 (optional)
	23	Additional host, HBA 1 (optional)

Table 11. Campus configuration connections (Secondary site) (continued)

Secondary site		
2	24	Host 3, HBA 2
	25	Controller port B1
	26	Host 4, HBA 2
	27	Additional host, HBA 2 (optional)
	28	Additional host, HBA 2 (optional)
	29	Additional host, HBA 2 (optional)
3	30	Controller port A2 (dedicated remote mirror port)
4	31	Controller port B2 (dedicated remote mirror port)

Setting up the Campus configuration

Complete the steps in this procedure to set up the Campus configuration for the Remote Mirror Option.

Before you begin: Note the following information:

- IBM recommends that you establish one-to-one zones between the DS4000 Storage Subsystems in the mirrored pair. The zoning and cabling procedures described in this section are for illustrative purposes only, and might not show one-to-one zoning. Adjust the procedures for your specific Campus installation.
- Refer to Figure 40 on page 122 as you complete the steps in this procedure.
- Begin the installation at the primary site. Repeat these steps for the secondary site when instructed to do so.
- All connections are completed using Fibre Channel cables of appropriate length.
- If you are adding Remote Mirror Option hardware to an existing storage subsystem environment that stops I/O from all host computers, begin with step 1. If this is a new storage subsystem installation, begin with step 2.

1. Power down all storage subsystems, host computers, Fibre Channel switches, and all other hardware in the storage subsystem environment.
2. Ensure that the basic cabling between all storage subsystems and storage expansion enclosures is complete.

   Note: Depending on which site is configured, Switch 1 represents Switch 1A for the primary site, and Switch 1B for the secondary site.
3. Connect the primary host bus adapter (Hx1) for each host at this site to an available port in Zone 1 of Switch 1.

   Note: You can connect the cables to any port in the proper zone of the switch.
4. Connect the secondary host bus adapter (Hx2) for each host at this site to an available port in Zone 2 of Switch 1.
5. Connect controller port A1 of the storage subsystem to an available port in Zone 1 of Switch 1.
6. Connect controller port B1 of the storage subsystem to an available port in Zone 2 of Switch 1.
7. Connect controller port A2 of the storage subsystem to an available port in Zone 3 of Switch 1.
8. Connect controller port B2 of the storage subsystem to an available port in Zone 4 of Switch 1.

Note: Controller ports A2 and B2 are reserved for mirror relationship synchronization when the Remote Mirror Option is activated. For more information, see "Connectivity and I/O" on page 102.

9. The primary site cabling is now complete. If the secondary site cabling is complete, go to step 10. Otherwise, repeat step 1 on page 124 through step 8 on page 124 for the secondary site.

10. Complete the Fabric 1 environment by connecting Switch 1A with Switch 1B. Connect each end of a long range Fibre Channel cable (that can support a distance of up to 10 Km [6.25 mi]) to an unzoned port in each switch.

11. Cabling for this Campus configuration is complete. Repeat step 3 on page 124 through step 9 for any additional storage subsystems that use the Remote Mirror Option.

12. Power up all storage subsystems, host computers, Fibre Channel switches, and any other hardware at both sites that were powered down in step 1 on page 124.

13. Hardware installation is complete. The next step is to configure the storage management software to support mirror relationships. Go to "Installing the software" on page 129.

Intra-site configuration

This configuration is similar to the Campus configuration in that there are only two Fibre Channel switches. However, no multiple-switch fabrics exist in this configuration. This configuration is used in environments where a long distance fabric is not required due to the close proximity of the host computers and storage subsystems. The configuration is still redundant for host bus adapters, controllers, remote logical drive mirroring ports, and Fibre Channel switches, but is a single point of failure for the site. For this reason, the Highest Availability Campus configuration is preferred for total environment redundancy.

Important:

- A switch failure in this configuration does not affect data access; however, an unsynchronized mirror state might occur as a result.
- IBM recommends that you establish one-to-one zones between the DS4000 Storage Subsystems in the mirrored pair. The zoning and cabling procedures described in this section are for illustrative purposes only, and might not show one-to-one zoning. Adjust the procedures for your specific Intra-site installation.

Figure 41 on page 126 shows the Intra-site configuration after installation is complete.
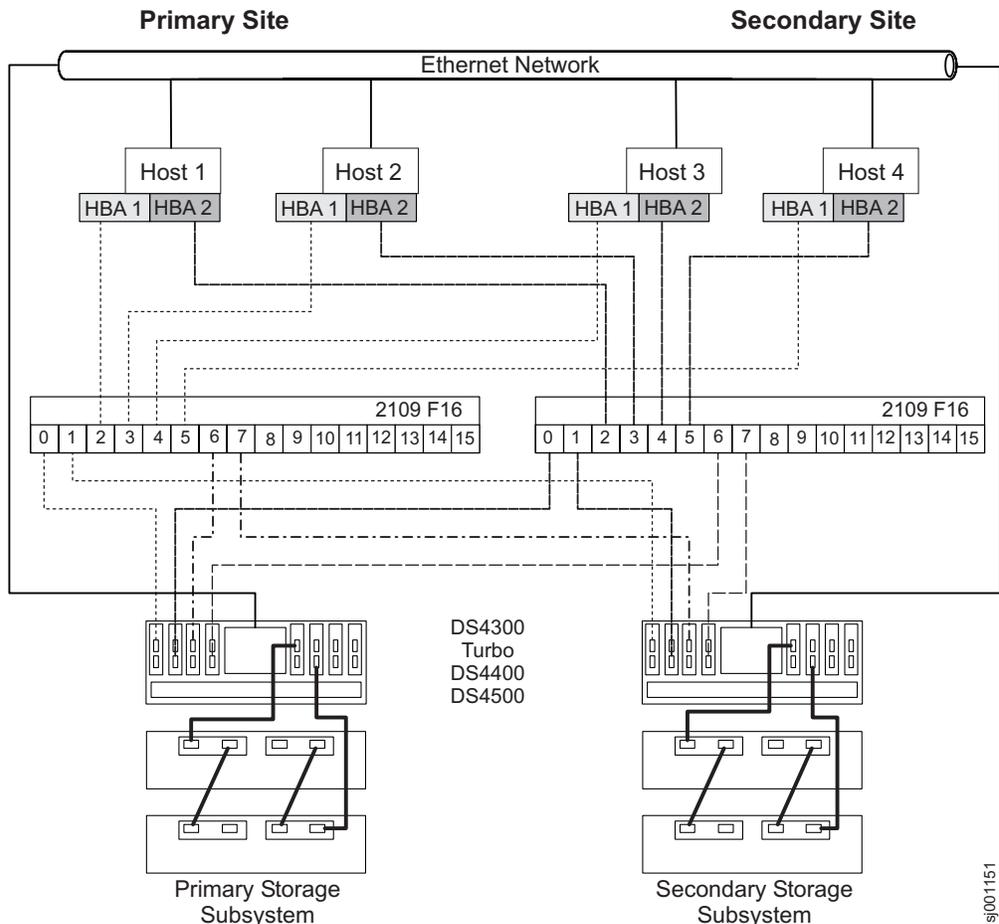
Figure 41. Intra-site configuration

Switch zoning for Intra-site configuration

Intra-site configuration is designed for switch redundancy. However, the Fibre Channel switches are not cascaded, and therefore are independent of each other. This configuration provides a separate zone for each reserved port for the Remote Mirror Option.

For an example of how to zone the Fibre Channel switches, see "Switch zoning for the Highest Availability Campus configuration" on page 117. Remember that the Intra-site configuration uses two Fibre Channel switches but does not use any 10Km (6.2 mi) ISLs.

Important: The Fibre Channel switches in Figure 41 contain 16 ports each, which leaves many unused ports per switch. If you are performing switch zoning using the Fibre Channel host port number, instead of the WWNN of the SAN fabric logged-in ports, do not include Fibre Channel switch ports with no Fibre Channel connections in the zone definition. If you include these unused ports in your zones, unauthorized access to the SAN might result.

Note: Figure 41 illustrates that there is no relationship between Zone A and Zone B in Switch 2 and Zone 1 and Zone 2 in Switch 1.

There are a total of four zones in this configuration.

- Zone 1 and Zone 2 exist on Switch 1
- Zone A and Zone B exist on Switch 2

Before proceeding to the next section, ensure that both Fibre Channel switches are properly zoned. For more information about zoning Fibre Channel switches, see "Switch zoning overview" on page 113.

Cabling examples for the intra-site configuration

Table 12 shows examples of the Fibre Channel cabling connections in the intra-site configuration. Refer to the examples before you complete the procedure in "Setting up the Intra-site configuration."

Important: IBM recommends that you establish one-to-one zones between the DS4000 Storage Subsystems in the mirrored pair. The examples shown in these tables are for illustrative purposes only, and do not show one-to-one zoning.

Table 12. Intra-site configuration connection

Switch 1			Switch 2		
Zone	Port	Connection to and from:	Zone	Port	Connection to and from:
1	0	Host 1, HBA 1 (HA1)	A	0	Host 1, HBA 2 (HA2)
	1	Controller port A1 (primary storage subsystem)		1	Controller port B1 (primary storage subsystem)
	2	Host 2, HBA 1 (HB1)		2	Host 2, HBA 2 (HB2)
	3	Controller port A1 (secondary storage subsystem)		3	Controller port B1 (secondary storage subsystem)
	4	Host 3, HBA 1 (HC1)		4	Host 3, HBA 2 (HC2)
	5	Additional host, HBA 1 (optional)		5	Additional host, HBA 2 (optional)
	6	Host 4, HBA 1 (HD1)		6	Host 4, HBA 2 (HD2)
	7	Additional host, HBA 1 (optional)		7	Additional host, HBA 2 (optional)
2	8	Unused	B	8	Unused
	9	Controller port A2 (primary storage subsystem - dedicated remote mirror port)		9	Controller port B2 (primary storage subsystem - dedicated remote mirror port)
	10	Unused		10	Unused
	11	Controller port A2 (secondary storage subsystem - dedicated remote mirror port)		11	Controller port B2 (secondary storage subsystem - dedicated remote mirror port)
	12	Unused		12	Unused
	13	Unused		13	Unused
	14	Unused		14	Unused
	15	Unused		15	Unused

Setting up the Intra-site configuration

Complete the steps in this procedure to set up the Intra-site configuration for the Remote Mirror Option.

Before you begin: Note the following information:

- IBM recommends that you establish one-to-one zones between the DS4000 Storage Subsystems in the mirrored pair. The zoning and cabling procedures described in this section are for illustrative purposes only, and might not show one-to-one zoning. Adjust the procedures for your specific Intra-site installation.
- Refer to Figure 41 on page 126 as you complete the steps in this procedure.
- Begin the installation at the primary site. Repeat these steps for the secondary site when instructed to do so.
- All connections are completed using Fibre Channel cables of appropriate length.
- If you are adding Remote Mirror Option hardware to an existing storage subsystem environment that stops I/O from all host computers, begin with step 1. If this is a new storage subsystem installation, begin with step 2.

1. Power down all storage subsystems, host computers, Fibre Channel switches, and all other hardware in the storage subsystem environment.
2. Ensure that the basic cabling between all storage subsystems and storage expansion enclosures is complete on both storage subsystems.
3. Connect the primary host bus adapter for each host (Hx1) to an available port in Zone 1 of Switch 1.

   Note: You can connect the cables to any port in the proper zone of the switch.
4. Connect the secondary host bus adapter (Hx2) for each host to an available port in Zone A of Switch 2.
5. Connect controller port A1 of the primary storage subsystem to an available port in Zone 1 of Switch 1.
6. Connect controller port B1 of the primary storage subsystem to an available port in Zone A of Switch 2.
7. Connect controller port A2 of the primary storage subsystem to an available port in Zone 2 of Switch 1.
8. Connect controller port B2 of the primary storage subsystem to an available port in Zone B of Switch 2.

   Note: Controller Ports A2 and B2 are reserved for mirror relationship synchronization when the Remote Mirror Option is activated. For more information, see "Connectivity and I/O" on page 102.
9. Connect controller port A1 of the secondary storage subsystem to an available port in Zone 1 of Switch 1.
10. Connect controller port B1 of the secondary storage subsystem to an available port in Zone A of Switch 2.
11. Connect controller port A2 of the secondary storage subsystem to an available port in Zone 2 of Switch 1.
12. Connect controller port B2 of the secondary storage subsystem to an available port in Zone B of Switch 2.
13. Cabling for this Intra-site configuration is complete. Repeat step 3 through step 12 for any additional storage subsystems that use the Remote Mirror Option.
14. Power up all storage subsystems, host computers, Fibre Channel switches and any other hardware that was powered down in step 1.
15. Hardware installation is complete. The next step is to configure the storage management software to support mirror relationships. Go to "Installing the software" on page 129.

Installing the software

The Remote Mirror Option is a premium feature that is included as part of the IBM DS4000 Storage Manager installation. You must purchase an IBM Storage Manager Remote Mirror Option for each storage subsystem in your remote mirror configuration. This option contains a GenKey file that will enable the Remote Mirror Option. If you want to purchase the Remote Mirror Premium Feature Option, contact your IBM technical-support representative.

Important: All storage subsystems participating in mirror relationships must have firmware level 05.2x.xx.xx or higher installed. For more information about upgrading firmware and installing the storage-management software, see your appropriate *IBM DS4000 Storage Manager Version 9 Installation and Support Guide*.

For a checklist to ensure that all the required software components are configured properly, see "Hardware and software checklists" on page 132.

For more information about enabling or activating the Remote Mirror Option, see "Enabling and activating the Remote Mirror Option."

Enabling and activating the Remote Mirror Option

The Remote Mirror Option premium feature key must be purchased before you can enable the option. The option must be activated by using a GenKey program before you can create any mirror relationships. First, determine the status of the Remote Mirror Option. Then enable and activate it.

Determining Remote Mirror Option status

There are four possible statuses of the Remote Mirror Option:

- `Disabled/Deactivated`
- `Disabled/Activated`
- `Enabled/Deactivated`
- `Enabled/Activated`

Important: The Remote Mirror Option must be in the `Enabled/Activated` state on the secondary storage subsystem as well as the primary storage subsystem to create and maintain mirror logical drive pairs.

You can determine the current status by hovering the mouse pointer over the **Remote Mirror Option** icon in the status area of the Subsystem Management window, as shown in Figure 42 on page 130.
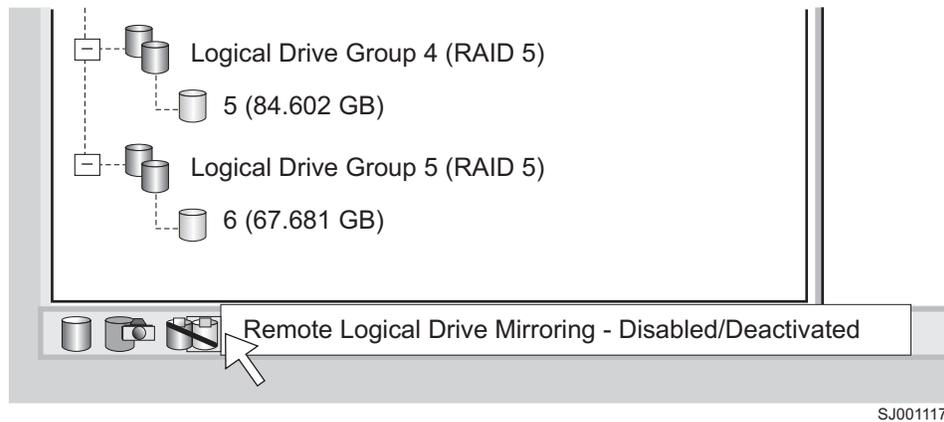
Figure 42. Remote Mirror Option status

Important: The Remote Mirror Option status for the primary storage subsystem is managed independently from the secondary storage subsystem. To determine the status for both storage subsystems, select each storage subsystem independently, then determine the status.

The Remote Mirror Option statuses are as follows:

Disabled and deactivated

No function of the Remote Mirror Option can be performed. Full Remote Mirror Option functionality is not available until the option is enabled and activated. The icon for this state is displayed in the Premium Feature status area as a cylinder with a mirrored reflection. The icon has a red slash through it to show it is disabled, and is greyed out to show it is deactivated. An example of this state is shown in Figure 42.

Disabled and activated

The Remote Mirror Option is disabled, preventing new mirror relationships from being created. However, any pre-existing mirror relationships are maintained with all functions of the Remote Mirror Option. The icon that is displayed for this state is similar to the disabled and deactivated state, because the red slash remains to show the option is disabled. However, the cylinder and its reflection are green to show that the option is active.

Enabled and deactivated

The Remote Mirror Option is enabled, but not activated. The icon that is displayed for this state is similar to the disabled and deactivated state, because the cylinder and its reflection remain grey. However, there is no red slash, indicating that the option is enabled.

Enabled and activated

The Remote Mirror Option is enabled and active. You can create and maintain mirror relationships. The icon for this state is displayed in the Premium Feature status area as a green cylinder with a mirrored reflection.

Enabling the Remote Mirror Option

If the current status of the Remote Mirror Option is `Disabled/Deactivated` or `Disabled/Activated`, complete the following steps to enable the Remote Mirror Option.

To enable the Remote Mirror Option, you must perform the following two procedures in the following order:

1. Obtain the feature enable identifier. This procedure is described in detail in "Obtaining the feature enable identifier" on page 9.
2. Generate the feature key file and enable the Remote Mirror Pption. This procedure is described in detail in "Generating the feature key file and enabling the premium feature" on page 9.

Before you begin, gather the following information:
- Your Feature Activation Code, which is printed on the IBM FlashCopy Premium entitlement card
- Your controller unit IBM serial number, which is printed on the label on the back of your DS4000 controller unit
- A 32 character alphanumeric IBM DS4000 Storage Subsystem premium feature identifier string.

To obtain the storage subsystem premium feature identifier string, ensure that your controller unit and storage expansion enclosures are connected, powered on, and managed using the SMclient.

If the Remote Mirror Option has not been activated, go to "Activating the Remote Mirror Option." If the Remote Mirror Option is activated, go to "Creating mirror relationships" on page 137.

For more detailed steps on how to enable the Remote Mirror Option, see "Enabling premium features" on page 8. For information on how to view a list of those premium features that are enabled on your storage subsystem, see "Viewing the status of premium features" on page 9.

Activating the Remote Mirror Option

Activating the Remote Mirror Option prepares the storage subsystem to create and configure mirror relationships. When the option is activated, ports A2 and B2 of the storage controller are reserved and dedicated to Remote Mirror Option usage. In addition, a mirror repository logical drive is created for each controller in the storage subsystem.

If the current status of the Remote Mirror Option is `Enabled/Deactivated`, complete the following steps to activate the option:
1. In the Subsystem Management window, click **Storage subsystem → Remote Mirroring → Activate** .

   The Activate Remote Logical Drive Mirroring - Introduction window opens.

   Note: Click **Back** at any time to change the information in the previous window.
2. Decide where the mirror repository logical drives will reside. Select one of the following:
   - **Use free capacity on existing arrays** - If this option is selected, then a corresponding logical drive must also be selected.
     a. Select a logical drive.
     b. Select **Finish** or **Next**.
     c. Go to step 6 on page 132.
   - **Create a new array using unconfigured capacity** - If this option is selected, more information must be collected about the new logical drive. Go to step 3.
3. In the Create New Array window, select the RAID level for the new logical drive.
4. Under the drive selection choices, select one of the following:

- **Automatic** - The drives are chosen automatically according to available capacity.
- **Manual** - This option gives you the option to specify which drives contain the mirror repository logical drive.
    a. Press and hold the Ctrl key and click to select the drives that you want to include in your array.
    b. Click **Apply**.

    Important: If the RAID level for the new array is RAID 1, then the number of drives must be an even number. If an odd number of drives are selected, an error message displays when you click **Apply**.

5. Click **Next**.
6. Review the information in the Preview window and click **Finish** if all information is satisfactory.
7. If the storage subsystem password is protected, type the password and click **OK**.

   If the storage subsystem password is not protected, go to step 8
8. Review the information in the Completed window and click **OK** to finish the Remote Mirror Option activation.

   The Remote Mirror Option must be enabled and activated on all storage subsystems that are part of a remote mirror setup. When the Remote Mirror Option is activated, the icon in the Premium Feature status area changes from grey to green. If this is not the case, repeat the steps in "Enabling and activating the Remote Mirror Option" on page 129 and step 1 on page 131 through step 8 of this procedure for each storage subsystem that has the remote mirror option disabled and deactivated.
9. Continue with "Creating mirror relationships" on page 137.

Hardware and software checklists

Complete the hardware checklist in Table 13 and the software checklist in Table 14 on page 133 to ensure that all the required hardware and software components are configured properly.

Hardware checklist

Complete the tasks in Table 13 before you configure the Remote Mirror Option using the storage management software.

Table 13. Hardware checklist

Task description	Validation activity
Ensure that the minimum hardware requirements are met. For a complete list of the hardware requirements, see "Hardware requirements" on page 111.	☐ Completed
Configure your primary and secondary storage subsystems. See the appropriate storage subsystem *Installation and User's Guide* for configuration information and see "Installing the hardware" on page 115.	☐ Completed
Configure your Fibre Channel switches and cables. For more information about configuring the Fibre Channel switches to use with the Remote Mirror Option, see "Installing the hardware" on page 115.	☐ Completed

Software checklist

Complete the tasks in Table 14 before you define mirror relationships in your storage subsystems.

Table 14. Software checklist

Task description	Validation activity
Back up all data on the primary and secondary storage subsystems that are participating in remote logical drive mirroring.	☐ Completed
Install the correct version of firmware and storage-management software. For more information about upgrading firmware or installing the storage management software, see the appropriate IBM DS4000 Storage Manager Installation and Support Guide or the Subsystem Management window online help.	☐ Completed
Enable the Remote Mirror Option on both the primary and secondary storage subsystems. For information about enabling the feature, see "Enabling and activating the Remote Mirror Option" on page 129.	☐ Completed
Activate the Remote Mirror Option and create a mirror repository logical drive for each controller on the primary storage subsystem. For more information about activating the Remote Mirror Option, see "Enabling and activating the Remote Mirror Option" on page 129.	☐ Completed
Create the required primary and secondary logical drives on the primary and secondary storage subsystems. For more information about establishing a mirror relationship, see Chapter 8, "Using the Enhanced Remote Mirroring option," on page 135.	☐ Completed

Verifying installation and configuration

All hardware and software is now set up to support mirror relationships through the Remote Mirror Option. However, before creating mirror relationships, ensure that all required components are working properly.

Complete the following procedure for each storage subsystem that is participating in any aspect of a mirror relationship to verify correct configuration:

1. Start the storage management software.

   For more information about starting the storage management software, see your *IBM DS4000 Storage Manager Version 9 Installation and Support Guide* for operating-system specific procedures.

   If this is the first time that you have started the storage management software, go to step 2. If this is not the first time that you have started the storage management software, go to step 3.

2. If this is the first time that you have started the storage management software, perform the following steps:

   a. Click **OK** when prompted for Automatic Discovery of devices.

   b. Ensure that all the storage subsystems that are designated to participate in mirror relationships are displayed in the Device Tree view of the Enterprise Management window.

   Note: If the storage subsystems do not display, see Chapter 10, "Troubleshooting the Enhanced Remote Mirroring option," on page 155.

3. If this is not the first time that you have started the storage management software, perform the following steps:

a. In the Enterprise Management Window, click **Tools → Automatic Discovery**.

b. Click **OK**.

c. Verify that all the storage subsystems that are designated to participate in mirror relationships are displayed in the Device Tree view of the Enterprise Management window.

   Note: If the storage subsystems do not display, see Chapter 10, "Troubleshooting the Enhanced Remote Mirroring option," on page 155.

4. In the Enterprise Management window, select a storage subsystem that will participate in mirror relationships.

5. Click **Tools → Manage Device** to open the Subsystem Management window for that storage subsystem.

6. In the Subsystem Management window, click **Help → About**.

7. Verify that the version of the storage management software is 08.3x.xx.xx or later. If this requirement is not met, see your specific *IBM DS4000 Storage Manager Version 9 Installation and Support Guide* for the procedures to upgrade the storage management software.

8. Click **OK**.

9. In the Subsystem Management window, click **Storage Subsystem → View Profile**.

10. Click the **All** tab, and verify that the current firmware version is 05.2x.xx.xx or later. If this requirement is not met, see your specific *IBM DS4000 Storage Manager Version 9 Installation and Support Guide* for the procedures to upgrade the firmware.

    When your installation is completed, refer to the following online help systems:

    • Enterprise Management window help - Use this online help system to learn more about working with the entire management domain.

    • Subsystem Management window help - Use this online help system to learn more about managing individual storage subsystems and Remote Mirror Option.

    You can access these help systems from within the SMClient. In either a Enterprise Management or Subsystem Management window, click **Help** or press F1.

11. Click **Close**.

12. Observe the **Remote Mirror Option** icon in the status area. The icon represents the Disabled and Deactivated status of the Remote Mirror Option.

13. To begin working with mirror relationships, go to Chapter 8, "Using the Enhanced Remote Mirroring option," on page 135.

Chapter 8. Using the Enhanced Remote Mirroring option

This chapter contains the procedures for completing the major tasks that are associated with the Remote Mirroring Option:

- "Upgrading mirror repository logical drives"
- "Creating mirror relationships" on page 137
- "Maintaining mirror relationships" on page 139
- "Deactivating and disabling the Remote Mirror Option" on page 145

Upgrading mirror repository logical drives

In previous versions of DS4000 Storage Manager, the maximum number of logical drives that could participate in mirror relationships was 32. DS4000 Storage Manager 9.1x, in conjunction with DS4000 Storage Subsystem controller firmware version 06.10.xx.xx or later, allows 64 logical drives to participate in mirror relationships. Therefore, to support creating more than 32 logical drives in mirror relationships, you need to upgrade any existing mirror repository logical drives on the storage subsystem to have a minimum capacity of 128 MB (increased from 4 MB). Because two mirror repository logical drives are required per DS4000 server, a maximum of 256M of disk space will be needed.

Note: You do not need to complete the steps in this section if DS4000 Storage Manager 9.1x is the first time you have activated the Remote Mirror Option. Upgrading the mirror repository logical drives is only required if a previous version of DS4000 Storage Manager existed on your system, with the Remote Mirror Option feature installed, before you installed DS4000 Storage Manager 9.1x.

Use the Upgrade Mirror Repository Logical Drives Wizard to create new, larger mirror repository logical drives on your storage subsystem, then to move any data from the existing mirror repository logical drives to the new ones, and then to delete the old mirror repository logical drives.

Important: If there is not enough free capacity or unconfigured capacity available on your storage subsystem, you will not be able to upgrade your mirror repository logical drives. The Free Capacity or Unconfigured Capacity options you select for the mirror repository logical drives must have a total of 256 MB capacity available. Two mirror repository logical drives are created on this capacity: one for each controller.

Recommendation: For each mirrored pair that you upgrade, leave a minimum of 0.25 GB free capacity in the same array as the mirror repository logical drives. If you someday deactivate the mirrored pair, this will ensure that you have enough capacity to reestablish the mirrored pair from the deactivated state. Otherwise, if there is no free capacity available on the storage subsystem, you might not be able to reestablish the mirrored pair.

Complete the following steps to upgrade the mirror repository logical drives:

1. Select **Storage Subsystems → Remote Mirroring → Upgrade Mirror Repository Logical Drives**.

The Upgrade Mirror Repository Logical Drives: Introduction dialog window opens.

2. In the Upgrade Mirror Repository Logical Drives: Introduction dialog window, select one of the following options, based on where the upgraded mirror repository logical drives will reside:

   - **Free capacity on same array (create individual logical drive)** – You must also select a corresponding array.

     a. Select an array.

     b. Select **Next**.

     c. Go to step 5.

   - **Free capacity on different array (create individual logical drive)** – You must also select a corresponding array.

     a. Select an array.

     b. Select **Next**.

     c. Go to step 5.

   - **Unconfigured capacity (create new array)** – If you select this option, the Create New Array dialog window opens. Go to step 3 to create a new array.

3. In the Create New Array dialog, select the RAID level for the new array.

   Note: If you need more detailed information about the options in this dialog window, select the Help button to launch the online help that is specific to this dialog window.

4. Under the drive selection choices, select one of the following options:

   - **Automatic** – The drives are chosen automatically according to available capacity. Click **Next**; the Preview dialog window opens.

   - **Manual** – The user specifies which drives contain the mirror repository logical drive, as follows:

     – Select the desired drives. You can select multiple drives by pressing and holding **Ctrl** while you select.

     – Click **Add** to move the drives to the Selected Drives panel.

     – Click **Next**. The Preview dialog window opens.

     Important: If the RAID level for the new array is RAID 1, then you must select an even number of drives. If you select an odd number of drives, an error message will display when you click **Apply**. RAID 0 is not an option; therefore, the number of drives that you select must always be greater than one for all RAID levels. RAID 3 and RAID 5 require a minimum of three drives.

5. Review the information that displays in the Preview dialog window, then click **Finish** if all information is satisfactory.

   Notes:

   a. If prompted for a password, enter the password and select **OK**.

   b. The upgrade process might take a minute or longer to complete, depending on the current workload of the storage subsystem. Any I/O activity to the storage subsystem might be delayed during the upgrade process.

   The Completed dialog window opens.

6. Review the information that displays in the Completed dialog window, then click **OK**. The mirror repository logical drives are now upgraded, and the storage subsystem can support up to 64 mirror relationships.

7. Repeat step 1 through step 6 on page 136 for the secondary storage subsystem, and for any additional storage subsystems that contain mirror repository logical drives that have not yet been upgraded.

Creating mirror relationships

Before you create mirror relationships, be sure that the Remote Mirroring Option is enabled and activated.

Note: The secondary host ports on the storage subsystems are reserved for data synchronization between a primary and secondary logical drive of a mirror relationship.

Creating logical drives for mirror relationships

Before you create mirror relationships, be sure that logical drives exist at both the primary and secondary storage subsystems. The logical drive of the remote mirror pair that is presented to the host is the primary logical drive. The storage subsystem that the primary drive resides in is called the *primary* storage subsystem. Similarly, the storage subsystem that the secondary logical drive resides in is called the *secondary* storage subsystem.

If a primary or secondary logical drive does not exist, you must create one on the corresponding storage subsystem.

Consider the following when creating a logical drive:
- The secondary logical drive must be of equal or greater size than the primary logical drive.
- The RAID level of the secondary logical drive does not have to be the same as that of the primary logical drive.

For more information about creating logical drives, see the Subsystem Management window online help.

When logical drives exist at both sites, you can create mirror relationships by using the Create Remote Mirror wizard.

Creating a mirror relationship using the Create Remote Mirror wizard

Using the Create Remote Mirror wizard, you can create a mirror relationship between a primary logical drive and a secondary logical drive. Before beginning the wizard, ensure that the following requirements are met:
- The Remote Mirroring Option is enabled on both storage subsystems in which the primary and secondary logical drives will reside.
- The Remote Mirroring Option is activated on both subsystems.
- The storage subsystems are connected through a proper Fibre Channel fabric configuration.
- The size of the secondary logical drive is equal to or greater than the primary logical drive.
- There are management connections to both the primary and secondary storage subsystems. The Enterprise Management window must display both primary and secondary storage subsystems in the management domain.
- The remote Fibre Channel switch connections are made between the primary and secondary storage subsystems. The Fibre Channel switches are zoned so that the controller host ports are by themselves.

When these requirements are met, complete the following steps to create a mirror relationship:

1. In the Logical/Physical view of the Subsystem Management window, select the logical drive that will become the primary logical drive in the mirror relationship.

2. Click **Logical Drive → Remote Mirroring → Create**.

3. Click **Next**.

4. Follow the instructions in the Select Remote Storage subsystem window.

   The Create Remote Mirror window opens and displays starting requirements that are similar to those listed at the beginning of this section.

   a. Select the proper storage subsystem. The wizard displays all available storage subsystems within the management domain that have the Remote Mirroring Option enabled and activated.

   b. Click **Next**. The Select Secondary Logical Drive window displays.

5. Select the logical drive that will become the secondary logical drive in the mirror relationship. If there are no logical drives listed, the secondary storage subsystem that you selected does not have logical drives with enough capacity available to mirror the selected logical drive.

6. Click **Next**. The Set Write Mode window displays.

7. Select one of the following write modes:
   - Synchronous
   - Asynchronous

   If you select Asynchronous mode, the ″Add to write consistency group″ check box becomes available. Select the ″Add to write consistency group″ check box if you want to define a Global Mirroring mirror pair (ensures that write operations to the secondary storage subsystem are completed in the same order as on the primary storage subsystem) instead of a Global Copy mirror pair. For more detailed descriptions of each type of write mode, see "Write options" on page 96.

   Notes:

   a. Synchronous remote mirroring is referred to as Metro Mirroring.

   b. Asynchronous remote mirroring with the consistency group option is referred to as Global Mirroring; without the consistency group option, it is referred to as Global Copy.

   c. Adding the mirrored pair to a write consistency group (Global Mirroring) might impact host I/O performance.

   d. For more information about write consistency groups, see "Write consistency groups" on page 98 or "Changing the write mode" on page 144.

8. Click **Next**. The Select Synchronization Settings window displays.

9. Select the synchronization priority level.

   Note: For more information about the synchronization priority level, see "Changing the synchronization settings" on page 141.

10. Select the resynchronization method.

    Note: For more information about resynchronization methods, see "Resynchronization methods" on page 99.

11. Click **Finish**.

12. If the remote storage subsystem is password protected, type the password and click **OK**.

If the remote storage subsystem is not password protected, go to step 13.

13. If you do not exceed the maximum number of mirrored logical drive pairs that can be created for the storage subsystem, you are prompted to create another mirror logical drive pair by the Create Remote Mirror wizard. If you do not want to create another mirror logical drive pair, click **No** and go to step 14. Otherwise, perform the following steps:

    a. Select the logical drive that will become the next primary logical drive.

    b. Click **Next**.

    c. Repeat step 4 through step 13 for each additional mirror relationship.

14. Review the information in the Completed window, then click **OK** to complete the Create Remote Mirror wizard.

The primary and secondary logical drives are now displayed with the mirror relationship icons, which will change slightly when the data synchronization is completed. The amount of time that is required for the data to be synchronized between the two logical drives varies proportionally to the size of the logical drive being mirrored and storage subsystem I/O loads. After the synchronization is complete, the icons change to the optimal state mirror relationship icons. Figure 43 shows how the icons display during and after data synchronization.

Note: To view all the icons that are associated with the Remote Mirror Option and a description of their purpose, see the Subsystem Management window online help.

Primary Logical Drive (5 GB)

Secondary Logical Drive

New mirror relationship with synchronizing data

Primary Logical Drive (5 GB)

Secondary Logical Drive

Optional mirror relationship with fully synchronized data   SJ001118
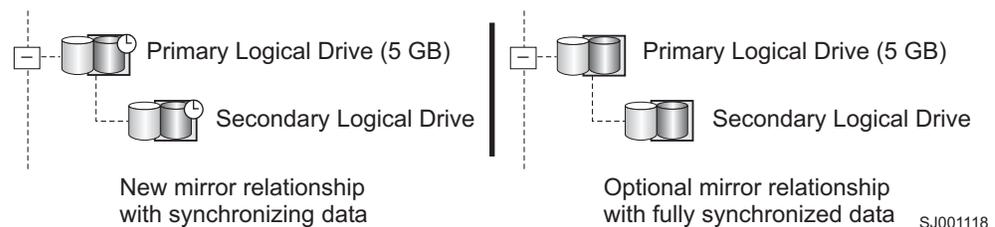
Figure 43. Synchronizing and optimal mirror relationship icons

The mirror relationship is now created and optimal.

Maintaining mirror relationships

When a mirror relationship is active, you can modify certain attributes of the relationship at any time. This section describes how to view information about the mirror relationship, how to change the synchronization priority level, how to remove a mirror relationship, and how to delete logical drives that are participating in a mirror relationship.

Viewing mirror relationships

The mirror relationship that exists between the primary logical drive and the secondary logical drive can be examined by various methods, such as using the storage subsystem profile, the Mirroring Properties window, and the View Associated Components window.

Displaying the storage subsystem profile

The storage subsystem profile is the most efficient way to view information about any or all components of the storage subsystem. Details for all logical drives, such as the primary, secondary, and mirror repository logical drives can all be easily viewed through the storage subsystem profile. The storage subsystem profile also contains specific information about components that are associated with mirror relationships.

Complete the following steps to display the storage subsystem profile:

1. In the Subsystem Management window click **Storage Subsystem → View Profile**.
2. Click the **Logical Drives** tab.
   - To view information about the mirror relationships that exist on this storage subsystem, click the **Mirrors** tab.
   - To view information about the mirror repository logical drive, click the **Repositories** tab.

Note: Click **Save As** to save all of the information that is shown in the storage subsystem profile as a .txt file. The Save Profile window that opens provides the option of saving the current window, multiple windows, or the entire storage subsystem profile.

The Mirroring Properties window

The Mirroring Properties window displays all the physical characteristics of a single logical drive in the mirror relationship.

The window displays the same information as the storage subsystem profile for the selected logical drive, but is specific only to that logical drive. The synchronization progress is displayed if the selected logical drive is synchronizing data with another logical drive in a newly defined mirror relationship or in an existing mirror relationship after the broken mirror link is restored.

Complete the following steps for each logical drive that needs to be examined in the mirror relationship:

1. Select the primary or secondary logical drive.
2. Click **Logical Drive → Properties**.
3. Click the **Mirroring** tab.

You can also use this procedure to view the synchronization progress of a recently-created mirror relationship.

The View Associated Components window

The View Associated Components window provides a graphical representation of the logical drives that are participating in the mirror relationship. Details are provided for all components, rather than just the logical drive that was initially selected.

Complete the following steps to view all the associated components in a mirror relationship, including primary, secondary, and mirror repository logical drives:

1. Select the primary or secondary logical drive in a mirror relationship.
2. Right click and select **View Associated Components**.

   The View Associated Components window opens.
3. Click **Close** to exit the window.

Changing the synchronization settings

The synchronization priority level of a mirror relationship defines the amount of system resources that are used to synchronize the data between the primary and secondary logical drives of a mirror relationship. If you select the highest priority level for a mirror relationship, the data synchronization uses a high amount of system resources to increase mirror performance, but might decrease performance for all other functions, including other mirror relationships. If you select the lowest synchronization level, there is less impact on complete system performance, but the mirror relationship synchronization might be slower.

The setting for the resynchronization method defines whether the communication between the primary and secondary logical drives is restored manually or automatically after a communication interrupted.

Complete the following steps to change the synchronization settings for a mirror relationship:

1. In the Logical/Physical view of the Subsystem Management window, select a primary logical drive of a mirror relationship.
2. Click **Logical Drive → Remote Mirroring → Change → Synchronization Settings**.

   The Change Synchronization Settings window opens. The primary logical drive that you chose in step 1 is selected by default in the **Select Logical Drives** field.
3. Select one or more logical drives.
4. Select the synchronization priority level. The five levels are Lowest, Low, Medium, High, and Highest. All selected logical drives will change to the same synchronization priority level.

   For more information about the performance impact of the five priority settings, see "General performance considerations" on page 106.
5. Select the resynchronization method. You can select Manual or Automatic.

   For more information about the resynchronization methods, see "Resynchronization methods" on page 99.
6. Click **OK**.
7. Click **Yes** when the Confirmation window opens.
8. Click **OK** when the Completed window opens.

Suspending a mirror relationship

Use the Suspend option to stop data transfer between a primary logical drive and a secondary logical drive participating in a mirror relationship, without removing the mirror relationship.

Suspending a mirror relationship enables you to control when the data on the primary and secondary logical drives should be synchronized. This helps reduce any performance impact to the host application that might occur while any changed data on the primary logical drive is copied to the secondary logical drive.

When a mirror relationship is in a Suspended state, no attempt is made to contact the secondary logical drive. Any writes to the primary logical drive are persistently logged in the mirror repository logical drives. After the mirror relationship is resumed, only the modified regions of the primary logical drive are written to the secondary logical drive. The Suspend option can be used to backup a secondary logical drive.

Attention: If the mirrored pair that you select to suspend is part of a write consistency group, the system automatically suspends all mirrored pairs in the write consistency group. Use the command line interface to resume single write-consistent mirrored pairs. For more information about using the command line interface, see the Enterprise Management Window online help. For more information about write consistency groups, see "Write consistency groups" on page 98.

Notes:

1. Suspending a mirror relationship removes any Needs Attention status resulting from communication failure between the primary and secondary logical drives.

2. Any data that is written to the primary volume will be logged while the mirror relationship is suspended and will automatically be written to the secondary volume when the mirror relationship is resumed. A full synchronization will not be required.

3. The state of the remote volume mirror remains suspended until you use the Resume option to resume synchronization activity.

Figure 44 shows a mirror relationship in Suspended state.
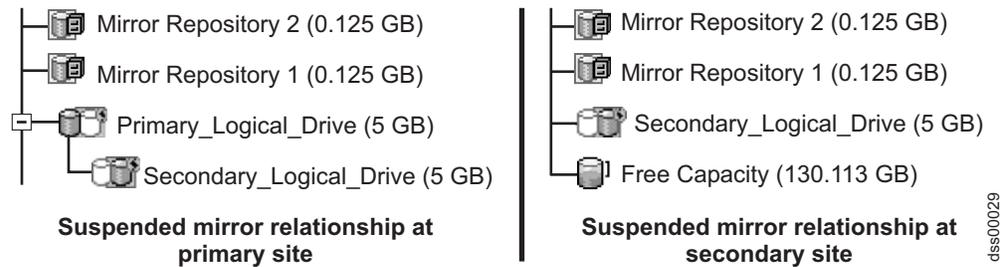
Figure 44. Suspended mirror relationships at primary site and secondary site

Complete the following procedure to suspend a mirror relationship:

1. In the Logical/Physical view of the Array Management Window, select a primary volume of a mirror relationship.

2. Select **Logical Drive → Remote Mirroring → Suspend**. The Suspend Mirrored Pair window opens.

3. Select one or more mirror relationships to suspend.

4. Click **Suspend**.

5. Carefully review the information that is presented in the Confirmation window.

6. If the information in the Confirmation window is correct, type `Yes` and click **OK**.

   Important: If the mirrored pair that you select to suspend is part of a write consistency group, the system automatically suspends all mirrored pairs in the write consistency group. Use the command line interface to resume single write-consistent mirrored pairs. For more information about using the command line interface, see the Enterprise Management Window online help. For more information about write consistency groups, see "Write consistency groups" on page 98.The Suspend Mirrored Pair - Progress window displays while the selected mirrored logical drives are suspended. After all of the selected mirrored pairs are suspended, the **OK** button becomes available.

7. Click **OK**. The Subsystem Management window opens, showing the primary and secondary logical drives in an Optimal/Suspended state.

   For information about icons used for mirror relationships, refer to the Subsystem Management window online help.

Resuming a mirror relationship

Use the Resume option to restart data transfer between a primary logical drive and secondary logical drive participating in a mirror relationship, after the mirror has been suspended or unsynchronized.

This option enables you to control when the data on the primary logical drive and secondary logical drive should be resynchronized. This helps reduce any performance impact to the host application that might occur while any changed data on the primary logical drive is copied to the secondary logical drive.

After the mirrored pair is resumed, only the regions of the primary logical drive that changed since the mirrored pair was suspended are written to the secondary drive.

Attention: If the mirrored pair that you select to resume is part of a write consistency group, the system automatically resumes all mirrored pairs in the write consistency group. Use the command line interface to resume single write-consistent mirrored pairs. For more information about using the command line interface, see the Enterprise Management Window online help. For more information about write consistency groups, see "Write consistency groups" on page 98.

Complete the following procedure to resume a suspended mirror relationship:

1. In the Logical/Physical view of the Subsystem Management Window, select a primary logical drive of a mirror relationship.
2. Select **Logical Drive → Remote Mirroring → Resume**. The Resume Mirrored Pair window opens.
3. Select one or more mirror relationships to resume.
4. Click **Resume**.
5. Carefully review the information that is presented in the Confirmation window.
6. If the information in the Confirmation window is correct, click **Yes** to resume data transfer to the mirrored pairs that you selected. The Resume Mirrored Pair - Progress window displays while data transfer is resumed to the selected mirrored pairs. After data transfer is resumed to the mirrored pairs, the **OK** button becomes available.
7. Click **OK**. The Subsystem Management Window opens, showing the primary and secondary logical drive in an Optimal or Synchronizing state.

Removing mirror relationships

Removing a mirror relationship between a primary and secondary logical drive does not affect any of the existing data on either logical drive. The link between the logical drives is removed, but the primary logical drive still continues normal I/O operation.

This method is not recommended for backup routines. Instead, suspend the mirror relationship, because suspend operation maintains the mirror relationship. See "Suspending a mirror relationship" on page 141 for more information about the suspend procedure.

A mirror relationship between the two logical drives can be recreated unless one of the logical drives is deleted.

Complete the following steps to remove a mirror relationship between two logical drives:

1. In the Subsystem Management window, select a local primary or local secondary logical drive of a mirror relationship.
2. Click **Logical Drive → Remote Mirror → Remove Mirror Relationship**.

   The Remove Mirror Relationship window displays all mirror relationships that are associated with this storage subsystem.
3. Select one or more mirror relationships to be removed, and click **Remove**.
4. Carefully review the information that is presented in the Confirmation window.
5. If all the information in the Confirmation window is correct, click **Yes**.

Changing the write mode

You can select one of the following two write modes:

Synchronous
> Synchronous write mode offers the best chance of full data recovery from the secondary storage subsystem in the event of a disaster. Although it provides slower host I/O performance than asynchronous write mode, synchronous write mode is the recommended mode.
>
> Remote mirroring using synchronous write mode is referred to as Metro Mirroring.

Asynchronous
> Asynchronous write mode offers faster host I/O performance than synchronous write mode, but it does not guarantee that data is successfully written to the secondary logical drive before indicating a successful write to the host system.
>
> Remote mirroring using asynchronous write mode with the consistency group option is referred to as Global Mirroring. Remote mirroring using asynchronous write mode without the consistency group option is referred to as Global Copy.

Complete the following steps to change the write mode of a mirror relationship:

1. From the Subsystem Management window, select a local primary logical drive of a mirror relationship.
2. Select **Logical Drive → Remote Mirror → Change → Write Mode**. The Change Write Mode window opens.
3. Select one or more mirrored pairs.
4. Select one of the following write modes:
   - Synchronous
   - Asynchronous

   If you select Asynchronous mode, the ″Add to write consistency group″ check box becomes available. Do not select the ″Add to write consistency group″ check box if you want to define a Global Copy mirror pair (in which write operations to the secondary storage subsystem are not required to be completed in the same order as on the primary storage subsystem) instead of a Global Mirroring mirror pair. For more detailed descriptions of each type of write mode, see "Write options" on page 96.

   Notes:

   a. Synchronous remote mirroring is referred to as Metro Mirroring.
   b. Asynchronous remote mirroring with the consistency group option is referred to as Global Mirroring; without the consistency group option, it is referred to as Global Copy.

     c. Adding the mirrored pair to a write consistency group (Global Mirroring) might impact host I/O performance.

     d. For more information about write consistency groups, see "Write consistency groups" on page 98.

Deleting primary and secondary logical drives

Deleting a logical drive that is participating in a mirror relationship removes the mirror relationship and completely deletes the logical drive from the storage subsystem. The mirror relationship cannot be redefined until you create a new logical drive or an alternate logical drive replaces the deleted logical drive.

You cannot delete a secondary logical drive that is actively participating in a mirror relationship. When you delete a primary logical drive, the mirror relationship is removed, and the secondary logical drive becomes a standard logical drive, which you can then delete.

Complete the following steps to delete a primary or secondary logical drive from a mirror relationship:

Attention:

- If you have data or logical drives that you want to keep, do not click **Recovery → Reset → Configuration**. This resets the controller unit and deletes all previously-configured logical drives.
- You must use Disk Administrator and delete operating system logical drives before you delete logical drives or reset the configuration in Storage Manager. This avoids damage to your registry information.
- The following steps will permanently remove data from the selected logical drive.

1. In the Subsystem Management window for the primary site, select a primary logical drive.
2. Select **Logical Drive → Delete**.
3. The Delete Logical Drives window opens.
4. Select one or more logical drives to delete.
5. Click **OK**. The confirmation window opens.
6. Carefully review the information in the confirmation window. If all the information is correct, type `Yes` in the text area and click **OK**.
7. In the Subsystem Management window for the secondary site, repeat these steps to remove the secondary logical drive, if required.

Deactivating and disabling the Remote Mirror Option

If no mirror relationships exist and the Remote Mirror Option is no longer required, you can deactivate the option to reestablish normal use of dedicated ports on both storage subsystems and delete both mirror repository logical drives.

The Remote Mirror Option can also be disabled. When the option is in the `Disabled/Active` state, you can still maintain and manage previously existing mirrors; however, you cannot create any new mirror relationships. When in the `Disabled/Deactivated` state, no Remote Mirror Option activity occurs.

Note: When all capacity on a DS4000 storage subsystem is used (no free capacity is available), attempts to re-enable or re-activate a disabled/deactivated remote mirror might fail with an error message indicating that there is not enough space available for creating the remote mirror repository logical

drives. Therefore, it is best practice to leave a minimum of 0.25 GB free capacity for each mirrored pair. The free capacity should be within the same array as the mirrored logical drives. Alternatively, you can add additional capacity to the storage array, or delete a logical drive from the array to create more space.

Deactivating the Remote Mirror Option

Complete the following steps to change the Remote Mirror Option status from `Enabled/Activated` to `Enabled/Deactivated` or from `Disabled/Activated` to `Disabled/Deactivated`:

1. Verify that all mirror relationships are removed. For more information, see "Removing mirror relationships" on page 143.
2. Click **Storage subsystem → Remote Mirror →Deactivate**.
3. Carefully review the information that is presented in the Confirmation window.
4. If the information in the Confirmation window is correct, click **Yes**.

Disabling the Remote Mirror Option

Complete the following steps to change the Remote Mirror Option status from `Enabled/Deactivated` to `Disabled/Deactivated` or from `Enabled/Activated` to `Disabled/Activated`:

Attention: After you disable the Remote Mirror Option, you will need the Enhanced Remote Mirroring premium key file to re-enable the feature. Make sure that you have this key file to re-enable the Remote Mirror option after you disable it. Do not disable the Remote Mirror feature if you do not have this key file.

1. In the Subsystem Management window, click **Storage subsystem → Features → Disable**.
2. Click **Remote Mirror**.
3. Click **OK**.
4. Carefully review the information that is presented in the Confirmation window.
5. If the information in the Confirmation window is correct, click **Yes**.

Chapter 9. Disaster recovery

This chapter describes the actions to take to prepare for a disaster, the actions to take if a hardware component failure occurs, and the actions to take if a complete site failure occurs.

As businesses increasingly require around-the-clock data access, you are required to ensure that critical data is safeguarded against potential disasters. In preparing for a potential disaster, you must develop a disaster recovery plan that details the procedures to prepare for and prevent disasters, and the actions that you need to take to respond to and recover from disasters if they occur.

Planning for disaster recovery

This section describes the steps that you must take to prepare for a possible disaster or unrecoverable error. Preparation includes backing up critical data before and during remote logical drive mirroring, using host clustering software for failover protection, and preparing the secondary storage subsystem that will participate in the remote logical drive mirror.

Be sure that you complete the checklists in Table 13 on page 132 and Table 14 on page 133 to ensure that your primary and secondary storage subsystems are prepared correctly.

Backing up critical data

It is vital that you back up critical data regularly to protect against disasters or unrecoverable error. Backups must be performed regardless of whether the Remote Mirror Option is in use.

A backup of all critical data on both the primary and secondary storage subsystems that participate in remote logical drive mirroring must be performed before you create a remote logical drive mirror. You must perform periodic backups of the primary storage subsystem when remote logical drive mirrors are in use.

You can use FlashCopy, which captures a point-in-time image of a logical drive, to make backups to tape or disk while I/O continues. For more information about using FlashCopy logical drives, see "FlashCopy and the Remote Mirror Option" on page 108 or the Subsystem Management window online help.

Preparing the secondary storage subsystem

When preparing for a potential disaster ensure that the secondary storage subsystem, to which the data is mirrored, is structured in the same manner as the primary storage subsystem.

Before you create a remote logical drive mirror, prepare your secondary storage subsystem to ensure that storage partitions and FlashCopy logical drives are defined and ready to function if the secondary storage subsystem is promoted to the primary role.

Defining storage partitioning

The Storage Partitioning feature enables you to define which host computers have access to which logical drives on the storage subsystem and at what LUN. When configuring your secondary storage subsystem, replicate the storage partitions that were previously defined on the primary storage subsystem. This ensures that if a

147

role reversal is carried out, host computers are able to access their required data. Depending on your operating system and host application software, you might not be able to map the secondary logical drive to the host that the primary logical drive is mapped to.

For more information about the Storage Partitioning feature, see the Subsystem Management window online help.

Ensuring failover protection using the host clustering software

Host failover clustering is a process in which the operating system and program software work together to provide continuous availability in the event of a program failure, hardware failure, or operating system error. Software products that support remote failover might refer to global or geographic cluster management.

You can use the Remote Mirror Option with remote host failover to provide complete redundancy of host computers and storage subsystems. If a disaster occurs at the primary storage subsystem, host computers at the secondary storage subsystem take over the processing and initiate a role change to the secondary storage subsystem.

Remote failover is not a requirement for a disaster recovery plan. Depending on the requirements for how quickly operations must again function at optimal status, mirroring the storage subsystems and relying on manual startup of the remote host computers might be acceptable.

For more information about host cluster software and configuration, see the readme in your *IBM DS4000 Storage Manager Version 9* CD.

Disaster recovery preparation checklist

Complete the tasks listed in Table 15 to ensure that access to the mirrored data is possible in the event of a disaster or an unrecoverable error.

Table 15. Disaster recovery preparation checklist

Task description	Validation activity
1. Back up all critical data on both the primary and secondary storage subsystems.	☐ Completed
2. Establish storage partitioning on the secondary storage subsystem. This reduces any lag time when promoting a secondary logical drive to the primary logical drive role.	☐ Completed
3. If required, configure the host clustering software to allow host failover between the primary storage subsystem and secondary storage subsystem that is participating in remote logical drive mirroring.	☐ Completed

Recovering from switch failures

The Campus configuration and the Intra-Site configuration are the two configurations where each switch is a single point of failure. In the Highest Availability Campus configuration, if a switch fails, at least one other switch is configured to be an alternate path for all I/O. The single switch at each site is not only responsible for the communication between the two sites for the Remote Mirror Option, but for all host-to-storage subsystem I/O as well.

If a switch fails in the Campus configuration or the Intra-Site configuration, you must decide whether or not to do a complete site failover. This decision must be based on the immediate availability of a backup switch or the time it will take to receive a replacement.

If a replacement switch is not readily available, you will need to use one of the following temporary scenarios until the switch is replaced.

- **Direct connection between host computers and storage subsystems** - This bypasses the switch and allows normal I/O to continue. All mirror relationships are suspended until a normal configuration is resumed. Since the storage subsystems have a finite number of host connections, all host computers might not be able to access the storage subsystem. For information about how to directly connect host computers and storage subsystems, see the *IBM DS4000 Storage Manager Version 9 Installation and Support Guide* for your specific operating system.
- **Entire site failover** - The switch at the secondary site is still functional, which enables all host computers to access the switch and storage subsystems. Mirror relationships are suspended until the primary storage subsystem is recovered. If a complete site failover is needed to continue normal operations, see "Performing an entire site failover."

Recovering from storage subsystem failures

This section provides procedures for recovering storage systems when one of the following situations has occurred:

- The primary storage subsystem is damaged or destroyed
- The entire primary site is damaged or destroyed

Both situations require a complete site failover from the primary site to the secondary site so that normal operations can continue. For a secondary site failure, no site failover is necessary. If the primary logical drive is not damaged, then a full synchronization occurs when the site is recovered. If the primary storage subsystem is damaged, follow the procedure in "Rebuilding a damaged site" on page 150.

Attention: You must complete the procedures in this section in the order that they are presented to ensure that the affected site or storage subsystem is recovered successfully.

Performing an entire site failover

Entire site failover is necessary when an event occurs that inhibits normal operation to the primary site for an extended period of time.

Complete the following steps to perform an entire site failover:

1. Manually reverse the role of the primary logical drive of the mirror relationship to the secondary role. For more information, see "Reversing the roles of primary and secondary logical drives" on page 151.
2. If storage partitioning is preconfigured so that hosts can access the logical drives, go to step 4 on page 150. Otherwise, continue with step 3.
3. Configure the storage partitioning so that host to logical drive access is identical to the primary site configuration. When configured, continue to step 4 on page 150. For more information about storage partitioning, see "Using other premium features with the Remote Mirror Option" on page 107 and the Subsystem Management window online help.

4. If the host computers at the secondary site are properly configured for host failover, go to step 6. Otherwise, continue with step 5.

5. Reinstall the host software and reconfigure the settings as needed. For more information about installing and configuring host software, see the documentation that comes with the software.

6. Run the Hot_add utility on hosts that have only mapped logical drives from the secondary storage subsystem. Restart all hosts that have logical drive mappings from the primary and secondary storage subsystems. Then resume normal operation with the secondary site acting as a new, fully-functioning primary site.

7. The entire site failover is complete. The primary site must now be reconfigured and the remote mirror environment must be re-created. The next step depends on the resulting status of the storage subsystem.

8. If the storage subsystem and all of the contained data is recovered and fully operational, go to "Recreating a mirror relationship." Otherwise, go to "Rebuilding a damaged site."

Rebuilding a damaged site

If a disaster occurs to the primary or secondary site that renders the storage subsystem or all data on the storage subsystem irreparable, then the site needs to be rebuilt with new hardware.

Complete the following steps to rebuild a damaged site:

1. Obtain new storage subsystems and any host computers and hardware that are needed to properly use the Remote Mirror Option. Be sure that the new hardware has the same level of specifications as the damaged hardware.

2. Depending on the configuration, complete the switch zoning and hardware installation procedures for this site only. See "Installing the hardware" on page 115.

3. Define a logical drive to replace the mirrored logical drive that was damaged on the original storage subsystem. Be sure that the new logical drive is identical to the specifications of the damaged logical drive.

4. Ensure that storage partitioning is properly defined so that it can take over normal operation from the secondary site. For more information about storage partitioning, see "Using other premium features with the Remote Mirror Option" on page 107 and the Subsystem Management window online help.

5. Ensure that the host software is properly configured so that the host computers can take over I/O from the secondary site host computers. For more information about installing and configuring host software, see the documentation that comes with the software.

6. The site is recovered and is now ready to resume any mirror relationships that were active before the failure. Go to "Recreating a mirror relationship."

Recreating a mirror relationship

After the damaged site is back online and properly configured, mirror relationships can be resumed.

Complete the following steps to recreate a mirror relationship:

1. From the active secondary site, define a mirror relationship using the logical drive on the recovered primary site as the secondary logical drive. For more information, see "Creating mirror relationships" on page 137.

2. Ensure that storage partitioning is properly defined on the recovered primary site so that it can take over normal operation from the secondary site. For more information about storage partitioning, see "Using other premium features with the Remote Mirror Option" on page 107 and the Subsystem Management window online help.

3. Ensure that the host software is properly configured so that the host computers at the recovered primary site can take over I/O from the secondary site host computers. For more information about installing and configuring host software, see the documentation provided with the software.

4. Perform a manual role reversal so that the recovered primary site now possesses the active primary logical drive, and the secondary logical drive now exists on the secondary site. For more information, see "Reversing the roles of primary and secondary logical drives."

5. The remote mirror configuration is now optimal.

Reversing the roles of primary and secondary logical drives

A role reversal is the process of promoting the secondary logical drive to be the primary logical drive within the mirrored logical drive pair, and demoting the primary logical drive to be the secondary logical drive.

A role reversal is performed using one of the following methods:

Changing a secondary mirrored logical drive to a primary logical drive
This method promotes a selected secondary logical drive to become the primary logical drive of the mirrored pair, and is used when an unrecoverable error has occurred. For step-by-step instructions, see "Changing a secondary logical drive to a primary drive."

Changing a primary mirrored logical drive to a secondary logical drive
This method demotes a selected primary logical drive to become the secondary logical drive of the mirrored pair, and is used during normal operating conditions. For step-by-step instructions, see "Changing a primary logical drive to a secondary drive" on page 152.

Role reversals can also be performed using the **Set** command in the Storage Manager Script window or the CLI. For more information, see the Enterprise Management window online help.

Changing a secondary logical drive to a primary drive

A secondary logical drive is usually promoted to a primary logical drive role when an unrecoverable error has occurred on the storage subsystem that contains the primary logical drive. The secondary logical drive needs to be promoted so that host computers can access data and normal operations can continue.

This method is not available unless the Remote Mirror Option is activated.

Note: When the secondary logical drive becomes a primary logical drive, any host computers that are accessing the logical drive through a logical drive-to-LUN mapping are now able to read or write to the logical drive. This condition applies if the host did not have the same logical-drive-to-LUN mapping as the LUN in the primary logical drive that was demoted to secondary logical drive. If it did, you must restart the host for the newly-promoted-to-primary (secondary) logical drive to replace the demoted (primary) logical drive.

If a communication problem between the secondary site and the primary site prevents the demotion of the primary logical drive, an error message displays. However, you are given the opportunity to proceed with the promotion of the secondary logical drive, even though this leads to a `Dual Primary Remote Mirror` status condition. The recovery for this condition occurs when the remote mirror pairs are recreated. If you attempt to change the role of one of the primary drives, an error occurs.

Complete the following steps to promote a secondary logical drive to the primary logical drive role:

1. Select the secondary logical drive in the Logical view of the secondary Subsystem Management window. Then, either click **Logical Drive → Remote Mirroring → Change → Role to Primary**, or right click the drive and click **Change → Role to Primary**. The Change to Primary window opens.
2. Click **Yes**. The secondary logical drive is promoted to the primary logical drive role in the remote logical drive mirror.

   When the controller owner of the primary logical drive is contacted, the primary logical drive is automatically demoted to the secondary logical drive role in the remote logical drive mirror.

Changing a primary logical drive to a secondary drive

Changing a primary logical drive to the secondary logical drive is used for role reversals during normal operating conditions. You can also use this option during a recovery procedure when a `Dual Primary Remote Mirror` status condition occurs.

Role reversal does not occur unless the Remote Mirror Option is activated.

Important: After the role reversal, any host computers that are accessing the primary logical drive through a logical drive-to-LUN mapping are no longer able to read or write to the logical drive. When the primary logical drive becomes a secondary logical drive, only remote write requests initiated by the primary controller are written to the logical drive.

If a communication problem between the primary and secondary sites prevents the demotion of the primary logical drive, an error message displays. However, you are given the opportunity to proceed with the demotion of the primary logical drive even though this leads to a `Dual Secondary Remote` logical drive mirror status condition. The recovery this status condition occurs when the remote mirror pairs are recreated. If you attempt to change the role of one of the primary drives, an error occurs.

Attention: If the selected primary logical drive has associated FlashCopy logical drives, demoting this logical drive to a secondary role causes the associated FlashCopy logical drives to fail.

Complete the following steps to demote a primary logical drive to the secondary logical drive role:

1. Select the primary logical drive in the Logical view of the primary Subsystem Management window. Then, either click **Logical Drive → Remote Mirror → Change → Role to Secondary**, or right-click the drive and click **Change → Role to Secondary**. The Change to Secondary window opens.
2. Click **Yes**. The primary logical drive is demoted to be the secondary logical drive in the remote logical drive mirror.

When the controller owner of the primary logical drive is contacted, the secondary logical drive is automatically promoted to the primary logical drive role in the remote logical drive mirror.

Chapter 10. Troubleshooting the Enhanced Remote Mirroring option

This chapter provides information about some problems that are commonly encountered when using the Remote Mirror Option and how to resolve them.

The following troubleshooting topics are included in this chapter :
- Testing communication between primary and secondary logical drives
- General remote logical drive mirroring problems
- Inappropriate Fibre Channel fabric configurations
- Problems with storage subsystem components that are involved in remote logical drive mirroring
- Basic switch troubleshooting

Also provided is a list of the critical events that might be generated, and instructions for upgrading future versions of controller firmware.

Locate the section that directly relates to your problem or consult the section describing general troubleshooting techniques. If your problem is not discussed in any of the sections in this chapter, contact your IBM technical-support representative.

Testing communication between primary and secondary logical drives

Use the Test Communication dialog to diagnose possible communication problems between a primary logical drive and secondary logical drive participating in a mirror relationship. After the communication test has been completed, the dialog will display either a Passed, Warning, or Failed status together with values for the following:
- Test data round trip time
- Maximum allowed round trip time
- Average round trip time

Important: If the communication test returns a Failed status, the test will continue to run after you close the Test Communication dialog until communication between the mirrored pair is restored. If you have enabled automatic resynchronization, the mirrored pair will automatically synchronize. Otherwise, select **Logical Drive → Remote Mirroring Option → Resume** to manually start re-synchronization.

To run the Test Communication function, follow the steps below:
1. Select a primary logical drive or secondary logical drive in the Logical View.
2. Select **Logical Drive → Remote Mirroring Option → Test Communication**.
3. The Communication Test dialog is displayed.
   If the communication test returns a Passed with Caution status, the primary logical drive and secondary logical drive are communicating correctly; however, the test data round trip time is approaching the maximum allowed. This indicates that you will need to take some kind of action to fix this problem.
   If the communication test returns a Failed status, the reason for the failure is indicated, and you are directed to reference the Recovery Guru to correct the problem.
4. Review the information displayed in the dialog, and click **OK** to return to the Storage Subsystem Management window.

General troubleshooting

Table 16 describes some of the usual problems that you might encounter when using the Remote Mirror Option. The information is presented in order from the time the option is enabled and activated, to problems that might be encountered as you use the Remote Mirror Option.

Information about the probable cause and how you can resolve each problem is provided. If your problem is not addressed in this section, see the remaining sections in this chapter before you contact your IBM technical-support representative.

Table 16. General Remote Mirror Option problems

Problem	Cause	Resolution
The Remote Mirror menu options in the Subsystem Management window are greyed out and unavailable.	The Remote Mirror Option is not enabled or activated.	1. Enable the Remote Mirror Option. A premium feature key is required to enable premium features. 2. Activate the Remote Mirror Option. The Remote Mirror Option is a premium feature option. Contact your IBM technical-support representative for purchase information. For step-by-step instructions to enable and activate the Remote Mirror Option, see "Enabling and activating the Remote Mirror Option" on page 129 or the Subsystem Management window online help.
The Remote Mirror icon in the premium feature status area is greyed out with a red line.	The Remote Mirror Option is not enabled or activated.	1. Enable the Remote Mirror Option. A premium feature key file is required to enable the feature. 2. Activate the Remote Mirror Option. The Remote Mirror Option is a premium feature option. Contact your IBM technical-support representative for purchase information. For step-by-step instructions to enable and activate the Remote Mirror Option, see "Enabling and activating the Remote Mirror Option" on page 129 or the Subsystem Management window online help.

Table 16. General Remote Mirror Option problems (continued)

Problem	Cause	Resolution
When creating a remote logical drive mirror, the following error message is received: `Error 158 - The operation cannot complete because the selected logical drive is not a a valid candidate for Remote Mirroring`	The secondary logical drive candidate was participating in a mirror relationship with a different logical drive on this storage subsystem. The mirror relationship was successfully removed from the other storage subsystem. However, a communication error prevented the successful removal of the mirror relationship on this storage subsystem.	A logical drive on this storage subsystem still has a mirror relationship defined with the secondary logical drive. 1. Click **View → Storage subsystem profile**. Click the **Logical Drives** tab and then click the **Mirrors** tab. 2. Locate the logical drive that is still participating in the mirror relationship with the secondary logical drive candidate and remove the mirror relationship. For step-by-step instructions, see "Removing mirror relationships" on page 143 or the Subsystem Management window online help. 3. Re-create the intended remote logical drive mirror using the original candidate logical drives. For step-by-step instructions, see "Creating mirror relationships" on page 137 or the Subsystem Management window online help.
The primary logical drive is showing a `Synchronization-in-Progress` status.	A full synchronization, between the primary and secondary logical drives participating in a mirror relationship, is in progress. Data available on the primary logical drive is copied in its entirety to its associated secondary logical drive.	Wait for the full synchronization to complete. When full synchronization has finished copying data from the primary logical drive to the secondary logical drive, the mirrored logical drive pair transitions to a `Synchronized` status. For more information about monitoring the status of a remote logical drive mirror, see the Subsystem Management window online help.

Table 16. General Remote Mirror Option problems (continued)

Problem	Cause	Resolution
Both the primary and secondary logical drive are displayed as being the primary logical drive.	A disaster or unrecoverable error has occurred on the storage subsystem that contains the primary logical drive, and the secondary logical drive is promoted to the primary logical drive role. The primary storage subsystem is now operational, but unreachable because of a link failure. A forced promotion of the secondary logical drive has resulted in both the primary and secondary logical drives being displayed in the primary logical drive role.	If the mirror logical drive pair status is `Synchronized`, perform step 1 and step 2. Otherwise, perform step 3 and step 4. 1. Determine which of the logical drives in the mirrored logical drive pair must be the primary logical drive. 2. Choose the logical drive that must be in the secondary logical drive role, then click **Storage subsystem → Change → Role to Secondary**. A resynchronization automatically occurs. 3. Delete the mirror relationship from either storage subsystem. Select either primary logical drive in its respective Subsystem Management window and click **Logical Drive → Remote Mirroring → Remove Mirror Relationship**. **Note:** The mirror relationship for the remote logical drive is not removed if there is a connection problem between the two storage subsystems. If the mirror relationship remains on the remote logical drive after the previous action, select that logical drive from its respective Subsystem Management window and click **Logical Drive → Remote Mirroring → Remove Mirror Relationship**. 4. In its respective Subsystem Management window, select the logical drive that you want to be the primary logical drive. Click **Logical Drive → Remote Mirroring → Create**. Follow the instructions in the Create Remote Mirror wizard to re-create the mirror relationship For step-by-step instructions, see "Changing a primary logical drive to a secondary drive" on page 152 or the Subsystem Management window online help.

Table 16. General Remote Mirror Option problems (continued)

Problem	Cause	Resolution
Both the primary and secondary logical drives are displayed as being the secondary logical drive.	In response to a dual primary logical drive condition, a role reversal was carried out and the primary logical drive was demoted to the secondary logical drive role. The secondary storage subsystem is operational, but unreachable because of a link failure. The forced demotion of the primary logical drive has resulted in both the primary and secondary logical drives being displayed in the secondary logical drive role.	If the mirror logical drive pair status is `Synchronized`, perform step 1 and step 2. Otherwise, perform step 3 and step 4. 1. Determine which of the logical drives in the mirrored logical drive pair must be the primary logical drive. 2. Choose the logical drive that must be in the primary logical drive role, then click **Storage Subsystem → Change → Role to Primary**. A resynchronization automatically occurs. 3. Delete the mirror relationship from either storage subsystem. Select either secondary logical drive in its respective Subsystem Management window and click **Logical Drive → Remote Mirroring → Remove Mirror Relationship**. **Note:** The mirror relationship for the remote logical drive is not removed if there is a connection problem between the two storage subsystems. If the mirror relationship remains on the remote logical drive after the previous action, select that logical drive from its respective Subsystem Management window and click **Logical Drive → Remote Mirroring → Remove Mirror Relationship**. 4. In its respective Subsystem Management window, select the logical drive that you want to be the secondary logical drive. Click **Logical Drive→ Remote Mirroring → Create**. Follow the instructions in the Create Remote Mirror wizard to recreate the mirror relationship. For step-by-step instructions, see "Changing a secondary logical drive to a primary drive" on page 151 or the Subsystem Management window online help.

Table 16. General Remote Mirror Option problems (continued)

Problem	Cause	Resolution
The primary logical drive or secondary logical drive is displayed as missing.	A physical logical drive that a remote logical drive mirror depends on (primary logical drive, secondary logical drive) is removed, and the logical drive is now displayed under the missing logical drives node in the Logical view of the Subsystem Management window.	If missing logical drives are detected because drives have accidentally been removed, or are detected as missing because of a loss of power to the storage expansion enclosures. You can recover these logical drives by completing the following steps: 1. Re-insert the drives back into the storage expansion enclosure. 2. Ensure that the storage expansion enclosure power supplies are properly connected to an operating power source and have an `Optimal` status. For more information, see the Recovery Guru or contact your IBM technical-support representative. If the missing logical drive is no longer required, it can be deleted. **Attention:** Deleting a missing logical drive is a permanent action. Any associated logical drives or logical drive-to-LUN mappings are also deleted. For more information, see the Recovery Guru or the Subsystem Management window online help.
The mirror relationship was removed successfully from the primary side, but not from the secondary side.	When removing a mirror relationship, a link failure occurred between the primary and secondary storage subsystems and an error message displays. The Subsystem Management window for the primary storage subsystem indicates that the mirror relationship was removed successfully; however, the Subsystem Management window for the secondary storage subsystem indicates that the mirror relationship still exists.	Open the Subsystem Management window for the secondary storage subsystem and remove the mirror relationship. For step-by-step instructions, see "Removing mirror relationships" on page 143 or the Subsystem Management window online help.

Table 16. General Remote Mirror Option problems (continued)

Problem	Cause	Resolution
The mirror relationship was removed successfully from the secondary side, but not from the primary side.	When removing a mirror relationship, a link failure occurred between the primary and secondary storage subsystems. The Subsystem Management window for the secondary storage subsystem indicates that the mirror relationship is removed successfully; however, the Subsystem Management window for the primary storage subsystem indicates that the mirror relationship still exists, with the primary logical drive showing an `Unresponsive` status.	Open the Subsystem Management window for the primary storage subsystem and remove the mirror relationship. For step-by-step instructions, see "Removing mirror relationships" on page 143 or the Subsystem Management window online help.
The primary logical drive is showing an `Unsynchronized` status.	The remote logical drive mirror is in an `Unsynchronized` status because the data that is mirrored between the primary logical drive and the secondary logical drive is no longer identical. Usual causes for this status include link errors, a failed primary logical drive or secondary logical drive, or a dual primary or dual secondary error condition. While the remote logical drive mirror is in an `Unsynchronized` status, no mirroring activity takes place. **Note:** The remote mirror link and the mirror logical drive pair status depends on I/O requests, especially I/O write requests to the primary logical drive. If there are no I/O requests, the displayed status of the mirror link and the mirror logical drive pair in the Storage Manager client might be incorrect. **Note:** Generate I/O write requests to the primary logical drive to force the storage subsystems updating the remote mirror status.	When the controller owner of the primary logical drive can communicate with the controller owner of the secondary logical drive and the logical drive is online and optimal, a full synchronization automatically takes place. When a full synchronization begins, the remote logical drive mirror transitions to a mirror `Synchronization-in-Progress` status. For information about monitoring the status of a remote logical drive mirror, see the Subsystem Management window online help.

Table 16. General Remote Mirror Option problems (continued)

Problem	Cause	Resolution
An error message indicates that the Remote Mirror Option is out of compliance.	The Remote Mirror Option is out of compliance. This normally occurs if a storage subsystem with logical drives that are participating in remote logical drive mirroring is moved into the primary storage subsystem and one of the following conditions now exists: • The Remote Mirror Option is not enabled on the selected storage subsystem. • The Remote Mirror Option is enabled, but the current number of remote logical drive mirrors that are defined on the primary storage subsystem exceeds the number of mirror relationships that are allowed for this storage subsystem.	If the Remote Mirror Option is not enabled for the primary storage subsystem: 1. Obtain a premium feature key for this feature from your IBM technical-support representative. 2. Enable the Remote Mirror Option. For step-by-step instructions, see "Enabling the Remote Mirror Option" on page 130, or the Subsystem Management window online help. If the Remote Mirror Option is enabled, but the current number of mirror relationships on the storage subsystem exceeds the number of mirror relationships that are allowed for the storage subsystem, reduce the number of mirror relationships to equal or less than the number of mirror relationships allowed. The maximum number of mirror relationships that are allowed is 64. For step-by step instructions, see "Removing mirror relationships" on page 143 or the Subsystem Management window online help.
The remote logical drive candidate is unresponsive and cannot be updated.	The primary storage subsystem is unable to notify the secondary storage subsystem that its worldwide name (WWN) has changed. This might be the result of a controller in the primary storage subsystem being swapped or removed. Storage subsystem recovery procedures that result in configurations being reset and can also cause a change to the WWN. The first write operation to the primary logical drive causes the mirrored logical drive pair to transition into an `Unsynchronized` status.	1. Remove all the existing mirror relationships from the primary storage subsystem. For step-by-step instructions, see "Removing mirror relationships" on page 143 or the Subsystem Management window online help. 2. Re-establish the required mirror relationships. For step-by step instructions, see "Creating mirror relationships" on page 137 or the Subsystem Management window online help.
There is a long boot time for Windows 2000 hosts with secondary volumes mapped.	A Windows 2000 host can take up to two hours to boot if all of the following statements are true: • The storage management software is installed on the host. • The Remote Volume Mirroring premium feature is enabled. • One or more secondary volumes are mapped to the host.	Do not map the secondary volumes to the host until they are needed for data access. If the host needs to be re-started, and the secondary volumes are mapped to that host, unmap the secondary volumes until the host has completed the restart. Remap the secondary volumes only when they are needed for data access. Because Windows does not allow mounting the file system as read-only, it is not recommended to mount the secondary logical drive to the Windows hosts.

General switch troubleshooting

Table 17 describes some of the common switch-related problems that you might encounter when using the Remote Mirror Option. The troubleshooting information provided relates to switches that are supported for use with DS4000 Storage Manager. For a list of supported switches, see the *IBM TotalStorage DS4000 Storage Manager Version 9 Installation and Support Guide* that is appropriate for your operating system.

Information about the probable cause and how you can resolve for each problem is provided. If your problem is not addressed in this section, see the remaining sections in this chapter before contacting your IBM technical-support representative.

Table 17. General switch problems

Problem	Cause	Resolution
The host is unable to detect primary and secondary storage subsystems that are participating in remote logical drive mirroring.	When two or more switches are cascaded together and have the same domain ID, host computers are unable to locate the target device. Each switch must have a unique domain ID when attempting to cascade two switches together.	Change the domain ID of one or more of your switches, ensuring that each one is unique. A domain ID must be a unique number between 1 and 239, which is used to identify the switch to a Fibre Channel fabric. For more information about setting domain IDs, see your switch documentation.

Inappropriate Fibre Channel fabric configurations

Table 18 describes Fibre Channel fabric configuration problems that you might encounter after you have configured your storage subsystems and have activated and enabled the Remote Mirror Option.

Information about the probable cause and how you can resolve each problem is provided. If your problem is not addressed in this section, see the remaining sections in this chapter before you contactyour IBM technical-support representative.

Table 18. Fibre-channel fabric configuration problems

Problem	Cause	Resolution
The primary logical drive is unable to contact the Fibre Channel fabric.	Usually, this error occurs because of a failed Fibre Channel fabric or because of cabling problems between the primary and secondary storage subsystems that are participating in a remote logical drive mirror.	• If the Fibre Channel fabric has failed, repair or replace the failed fabric. • If the Fibre Channel fabric is operational, check the configuration cabling. The cable must not go through a hub or be connected directly between storage subsystems. Ensure that the cable is attached through a switch. For step-by-step instructions to configure storage subsystems for remote logical drive mirroring, see Chapter 7, "Installing hardware and software for the Enhanced Remote Mirroring option," on page 111.

Table 18. Fibre-channel fabric configuration problems (continued)

Problem	Cause	Resolution
The primary logical drive is unable to communicate with the secondary storage subsystem. The primary storage subsystem can still communicate with the fabric.	Usually, this error occurs when the secondary storage subsystem has lost power or when network problems exist between the secondary storage subsystem and the fabric.	• The secondary storage subsystem has no power. If the secondary storage subsystem has no power and is not operational, restore power to the storage subsystem. For information about powering on storage subsystems, see your hardware documentation. • The secondary storage subsystem has power and is operational. Check the network status. Ensure that the secondary storage subsystem is visible on the network. Ensure that the cables are correctly connected. For step-by-step instructions to configure storage subsystems for remote logical drive mirroring, see Chapter 7, "Installing hardware and software for the Enhanced Remote Mirroring option," on page 111.

Storage subsystem component failures

Table 19 describes how physical or logical storage subsystem component failures can impact remote logical drive mirroring functionality. Information about the probable cause and how you can resolve each problem is provided. If your problem is not addressed in this section, see the remaining sections in this chapter before you contact your IBM technical-support representative.

Table 19. Storage subsystem component failures

Problem	Cause	Resolution
A FlashCopy logical drive that was created for a primary logical drive indicates that it has failed, after its role in the remote mirroring relationship has been changed to secondary.	The base logical drive for the FlashCopy logical drive is a primary logical drive that is involved in a mirror relationship. A role reversal was performed, which demoted the primary logical drive to secondary logical drive status, resulting in a FlashCopy logical drive on the secondary logical drive. The base logical drive for a FlashCopy logical drive cannot be a candidate for the secondary logical drive role in a remote logical drive mirror. Therefore, the FlashCopy logical drive has failed.	Perform a role reversal to promote the secondary logical drive to the primary logical drive role. After the role reversal is complete, the FlashCopy logical drive returns to `Optimal` status. For step-by-step instruction, see "Changing a secondary logical drive to a primary drive" on page 151 or the Subsystem Management window online help.

Table 19. Storage subsystem component failures (continued)

Problem	Cause	Resolution
The primary storage subsystem controller indicates that it has failed.	Failure of the owning controller on the primary storage subsystem usually causes the associated multipath driver on the attached host computer to transfer ownership of the alternate controller on the primary storage subsystem. When this occurs, the alternate controller on the primary storage subsystem begins forwarding newly-written data to its peer on the secondary storage subsystem. The secondary controller takes ownership of the logical drive from its (secondary) peer controller. This is a reactive event; it occurs because of the arrival of a write request from the primary storage subsystem to the non-owning controller on the secondary storage subsystem.	Allow the ownership transfer to complete. Operations continue in a normal fashion, with the alternate (usually the non-preferred) controller on the primary storage subsystem interacting with the alternate controller on the secondary storage subsystem. Failure of the non-owning controller on the primary storage subsystem has no direct impact on the status of the remote logical drive mirrors.
The secondary storage subsystem controller indicates that it has failed.	One of the following scenarios has occurred: • Controller A on the secondary storage subsystem has failed while Controller A is the owner of the primary logical drive. • Controller B on the secondary storage subsystem has failed while Controller B is the owner of the primary logical drive. In both scenarios, the mirrored logical drive pair transitions to the `Unsynchronized` status.	Restore the failed controller. For detailed recovery procedures, see the Recovery Guru. After the failed controller is restored, the primary storage subsystem automatically transitions to a `Synchronizing` status.

Remote Mirror critical events

Critical major event log (MEL) events are generated when an error occurs that can affect data availability or that results in a degraded mode of operation. The storage management software responds by alerting the appropriate administrators by e-mail, SNMP trap, or other configured devices. Because administrative action is required to correct the problem, the storage subsystem generally enters a `Needs Attention` status. This causes the appropriate indications to be presented through the storage management software and an associated Recovery Guru procedure to be displayed when requested by the end user.

Critical events table

Table 20 provides a description of critical MEL events, with a brief explanation of what caused the event to be triggered, and how you can resolve the problem. If your problem is not addressed in this section, see the remaining sections in this chapter before you contact your IBM technical-support representative.

Table 20. Remote Mirror critical events

Problem	Cause	Resolution
Mirrored pair becomes unsynchronized.	This event is logged when a remote logical drive mirror transitions to an `Unsynchronized` status, from either a `Synchronizing` or `Optimal` status.	See the associated Recovery Guru message for specific recovery procedures.

Table 20. Remote Mirror critical events (continued)

Problem	Cause	Resolution
Dual-role conflict detected.	This event is logged when a dual-role conflict is detected, and is usually the result of a role reversal. Because both sides of the mirrored logical drive pair are in the same primary or secondary logical drive role, both the primary and secondary storage subsystems will report this MEL event.	See the associated Recovery Guru message for specific recovery procedures.
Communication error with the secondary logical drive on the secondary remote storage subsystem.	This event is logged when an interruption in the link that cannot be recovered by the firmware Fibre Channel device driver is detected. Error codes and recovery procedures assist you in finding the exact cause of the communication problem between storage subsystems that are participating in a mirror relationship.	See the associated Recovery Guru message for specific recovery procedures.
Worldwide name (WWN) change notification failed.	This event is logged when a storage subsystem detects during start-up processing that its WWN has changed. The WWN can only change if both controllers of the array are exchanged while the array is powered off. When the firmware detects this name change, it attempts to notify any remote storage subsystem that had previously been participating in a mirroring relationship with any logical drive on the array.	See the associated Recovery Guru message for specific recovery procedures.

Problem resolution scenarios

The following scenarios present resolutions or workarounds to potential problems when using Remote Mirroring:

Problem:
When you create a remote mirror of a FlashCopy base logical drive, the following scenario is possible.

- First, you have created a FlashCopy of a base logical drive and the base logical drive is receiving I/O.
- Second, you decide to create a remote mirror relationship, using the base logical drive as the primary logical drive in the remote mirror pair.
- As you create the remote mirror relationship, the FlashCopy logical drive fails.

Workaround:
Quiesce I/O to the base logical drive while you are creating the remote mirror relationship. Alternatively, if the remote mirror relationship is created before you create the FlashCopy logical drive, this event will not occur.

Problem:
When alternately switching the roles of the logical drives in a remote mirrored relationship back and forth, Windows NT 4.0 and Windows 2000

might cache the file or files on the logical drive (disk) in memory and use the cached data instead of going out to the disk to get the data. This Windows operating system behavior might make the data look like it was not synchronized between logical drives in a remote mirror relationship.

Resolution:

Unmount the primary logical drive in the server before demoting it to the secondary role. In a Microsoft Windows environment, shut down the server that the primary logical drive is mapped to. Then, promote the secondary logical drive to the primary role and hot_add it to the appropriate server.

If the logical drive is of the "Dynamic Disk" type, you might be able to resolve the situation without shutting down the server. Perform the following steps:

1. In the server that has the primary logical drive, run the SMrepassist program in the DS4000 Storage Manager utility directory with the `-f` option to flush the cached data to disk.

2. Promote the secondary logical drive and hot_add it to the appropriate server.

3. Before you promote the logical drive to the primary role in the original server, force a failure to the disk by running **chkdsk** on the disk.

4. Promote the logical drive to primary role in the original server and hot_add it.

5. You might have to reactivate the disk after it is hot_added to the server.

If the server environment prevents the server from being restarted and the logical drive is of the "Basic Disk" type, perform the following steps:

1. In the server that has the primary logical drive, run the SMrepassist program in the DS4000 Storage Manager util directory with the `-f` option to flush the cached data to disk.

2. Use the DS4000 Storage Manager to remove the LUN mapping of the logical drive that had the primary role from its server (host computer).

3. Promote the secondary role LUN to the primary role and hot_add it in the appropriate server assuming that the LUN mapping is already defined for this server in the DS4000 Storage Subsystem.

4. Before you promote the logical drive to the primary role in the original server, run the Hot_add program or initiate a Scan for Hardware Changes task in the original server. This removes the logical drive from the available disks. In Windows 2000, you might see `Unsafe Removal of Devices` messages.

5. Use the DS4000 Storage Manager to add the LUN mapping of the logical drive that will be promoted to primary role to the original server (host computer).

6. Promote the logical drive to primary role and hot_add it in the original server. If you are unable to hot_add the logical drive or the data still seems to be mismatched, you must restart the server.

Appendix A. Upgrading controller firmware

The Remote Mirror Option is designed so that it is not necessary for the primary storage subsystem and the secondary storage subsystem to run exactly the same controller firmware level. All inter-controller operations (including those needed for propagation of newly-written data from the primary logical drive to the secondary logical drive) are implemented so as to support mixed firmware levels to the greatest extent possible. This allows firmware upgrades to be performed on both the primary and secondary storage subsystems without any loss of data. This is also true in the case that the controller firmware of the DS4000 Storage Subsystem at the primary site is version 06.10.xx.xx and the controller firmware of the one at the secondary site is version 05.xx.xx.xx and vice versa. The capabilities of the remote mirror depend on the version of the controller firmware installed at the DS4000 Storage Subsystem where the primary logical drive of remote mirror located.

The key data availability operations, including promotion from the secondary logical drive to the primary logical drive, are allowed in mixed firmware levels. However, IBM strongly recommends upgrading firmware to the same levels. This will avoid restrictions in Remote Mirroring configuration operations due to a mixed primary and secondary DS4000 Storage Subsystem controller firmware environment. In a mixed firmware level environment, the following configuration requests are the only ones that can be completed: mirror deletion, changing the logical drive user label, and changing the synchronization priority. All other mirror configuration functions are not allowed.

Important: Make sure that the DS4000 Storage Subsystem are in Optimal state before attempting controller firmware and NVSRAM download. Use the Recovery Guru in the Storage Manager subsystem window to correct any problems before the downloading the firmware.

Upgrades to controller firmware should be completed in different ways depending on whether the primary controller currently has the Enhanced Remote Mirroring option, or the earlier Remote Mirror Option installed. Follow the steps below, based on the remote mirroring version installed.

Upgrading controller firmware with Enhanced Remote Mirroring installed

This section describes the procedure that you must follow to upgrade controller firmware (version 5.2xx.xx and higher) if you are currently running the Enhanced Remote Mirroring option on the primary controller. Performing firmware upgrades on storage subsystems that are participating in mirror relationships in sequence detailed in the steps below.

1. Download the firmware to the primary storage subsystem.
2. Download firmware to the secondary storage subsystem.

The Enhanced Remote Mirroring controller firmware will cache the write I/Os during the unsynchronized period and will perform these cached writes only after the secondary DS4000 storage subsystem has completed the firmware download.

Note: For more information about upgrading controller firmware, including detailed procedures, see the *IBM DS4000 Storage Manager 9 Installation and Support Guide* for your operating system.

Upgrading controller firmware with the previous Remote Mirror option installed

This section describes the procedure that you must follow to upgrade controller firmware (version 5.2xx.xx and higher) if the storage subsystems are using the earlier version of the Remote Mirror option. The sequence for firmware upgrades on storage subsystems that are participating in mirror relationships is detailed in the steps below.

Important: By following this sequence, it is possible to avoid transitions of the mirrored logical drive pair to an `Unsynchronized` status, avoiding the need for a full resynchronization afterwards. The secondary array is offline for some interval while the firmware updates are performed (using the previous Remote Mirror functionality), which will cause the remote mirror status to change to Unsynchronized. This will require full resynchronization when the firmware download operation is complete. To minimize the resyncronization process, one has to stop I/Os to the primary DS4000 storage subsystem while upgrading the secondary storage subsystem.

1. Stop I/O to programs that operate on all the affected primary logical drives that are temporarily inactive.
2. Download firmware to the secondary storage subsystem.

   Resume program access to the primary logical drives. You can operate the primary storage subsystem with a different firmware level than the secondary storage subsystem for a time, but the inter-controller protocols for data replication do not support such interactions.
3. Download the firmware to the primary storage subsystem.

Resynchronization of the primary and secondary storage subsystems will then be initiated.

Appendix B. Additional DS4000 documentation

The following tables present an overview of the DS4500, DS4400, DS4300, DS4100, and DS4800 Storage Subsystem product libraries, as well as other related documents. Each table lists documents that are included in the libraries and what common tasks they address.

You can access the documents listed in these tables at one of the following Web sites:

www.ibm.com/servers/storage/support/disk/

www.ibm.com/shop/publications/order/

DS4500 Fibre Channel Storage Server library

Table 21 associates each document in the DS4500 (previously FAStT900) Fibre Channel Storage Server library with its related common user tasks.

Table 21. TotalStorage DS4500 Fibre Channel Storage Server document titles by user tasks

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
IBM TotalStorage DS4500 Installation and Support Guide, GC26-7727	✔	✔		✔		
IBM TotalStorage DS4500 Fibre Channel Cabling Instructions, GC26-7729	✔	✔				
IBM TotalStorage DS4500 Storage Server User's Guide, GC26-7726				✔	✔	✔
IBM TotalStorage DS4500 Rack Mounting Instructions, GC26-7728	✔	✔				

DS4400 Fibre Channel Storage Server library

Table 22 associates each document in the DS4400 (previously FAStT700) Fibre Channel Storage Server library with its related common user tasks.

Table 22. TotalStorage DS4400 Fibre Channel Storage Server document titles by user tasks

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
IBM DS4400 Fibre Channel Storage Server User's Guide, GC26-7730	✔	✔		✔	✔	✔
IBM DS4400 Fibre Channel Storage Server Installation and Support Guide, GC26-7731	✔	✔		✔	✔	
IBM DS4400 Fibre Channel Cabling Instructions, GC26-7732	✔	✔				

DS4300 Fibre Channel Storage Server library

Table 23 associates each document in the DS4300 (previously FAStT600) Fibre Channel Storage Server library with its related common user tasks.

Table 23. TotalStorage DS4300 Fibre Channel Storage Server document titles by user tasks

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
IBM TotalStorage DS4300 Fibre Channel Storage Server Installation and User's Guide, GC26-7722	✔	✔		✔		
IBM TotalStorage DS4300 Rack Mounting Instructions, GC26-7724	✔	✔				
IBM TotalStorage DS4300 Fibre Channel Cabling Instructions, GC26-7725	✔	✔				
IBM TotalStorage DS4300 SCU Base Upgrade Kit, GC26-7740		✔	✔			
IBM TotalStorage DS4300 SCU Turbo Upgrade Kit, GC26-7741		✔	✔			
IBM TotalStorage DS4300 Turbo Models 6LU/6LX Upgrade Kit, GC26-7723		✔	✔			

DS4100 SATA Storage Server library

Table 24 associates each document in the DS4100 (previously FAStT100) SATA Storage Server library with its related common user tasks.

Table 24. TotalStorage DS4100 SATA Storage Server document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
IBM TotalStorage DS4100 Installation, User's and Maintenance Guide, GC26-7733	✔	✔		✔	✔	✔
IBM TotalStorage DS4100 Cabling Guide, 24P8973		✔				

DS4800 Storage Subsystem library

Table 25 associates each document in the DS4800 Storage Subsystem library with its related common user tasks.

Table 25. TotalStorage DS4800 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
IBM TotalStorage DS4800 Installation, User's and Maintenance Guide, GC26-7748	✔	✔		✔	✔	✔
IBM TotalStorage DS4800 Installation and Cabling Overview, 22R4738		✔				

Other DS4000 and DS4000-related documents

Table 26 associates each of the following documents with its related common user tasks.

Table 26. TotalStorage DS4000 and DS4000–related document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
IBM Safety Information, 33P2406					✔	
IBM TotalStorage DS4000 Quick Start Guide, GC26-7738	✔	✔				
IBM TotalStorage DS4000 Hardware Maintenance Manual, GC26-7702						✔
IBM TotalStorage DS4000 Problem Determination Guide, GC26-7703						✔
IBM Fibre Channel Planning and Integration: User's Guide and Service Information, SC23-4329	✔	✔			✔	✔
IBM TotalStorage DS4000 FC2-133 Host Bus Adapter Installation and User's Guide, GC26-7736		✔			✔	
IBM TotalStorage DS4000 FC2-133 Dual Port Host Bus Adapter Installation and User's Guide, GC26-7737		✔			✔	
IBM TotalStorage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview GC26-7713	✔	✔	✔	✔		
Fibre Channel Solutions - IBM DS4000 EXP500 Installation and User's Guide, 59P5637	✔	✔		✔	✔	✔

Table 26. TotalStorage DS4000 and DS4000–related document titles by user tasks (continued)

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
IBM TotalStorage DS4000 EXP700 and EXP710 Storage Expansion Enclosures Installation, User's, and Maintenance Guide, GC26-7735	✔	✔		✔	✔	✔
IBM TotalStorage DS4000 Hard Drive and Storage Expansion Enclosures Installation and Migration Guide, GC26-7704	✔	✔				
IBM DS4000 Management Suite Java User's Guide, 32P0081					✔	✔
IBM Netfinity® Fibre Channel Cabling Instructions, 19K0906		✔				
IBM Fibre Channel SAN Configuration Setup Guide, 25P2509	✔		✔	✔	✔	

Appendix C. Accessibility

This section provides information about alternate keyboard navigation, which is a DS4000 Storage Manager accessibility feature. Accessibility features help a user who has a physical disability, such as restricted mobility or limited vision, to use software products successfully.

By using the alternate keyboard operations that are described in this section, you can use keys or key combinations to perform Storage Manager tasks and initiate many menu actions that can also be done with a mouse.

Note: In addition to the keyboard operations that are described in this section, the DS4000 Storage Manager 9.14 software installation package for Windows includes a screen reader software interface. To enable the screen reader, select Custom Installation when using the installation wizard to install Storage Manager 9.14 on a Windows host/management station. Then, in the Select Product Features window, select Java Access Bridge in addition to the other required host software components.

Table 27 defines the keyboard operations that enable you to navigate, select, or activate user interface components. The following terms are used in the table:
- *Navigate* means to move the input focus from one user interface component to another.
- *Select* means to choose one or more components, typically for a subsequent action.
- *Activate* means to carry out the action of a particular component.

Note: In general, navigation between components requires the following keys:
  - **Tab** - Moves keyboard focus to the next component or to the first member of the next group of components
  - **Shift-Tab** - Moves keyboard focus to the previous component or to the first component in the previous group of components
  - **Arrow keys** - Move keyboard focus within the individual components of a group of components

Table 27. DS4000 Storage Manager alternate keyboard operations

Short cut	Action
F1	Open the Help.
F10	Move keyboard focus to main menu bar and post first menu; use the arrow keys to navigate through the available options.
Alt+F4	Close the management window.
Alt+F6	Move keyboard focus between dialogs (non-modal) and between management windows.

Table 27. DS4000 Storage Manager alternate keyboard operations (continued)

Short cut	Action
Alt+ underlined letter	Access menu items, buttons, and other interface components by using the keys associated with the underlined letters. For the menu options, select the Alt + underlined letter combination to access a main menu, and then select the underlined letter to access the individual menu item. For other interface components, use the Alt + underlined letter combination.
Ctrl+F1	Display or conceal a tool tip when keyboard focus is on the toolbar.
Spacebar	Select an item or activate a hyperlink.
Ctrl+Spacebar (Contiguous/Non-contiguous) AMW Logical/Physical View	Select multiple drives in the Physical View. To select multiple drives, select one drive by pressing Spacebar, and then press Tab to switch focus to the next drive you want to select; press Ctrl+Spacebar to select the drive. If you press Spacebar alone when multiple drives are selected then all selections are removed. Use the Ctrl+Spacebar combination to deselect a drive when multiple drives are selected. This behavior is the same for contiguous and non-contiguous selection of drives.
End, Page Down	Move keyboard focus to the last item in the list.
Esc	Close the current dialog (does not require keyboard focus).
Home, Page Up	Move keyboard focus to the first item in the list.
Shift+Tab	Move keyboard focus through components in the reverse direction.
Ctrl+Tab	Move keyboard focus from a table to the next user interface component.
Tab	Navigate keyboard focus between components or select a hyperlink.
Down arrow	Move keyboard focus down one item in the list.
Left arrow	Move keyboard focus to the left.
Right arrow	Move keyboard focus to the right.
Up arrow	Move keyboard focus up one item in the list.

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181

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Important notes

Processor speeds indicate the internal clock speed of the microprocessor; other factors also affect application performance.

CD-ROM drive speeds list the variable read rate. Actual speeds vary and are often less than the maximum possible.

When referring to processor storage, real and virtual storage, or channel volume, KB stands for approximately 1000 bytes, MB stands for approximately 1 000 000 bytes, and GB stands for approximately 1 000 000 000 bytes.

When referring to hard disk drive capacity or communications volume, MB stands for 1 000 000 bytes, and GB stands for 1 000 000 000 bytes. Total user-accessible capacity may vary depending on operating environments.

Maximum internal hard disk drive capacities assume the replacement of any standard hard disk drives and population of all hard disk drive bays with the largest currently supported drives available from IBM.

Maximum memory may require replacement of the standard memory with an optional memory module.

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Glossary

This glossary provides definitions for the terminology and abbreviations used in IBM TotalStorage DS4000 publications.

If you do not find the term you are looking for, see the *IBM Glossary of Computing Terms* located at the following Web site:

www.ibm.com/ibm/terminology

This glossary also includes terms and definitions from:

- *Information Technology Vocabulary* by Subcommittee 1, Joint Technical Committee 1, of the International Organization for Standardization and the International Electrotechnical Commission (ISO/IEC JTC1/SC1). Definitions are identified by the symbol (I) after the definition; definitions taken from draft international standards, committee drafts, and working papers by ISO/IEC JTC1/SC1 are identified by the symbol (T) after the definition, indicating that final agreement has not yet been reached among the participating National Bodies of SC1.
- *IBM Glossary of Computing Terms*. New York: McGraw-Hill, 1994.

The following cross-reference conventions are used in this glossary:

See Refers you to (a) a term that is the expanded form of an abbreviation or acronym, or (b) a synonym or more preferred term.

See also
Refers you to a related term.

Abstract Windowing Toolkit (AWT). A Java graphical user interface (GUI).

accelerated graphics port (AGP). A bus specification that gives low-cost 3D graphics cards faster access to main memory on personal computers than the usual peripheral component interconnect (PCI) bus. AGP reduces the overall cost of creating high-end graphics subsystems by using existing system memory.

access volume. A special logical drive that allows the host-agent to communicate with the controllers in the storage subsystem.

adapter. A printed circuit assembly that transmits user data input/output (I/O) between the internal bus of the host system and the external fibre-channel (FC) link and vice versa. Also called an I/O adapter, host adapter, or FC adapter.

advanced technology (AT) bus architecture. A bus standard for IBM compatibles. It extends the XT bus architecture to 16 bits and also allows for bus mastering, although only the first 16 MB of main memory are available for direct access.

agent. A server program that receives virtual connections from the network manager (the client program) in a Simple Network Management Protocol-Transmission Control Protocol/Internet Protocol (SNMP-TCP/IP) network-managing environment.

AGP. See *accelerated graphics port*.

AL_PA. See *arbitrated loop physical address*.

arbitrated loop. One of three existing fibre-channel topologies, in which 2 - 126 ports are interconnected serially in a single loop circuit. Access to the Fibre Channel-Arbitrated Loop (FC-AL) is controlled by an arbitration scheme. The FC-AL topology supports all classes of service and guarantees in-order delivery of FC frames when the originator and responder are on the same FC-AL. The default topology for the disk array is arbitrated loop. An arbitrated loop is sometimes referred to as a Stealth Mode.

arbitrated loop physical address (AL_PA). An 8-bit value that is used to uniquely identify an individual port within a loop. A loop can have one or more AL_PAs.

array. A collection of fibre-channel or SATA hard drives that are logically grouped together. All the drives in the array are assigned the same RAID level. An array is sometimes referred to as a ″RAID set.″ See also *redundant array of independent disks (RAID)*, *RAID level*.

asynchronous write mode. In remote mirroring, an option that allows the primary controller to return a write I/O request completion to the host server before data has been successfully written by the secondary controller. See also *synchronous write mode*, *remote mirroring*, *Global Copy*, *Global Mirroring*.

AT. See *advanced technology (AT) bus architecture*.

ATA. See *AT-attached*.

AT-attached. Peripheral devices that are compatible with the original IBM AT computer standard in which signals on a 40-pin AT-attached (ATA) ribbon cable followed the timings and constraints of the Industry Standard Architecture (ISA) system bus on the IBM PC AT computer. Equivalent to integrated drive electronics (IDE).

auto-volume transfer/auto-disk transfer (AVT/ADT).
A function that provides automatic failover in case of controller failure on a storage subsystem.

AVT/ADT. See *auto-volume transfer/auto-disk transfer*.

AWT. See *Abstract Windowing Toolkit*.

basic input/output system (BIOS). The personal computer code that controls basic hardware operations, such as interactions with diskette drives, hard disk drives, and the keyboard.

BIOS. See *basic input/output system*.

BOOTP. See *bootstrap protocol*.

bootstrap protocol (BOOTP). In Transmission Control Protocol/Internet Protocol (TCP/IP) networking, an alternative protocol by which a diskless machine can obtain its Internet Protocol (IP) address and such configuration information as IP addresses of various servers from a BOOTP server.

bridge. A storage area network (SAN) device that provides physical and transport conversion, such as fibre channel to small computer system interface (SCSI) bridge.

bridge group. A bridge and the collection of devices connected to it.

broadcast. The simultaneous transmission of data to more than one destination.

cathode ray tube (CRT). A display device in which controlled electron beams are used to display alphanumeric or graphical data on an electroluminescent screen.

client. A computer system or process that requests a service of another computer system or process that is typically referred to as a server. Multiple clients can share access to a common server.

command. A statement used to initiate an action or start a service. A command consists of the command name abbreviation, and its parameters and flags if applicable. A command can be issued by typing it on a command line or selecting it from a menu.

community string. The name of a community contained in each Simple Network Management Protocol (SNMP) message.

concurrent download. A method of downloading and installing firmware that does not require the user to stop I/O to the controllers during the process.

CRC. See *cyclic redundancy check*.

CRT. See *cathode ray tube*.

CRU. See *customer replaceable unit*.

customer replaceable unit (CRU). An assembly or part that a customer can replace in its entirety when any of its components fail. Contrast with *field replaceable unit (FRU)*.

cyclic redundancy check (CRC). (1) A redundancy check in which the check key is generated by a cyclic algorithm. (2) An error detection technique performed at both the sending and receiving stations.

dac. See *disk array controller*.

dar. See *disk array router*.

DASD. See *direct access storage device*.

data striping. See *striping*.

default host group. A logical collection of discovered host ports, defined host computers, and defined host groups in the storage-partition topology that fulfill the following requirements:
- Are not involved in specific logical drive-to-LUN mappings
- Share access to logical drives with default logical drive-to-LUN mappings

device type. Identifier used to place devices in the physical map, such as the switch, hub, or storage.

DHCP. See *Dynamic Host Configuration Protocol*.

direct access storage device (DASD). A device in which access time is effectively independent of the location of the data. Information is entered and retrieved without reference to previously accessed data. (For example, a disk drive is a DASD, in contrast with a tape drive, which stores data as a linear sequence.) DASDs include both fixed and removable storage devices.

direct memory access (DMA). The transfer of data between memory and an input/output (I/O) device without processor intervention.

disk array controller (dac). A disk array controller device that represents the two controllers of an array. See also *disk array router*.

disk array router (dar). A disk array router that represents an entire array, including current and deferred paths to all logical unit numbers (LUNs) (hdisks on AIX). See also *disk array controller*.

DMA. See *direct memory access*.

domain. The most significant byte in the node port (N_port) identifier for the fibre-channel (FC) device. It is not used in the fibre channel-small computer system interface (FC-SCSI) hardware path ID. It is required to be the same for all SCSI targets logically connected to an FC adapter.

DRAM. See *dynamic random access memory*.

Dynamic Host Configuration Protocol (DHCP). A protocol defined by the Internet Engineering Task Force that is used for dynamically assigning Internet Protocol (IP) addresses to computers in a network.

dynamic random access memory (DRAM). A storage in which the cells require repetitive application of control signals to retain stored data.

ECC. See *error correction coding*.

EEPROM. See *electrically erasable programmable read-only memory*.

EISA. See *Extended Industry Standard Architecture*.

electrically erasable programmable read-only memory (EEPROM). A type of memory chip which can retain its contents without consistent electrical power. Unlike the PROM which can be programmed only once, the EEPROM can be erased electrically. Because it can only be reprogrammed a limited number of times before it wears out, it is appropriate for storing small amounts of data that are changed infrequently.

electrostatic discharge (ESD). The flow of current that results when objects that have a static charge come into close enough proximity to discharge.

environmental service module (ESM) canister. A component in a storage expansion enclosure that monitors the environmental condition of the components in that enclosure. Not all storage subsystems have ESM canisters.

E_port. See *expansion port*.

error correction coding (ECC). A method for encoding data so that transmission errors can be detected and corrected by examining the data on the receiving end. Most ECCs are characterized by the maximum number of errors they can detect and correct.

ESD. See *electrostatic discharge*.

ESM canister. See *environmental service module canister*.

EXP. See *storage expansion enclosure*.

expansion port (E_port). A port that connects the switches for two fabrics.

Extended Industry Standard Architecture (EISA). A bus standard for IBM compatibles that extends the Industry Standard Architecture (ISA) bus architecture to 32 bits and allows more than one central processing unit (CPU) to share the bus. See also *Industry Standard Architecture*.

fabric. A Fibre Channel entity which interconnects and facilitates logins of N_ports attached to it. The fabric is responsible for routing frames between source and destination N_ports using address information in the frame header. A fabric can be as simple as a point-to-point channel between two N-ports, or as complex as a frame-routing switch that provides multiple and redundant internal pathways within the fabric between F_ports.

fabric port (F_port). In a fabric, an access point for connecting a user's N_port. An F_port facilitates N_port logins to the fabric from nodes connected to the fabric. An F_port is addressable by the N_port connected to it. See also *fabric*.

FAStT MSJ. See *FAStT Management Suite Java*.

FAStT Management Suite Java (FAStT MSJ). A diagnostic and configuration utility that can be used on Linux, Microsoft Windows, and Novell NetWare host systems. In Linux, it is also used with the QLRemote agent to define preferred and non-preferred paths for logical drives.

FC. See *fibre channel*.

FC-AL. See *arbitrated loop*.

feature enable identifier. A unique identifier for the storage subsystem, which is used in the process of generating a premium feature key. See also *premium feature key*.

fibre channel (FC). A set of standards for a serial input/output (I/O) bus capable of transferring data between two ports at up to 100 Mbps, with standards proposals to go to higher speeds. FC supports point-to-point, arbitrated loop, and switched topologies.

Fibre Channel-Arbitrated Loop (FC-AL). See *arbitrated loop*.

Fibre Channel Protocol (FCP) for small computer system interface (SCSI). A high-level fibre-channel mapping layer (FC-4) that uses lower-level fibre-channel (FC-PH) services to transmit SCSI commands, data, and status information between a SCSI initiator and a SCSI target across the FC link by using FC frame and sequence formats.

field replaceable unit (FRU). An assembly that is replaced in its entirety when any one of its components fails. In some cases, a field replaceable unit might contain other field replaceable units. Contrast with *customer replaceable unit (CRU)*.

FlashCopy. A premium feature for DS4000 that can make an instantaneous copy of the data in a volume.

F_port. See *fabric port*.

FRU. See *field replaceable unit*.

GBIC. See *gigabit interface converter*

gigabit interface converter (GBIC). A transceiver that performs serial, optical-to-electrical, and

electrical-to-optical signal conversions for high-speed networking. A GBIC can be hot swapped. See also *small form-factor pluggable*.

Global Copy.   Refers to a remote logical drive mirror pair that is set up using asynchronous write mode without the write consistency group option. This is also referred to as "Asynchronous Mirroring without Consistency Group." Global Copy does not ensure that write requests to multiple primary logical drives are carried out in the same order on the secondary logical drives as they are on the primary logical drives. If it is critical that writes to the primary logical drives are carried out in the same order in the appropriate secondary logical drives, Global Mirroring should be used instead of Global Copy. See also *asynchronous write mode*, *Global Mirroring*, *remote mirroring*, *Metro Mirroring*.

Global Mirroring.   Refers to a remote logical drive mirror pair that is set up using asynchronous write mode with the write consistency group option. This is also referred to as "Asynchronous Mirroring with Consistency Group." Global Mirroring ensures that write requests to multiple primary logical drives are carried out in the same order on the secondary logical drives as they are on the primary logical drives, preventing data on the secondary logical drives from becoming inconsistent with the data on the primary logical drives. See also *asynchronous write mode*, *Global Copy*, *remote mirroring*, *Metro Mirroring*.

graphical user interface (GUI).   A type of computer interface that presents a visual metaphor of a real-world scene, often of a desktop, by combining high-resolution graphics, pointing devices, menu bars and other menus, overlapping windows, icons, and the object-action relationship.

GUI.   See *graphical user interface.*

HBA.   See *host bus adapter*.

hdisk.   An AIX term representing a logical unit number (LUN) on an array.

host.   A system that is directly attached to the storage subsystem through a fibre-channel input/output (I/O) path. This system is used to serve data (typically in the form of files) from the storage subsystem. A system can be both a storage management station and a host simultaneously.

host bus adapter (HBA).   An interface between the fibre-channel network and a workstation or server.

host computer.   See *host*.

host group.   An entity in the storage partition topology that defines a logical collection of host computers that require shared access to one or more logical drives.

host port.   Ports that physically reside on the host adapters and are automatically discovered by the DS4000 Storage Manager software. To give a host computer access to a partition, its associated host ports must be defined.

hot swap.   To replace a hardware component without turning off the system.

hub.   In a network, a point at which circuits are either connected or switched. For example, in a star network, the hub is the central node; in a star/ring network, it is the location of wiring concentrators.

IBMSAN driver.   The device driver that is used in a Novell NetWare environment to provide multipath input/output (I/O) support to the storage controller.

IC.   See *integrated circuit*.

IDE.   See *integrated drive electronics*.

in-band.   Transmission of management protocol over the fibre-channel transport.

Industry Standard Architecture (ISA).   Unofficial name for the bus architecture of the IBM PC/XT personal computer. This bus design included expansion slots for plugging in various adapter boards. Early versions had an 8-bit data path, later expanded to 16 bits. The "Extended Industry Standard Architecture" (EISA) further expanded the data path to 32 bits. See also *Extended Industry Standard Architecture*.

initial program load (IPL).   The initialization procedure that causes an operating system to commence operation. Also referred to as a system restart, system startup, and boot.

integrated circuit (IC).   A microelectronic semiconductor device that consists of many interconnected transistors and other components. ICs are constructed on a small rectangle cut from a silicon crystal or other semiconductor material. The small size of these circuits allows high speed, low power dissipation, and reduced manufacturing cost compared with board-level integration. Also known as a *chip*.

integrated drive electronics (IDE).   A disk drive interface based on the 16-bit IBM personal computer Industry Standard Architecture (ISA) in which the controller electronics reside on the drive itself, eliminating the need for a separate adapter card. Also known as an Advanced Technology Attachment Interface (ATA).

Internet Protocol (IP).   A protocol that routes data through a network or interconnected networks. IP acts as an intermediary between the higher protocol layers and the physical network.

Internet Protocol (IP) address. The unique 32-bit address that specifies the location of each device or workstation on the Internet. For example, 9.67.97.103 is an IP address.

interrupt request (IRQ). A type of input found on many processors that causes the processor to suspend normal processing temporarily and start running an interrupt handler routine. Some processors have several interrupt request inputs that allow different priority interrupts.

IP. See *Internet Protocol*.

IPL. See *initial program load*.

IRQ. See *interrupt request*.

ISA. See *Industry Standard Architecture*.

Java Runtime Environment (JRE). A subset of the Java Development Kit (JDK) for end users and developers who want to redistribute the Java Runtime Environment (JRE). The JRE consists of the Java virtual machine, the Java Core Classes, and supporting files.

JRE. See *Java Runtime Environment*.

label. A discovered or user entered property value that is displayed underneath each device in the Physical and Data Path maps.

LAN. See *local area network*.

LBA. See *logical block address*.

local area network (LAN). A computer network located on a user's premises within a limited geographic area.

logical block address (LBA). The address of a logical block. Logical block addresses are typically used in hosts' I/O commands. The SCSI disk command protocol, for example, uses logical block addresses.

logical partition (LPAR). (1) A subset of a single system that contains resources (processors, memory, and input/output devices). A logical partition operates as an independent system. If hardware requirements are met, multiple logical partitions can exist within a system. (2) A fixed-size portion of a logical volume. A logical partition is the same size as the physical partitions in its volume group. Unless the logical volume of which it is a part is mirrored, each logical partition corresponds to, and its contents are stored on, a single physical partition. (3) One to three physical partitions (copies). The number of logical partitions within a logical volume is variable.

logical unit number (LUN). An identifier used on a small computer system interface (SCSI) bus to distinguish among up to eight devices (logical units) with the same SCSI ID.

loop address. The unique ID of a node in fibre-channel loop topology sometimes referred to as a loop ID.

loop group. A collection of storage area network (SAN) devices that are interconnected serially in a single loop circuit.

loop port. A node port (N_port) or fabric port (F_port) that supports arbitrated loop functions associated with an arbitrated loop topology.

LPAR. See *logical partition*.

LUN. See *logical unit number*.

MAC. See *medium access control*.

management information base (MIB). The information that is on an agent. It is an abstraction of configuration and status information.

man pages. In UNIX-based operating systems, online documentation for operating system commands, subroutines, system calls, file formats, special files, stand-alone utilities, and miscellaneous facilities. Invoked by the **man** command.

MCA. See *micro channel architecture*.

media scan. A media scan is a background process that runs on all logical drives in the storage subsystem for which it has been enabled, providing error detection on the drive media. The media scan process scans all logical drive data to verify that it can be accessed, and optionally scans the logical drive redundancy information.

medium access control (MAC). In local area networks (LANs), the sublayer of the data link control layer that supports medium-dependent functions and uses the services of the physical layer to provide services to the logical link control sublayer. The MAC sublayer includes the method of determining when a device has access to the transmission medium.

Metro Mirroring. This term is used to refer to a remote logical drive mirror pair which is set up with synchronous write mode. See also *remote mirroring*, *Global Mirroring*.

MIB. See *management information base*.

micro channel architecture (MCA). Hardware that is used for PS/2 Model 50 computers and above to provide better growth potential and performance characteristics when compared with the original personal computer design.

Microsoft Cluster Server (MSCS). MSCS, a feature of Windows NT Server (Enterprise Edition), supports the connection of two servers into a cluster for higher availability and easier manageability. MSCS can automatically detect and recover from server or

application failures. It can also be used to balance server workload and provide for planned maintenance.

mini hub. An interface card or port device that receives short-wave fiber channel GBICs or SFPs. These devices enable redundant fibre channel connections from the host computers, either directly or through a fibre channel switch or managed hub, over optical fiber cables to the DS4000 Storage Server controllers. Each DS4000 controller is responsible for two mini hubs. Each mini hub has two ports. Four host ports (two on each controller) provide a cluster solution without use of a switch. Two host-side mini hubs are shipped as standard. See also *host port, gigabit interface converter (GBIC), small form-factor pluggable (SFP)*.

mirroring. A fault-tolerance technique in which information on a hard disk is duplicated on additional hard disks. See also *remote mirroring*.

model. The model identification that is assigned to a device by its manufacturer.

MSCS. See *Microsoft Cluster Server*.

network management station (NMS). In the Simple Network Management Protocol (SNMP), a station that runs management application programs that monitor and control network elements.

NMI. See *non-maskable interrupt*.

NMS. See *network management station*.

non-maskable interrupt (NMI). A hardware interrupt that another service request cannot overrule (mask). An NMI bypasses and takes priority over interrupt requests generated by software, the keyboard, and other such devices and is issued to the microprocessor only in disastrous circumstances, such as severe memory errors or impending power failures.

node. A physical device that allows for the transmission of data within a network.

node port (N_port). A fibre-channel defined hardware entity that performs data communications over the fibre-channel link. It is identifiable by a unique worldwide name. It can act as an originator or a responder.

nonvolatile storage (NVS). A storage device whose contents are not lost when power is cut off.

N_port. See *node port*.

NVS. See *nonvolatile storage*.

NVSRAM. Nonvolatile storage random access memory. See *nonvolatile storage*.

Object Data Manager (ODM). An AIX proprietary storage mechanism for ASCII stanza files that are edited as part of configuring a drive into the kernel.

ODM. See *Object Data Manager*.

out-of-band. Transmission of management protocols outside of the fibre-channel network, typically over Ethernet.

partitioning. See *storage partition*.

parity check. (1) A test to determine whether the number of ones (or zeros) in an array of binary digits is odd or even. (2) A mathematical operation on the numerical representation of the information communicated between two pieces. For example, if parity is odd, any character represented by an even number has a bit added to it, making it odd, and an information receiver checks that each unit of information has an odd value.

PCI local bus. See *peripheral component interconnect local bus*.

PDF. See *portable document format*.

performance events. Events related to thresholds set on storage area network (SAN) performance.

peripheral component interconnect local bus (PCI local bus). A local bus for PCs, from Intel, that provides a high-speed data path between the CPU and up to 10 peripherals (video, disk, network, and so on). The PCI bus coexists in the PC with the Industry Standard Architecture (ISA) or Extended Industry Standard Architecture (EISA) bus. ISA and EISA boards plug into an IA or EISA slot, while high-speed PCI controllers plug into a PCI slot. See also *Industry Standard Architecture*, *Extended Industry Standard Architecture*.

polling delay. The time in seconds between successive discovery processes during which discovery is inactive.

port. A part of the system unit or remote controller to which cables for external devices (such as display stations, terminals, printers, switches, or external storage units) are attached. The port is an access point for data entry or exit. A device can contain one or more ports.

portable document format (PDF). A standard specified by Adobe Systems, Incorporated, for the electronic distribution of documents. PDF files are compact; can be distributed globally by e-mail, the Web, intranets, or CD-ROM; and can be viewed with the Acrobat Reader, which is software from Adobe Systems that can be downloaded at no cost from the Adobe Systems home page.

premium feature key. A file that the storage subsystem controller uses to enable an authorized premium feature. The file contains the feature enable identifier of the storage subsystem for which the

premium feature is authorized, and data about the premium feature. See also *feature enable identifier*.

private loop.   A freestanding arbitrated loop with no fabric attachment. See also *arbitrated loop*.

program temporary fix (PTF).   A temporary solution or bypass of a problem diagnosed by IBM in a current unaltered release of the program.

PTF.   See *program temporary fix*.

RAID.   See *redundant array of independent disks (RAID)*.

RAID level.   An array's RAID level is a number that refers to the method used to achieve redundancy and fault tolerance in the array. See also *array, redundant array of independent disks (RAID)*.

RAID set.   See *array*.

RAM.   See *random-access memory*.

random-access memory (RAM).   A temporary storage location in which the central processing unit (CPU) stores and executes its processes. Contrast with *DASD*.

RDAC.   See *redundant disk array controller*.

read-only memory (ROM).   Memory in which stored data cannot be changed by the user except under special conditions.

recoverable virtual shared disk (RVSD).   A virtual shared disk on a server node configured to provide continuous access to data and file systems in a cluster.

redundant array of independent disks (RAID).   A collection of disk drives (*array*) that appears as a single volume to the server, which is fault tolerant through an assigned method of data striping, mirroring, or parity checking. Each array is assigned a RAID level, which is a specific number that refers to the method used to achieve redundancy and fault tolerance. See also *array, parity check, mirroring, RAID level, striping*.

redundant disk array controller (RDAC).   (1) In hardware, a redundant set of controllers (either active/passive or active/active). (2) In software, a layer that manages the input/output (I/O) through the active controller during normal operation and transparently reroutes I/Os to the other controller in the redundant set if a controller or I/O path fails.

remote mirroring.   Online, real-time replication of data between storage subsystems that are maintained on separate media. The Enhanced Remote Mirror Option is a DS4000 premium feature that provides support for remote mirroring. See also *Global Mirroring*, *Metro Mirroring*.

ROM.   See *read-only memory*.

router.   A computer that determines the path of network traffic flow. The path selection is made from several paths based on information obtained from specific protocols, algorithms that attempt to identify the shortest or best path, and other criteria such as metrics or protocol-specific destination addresses.

RVSD.   See *recoverable virtual shared disk*.

SAI.   See *Storage Array Identifier*.

SA Identifier.   See *Storage Array Identifier*.

SAN.   See *storage area network*.

SATA.   See *serial ATA*.

scope.   Defines a group of controllers by their Internet Protocol (IP) addresses. A scope must be created and defined so that dynamic IP addresses can be assigned to controllers on the network.

SCSI.   See *small computer system interface*.

segmented loop port (SL_port).   A port that allows division of a fibre-channel private loop into multiple segments. Each segment can pass frames around as an independent loop and can connect through the fabric to other segments of the same loop.

sense data.   (1) Data sent with a negative response, indicating the reason for the response. (2) Data describing an I/O error. Sense data is presented to a host system in response to a sense request command.

serial ATA.   The standard for a high-speed alternative to small computer system interface (SCSI) hard drives. The SATA-1 standard is equivalent in performance to a 10 000 RPM SCSI drive.

serial storage architecture (SSA).   An interface specification from IBM in which devices are arranged in a ring topology. SSA, which is compatible with small computer system interface (SCSI) devices, allows full-duplex packet multiplexed serial data transfers at rates of 20 Mbps in each direction.

server.   A functional hardware and software unit that delivers shared resources to workstation client units on a computer network.

server/device events.   Events that occur on the server or a designated device that meet criteria that the user sets.

SFP.   See *small form-factor pluggable*.

Simple Network Management Protocol (SNMP).   In the Internet suite of protocols, a network management protocol that is used to monitor routers and attached networks. SNMP is an application layer protocol. Information on devices managed is defined and stored in the application's Management Information Base (MIB).

SL_port. See *segmented loop port*.

SMagent. The DS4000 Storage Manager optional Java-based host-agent software, which can be used on Microsoft Windows, Novell NetWare, HP-UX, and Solaris host systems to manage storage subsystems through the host fibre-channel connection.

SMclient. The DS4000 Storage Manager client software, which is a Java-based graphical user interface (GUI) that is used to configure, manage, and troubleshoot storage servers and storage expansion enclosures in a DS4000 storage subsystem. SMclient can be used on a host system or on a storage management station.

SMruntime. A Java compiler for the SMclient.

SMutil. The DS4000 Storage Manager utility software that is used on Microsoft Windows, HP-UX, and Solaris host systems to register and map new logical drives to the operating system. In Microsoft Windows, it also contains a utility to flush the cached data of the operating system for a particular drive before creating a FlashCopy.

small computer system interface (SCSI). A standard hardware interface that enables a variety of peripheral devices to communicate with one another.

small form-factor pluggable (SFP). An optical transceiver that is used to convert signals between optical fiber cables and switches. An SFP is smaller than a gigabit interface converter (GBIC). See also *gigabit interface converter*.

SNMP. See *Simple Network Management Protocol* and *SNMPv1*.

SNMP trap event. (1) (2) An event notification sent by the SNMP agent that identifies conditions, such as thresholds, that exceed a predetermined value. See also *Simple Network Management Protocol*.

SNMPv1. The original standard for SNMP is now referred to as SNMPv1, as opposed to SNMPv2, a revision of SNMP. See also *Simple Network Management Protocol*.

SRAM. See *static random access memory*.

SSA. See *serial storage architecture*.

static random access memory (SRAM). Random access memory based on the logic circuit know as flip-flop. It is called static because it retains a value as long as power is supplied, unlike dynamic random access memory (DRAM), which must be regularly refreshed. It is however, still volatile, meaning that it can lose its contents when the power is turned off.

storage area network (SAN). A dedicated storage network tailored to a specific environment, combining servers, storage products, networking products, software, and services. See also *fabric*.

Storage Array Identifier (SAI or SA Identifier). The Storage Array Identifier is the identification value used by the DS4000 Storage Manager host software (SMClient) to uniquely identify each managed storage server. The DS4000 Storage Manager SMClient program maintains Storage Array Identifier records of previously-discovered storage servers in the host resident file, which allows it to retain discovery information in a persistent fashion.

storage expansion enclosure (EXP). A feature that can be connected to a system unit to provide additional storage and processing capacity.

storage management station. A system that is used to manage the storage subsystem. A storage management station does not need to be attached to the storage subsystem through the fibre-channel input/output (I/O) path.

storage partition. Storage subsystem logical drives that are visible to a host computer or are shared among host computers that are part of a host group.

storage partition topology. In the DS4000 Storage Manager client, the Topology view of the Mappings window displays the default host group, the defined host group, the host computer, and host-port nodes. The host port, host computer, and host group topological elements must be defined to grant access to host computers and host groups using logical drive-to-LUN mappings.

striping. Splitting data to be written into equal blocks and writing blocks simultaneously to separate disk drives. Striping maximizes performance to the disks. Reading the data back is also scheduled in parallel, with a block being read concurrently from each disk then reassembled at the host.

subnet. An interconnected but independent segment of a network that is identified by its Internet Protocol (IP) address.

sweep method. A method of sending Simple Network Management Protocol (SNMP) requests for information to all the devices on a subnet by sending the request to every device in the network.

switch. A fibre-channel device that provides full bandwidth per port and high-speed routing of data by using link-level addressing.

switch group. A switch and the collection of devices connected to it that are not in other groups.

switch zoning. See *zoning*.

synchronous write mode. In remote mirroring, an option that requires the primary controller to wait for the

acknowledgment of a write operation from the secondary controller before returning a write I/O request completion to the host. See also *asynchronous write mode*, *remote mirroring*, *Metro Mirroring*.

system name.   Device name assigned by the vendor's third-party software.

TCP.   See *Transmission Control Protocol*.

TCP/IP.   See *Transmission Control Protocol/Internet Protocol*.

terminate and stay resident program (TSR program).   A program that installs part of itself as an extension of DOS when it is executed.

topology.   The physical or logical arrangement of devices on a network. The three fibre-channel topologies are fabric, arbitrated loop, and point-to-point. The default topology for the disk array is arbitrated loop.

TL_port.   See *translated loop port*.

transceiver.   A device that is used to transmit and receive data. Transceiver is an abbreviation of transmitter-receiver.

translated loop port (TL_port).   A port that connects to a private loop and allows connectivity between the private loop devices and off loop devices (devices not connected to that particular TL_port).

Transmission Control Protocol (TCP).   A communication protocol used in the Internet and in any network that follows the Internet Engineering Task Force (IETF) standards for internetwork protocol. TCP provides a reliable host-to-host protocol between hosts in packed-switched communication networks and in interconnected systems of such networks. It uses the Internet Protocol (IP) as the underlying protocol.

Transmission Control Protocol/Internet Protocol (TCP/IP).   A set of communication protocols that provide peer-to-peer connectivity functions for both local and wide-area networks.

trap.   In the Simple Network Management Protocol (SNMP), a message sent by a managed node (agent function) to a management station to report an exception condition.

trap recipient.   Receiver of a forwarded Simple Network Management Protocol (SNMP) trap. Specifically, a trap receiver is defined by an Internet Protocol (IP) address and port to which traps are sent. Presumably, the actual recipient is a software application running at the IP address and listening to the port.

TSR program.   See *terminate and stay resident program*.

uninterruptible power supply.   A source of power from a battery that is installed between a computer system and its power source. The uninterruptible power supply keeps the system running if a commercial power failure occurs, until an orderly shutdown of the system can be performed.

user action events.   Actions that the user takes, such as changes in the storage area network (SAN), changed settings, and so on.

worldwide port name (WWPN).   A unique identifier for a switch on local and global networks.

worldwide name (WWN).   A globally unique 64-bit identifier assigned to each Fibre Channel port.

WORM.   See *write-once read-many*.

write-once read many (WORM).   Any type of storage medium to which data can be written only a single time, but can be read from any number of times. After the data is recorded, it cannot be altered.

WWN.   See *worldwide name*.

zoning.   (1) In Fibre Channel environments, the grouping of multiple ports to form a virtual, private, storage network. Ports that are members of a zone can communicate with each other, but are isolated from ports in other zones. (2) A function that allows segmentation of nodes by address, name, or physical port and is provided by fabric switches or hubs.

Index

A

C

D

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