

IBM System Storage SAN Volume Controller



Software Installation and Configuration Guide

Version 4.3.1

IBM System Storage SAN Volume Controller



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Note:

Before using this information and the product it supports, read the information in **Notices**.

This edition applies to the IBM System Storage SAN Volume Controller, release 4.3.1, and to all subsequent releases and modifications until otherwise indicated in new editions. This edition replaces SC23-6628-02.

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About this guide

This publication provides information that helps you configure and use the IBM® System Storage™ SAN Volume Controller.

This publication also describes the configuration tools, both command-line and Web-based, that you can use to define, expand, and maintain the storage of the SAN Volume Controller.

Who should use this guide

This guide is intended for system administrators or others who install and use the IBM System Storage SAN Volume Controller.

Before using the SAN Volume Controller, you should have an understanding of storage area networks (SANs), the storage requirements of your enterprise, and the capabilities of your storage units.

Summary of changes

This summary of changes describes new functions that have been added to this release. Technical changes or additions to the text and illustrations are indicated by a vertical line to the left of the change. This document also contains terminology, maintenance, and editorial changes.

Summary of changes for SC23-6628-03 SAN Volume Controller Software Installation and Configuration Guide

This summary of changes provides a list of new, modified, and changed information since the last version of the guide. This topic describes the changes to this guide since the previous edition, SC23-6628-02.

New information

The following sections summarize the changes that have since been implemented from the previous version.

This version includes the following new information:

- Information about the new SAN Volume Controller hardware model 2145-8A4.
- New Capacity Licensing and Physical Disk Licensing options.
- Information about the newly supported IBM XIV systems.
- Support details for IBM System Storage DS5000.
- Back-end storage requirements for FlashCopy, Metro Mirror and Global Mirror, and space-efficient VDisks.
- Support for N-port virtualization in the host bus adapter or SAN switch.
- Usage information for the new recover VDisk commands.
- New licensing and hardware error codes.
- New event and reason codes.

Changed information

This section lists the updates that were made in this document.

- Change in terminology from storage subsystem to storage system.
- Updates to the space-efficient VDisks overview.
- Updates to Brocade core-edge fabrics support.

Removed Information

This section lists information that was removed from this book.

- Information about the master console was moved to the new *IBM System Storage SAN Volume Controller Master Console Guide*, which is available at the following Web site:

www.ibm.com/storage/support/2145

Summary of changes for SC23-6628-02 SAN Volume Controller Software Installation and Configuration Guide

This summary of changes provides a list of new, modified, and changed information since the last version of the guide.

New information

This topic describes the changes to this guide since the previous edition, SC23-6628-01. The following sections summarize the changes that have since been implemented from the previous version.

This version includes the following new information:

- VDisk mirroring is now supported.
- Space-efficient virtual disks are now supported.
- Automatic expansion of virtual disks is now supported.
- Pillar Axiom systems are now supported.
- IBM System Storage Productivity Center has replaced the master console that was offered in previous releases.
- The Internet Protocol Version 6 (IPv6) standard is now supported in addition to the Internet Protocol Version 4 (IPv4) standard.

Changed information

This section lists the updates that were made in this document.

- Information about the improvements to the front-panel displays to more easily display and edit the node's WWNN
- Information about Copy Services, creating clusters, using the SAN Volume Controller Console, upgrading the SAN Volume Controller, and replacing or adding nodes to an existing cluster

Removed Information

This section lists information that was removed from this book.

- Information about the master console has been moved to a separate document.

Emphasis

Different typefaces are used in this guide to show emphasis.

The following typefaces are used to show emphasis:

Boldface	Text in boldface represents menu items and command names.
<i>Italics</i>	Text in <i>italics</i> is used to emphasize a word. In command syntax, it is used for variables for which you supply actual values, such as a default directory or the name of a cluster.
Monospace	Text in monospace identifies the data or commands that you type, samples of command output, examples of program code or messages from the system, or names of command flags, parameters, arguments, and name-value pairs.

Numbering conventions

A specific numbering convention is used in this guide and product.

The following numbering conventions are used in this guide and in the product:

- 1 kilobyte (KB) is equal to 1024 bytes
- 1 megabyte (MB) is equal to 1 048 576 bytes
- 1 gigabyte (GB) is equal to 1 073 741 824 bytes
- 1 terabyte (TB) is equal to 1 099 511 627 776 bytes
- 1 petabyte (PB) is equal to 1 125 899 906 842 624 bytes

SAN Volume Controller library and related publications

A list of other publications that are related to this product are provided to you for your reference.

The tables in this section list and describe the following publications:

- The publications that make up the library for the IBM System Storage SAN Volume Controller
- Other IBM publications that relate to the SAN Volume Controller

SAN Volume Controller library

The following table lists and describes the publications that make up the SAN Volume Controller library. Unless otherwise noted, these publications are available in Adobe® portable document format (PDF) from the following Web site:

www.ibm.com/storage/support/2145

Title	Description	Order number
<i>IBM System Storage SAN Volume Controller Planning Guide</i>	This guide introduces the SAN Volume Controller and lists the features you can order. It also provides guidelines for planning the installation and configuration of the SAN Volume Controller.	GA32-0551
<i>IBM System Storage SAN Volume Controller Model 2145-8A4 Hardware Installation Guide</i>	This guide provides the instructions that the IBM service representative uses to install the hardware for SAN Volume Controller model 2145-8A4.	GC27-2219
<i>IBM System Storage SAN Volume Controller Model 2145-8G4 Hardware Installation Guide</i>	This guide provides the instructions that the IBM service representative uses to install the hardware for SAN Volume Controller model 2145-8G4.	GC27-2220
<i>IBM System Storage SAN Volume Controller Software Installation and Configuration Guide</i>	This guide provides guidelines for configuring your SAN Volume Controller. Instructions for backing up and restoring the cluster configuration, using and upgrading the SAN Volume Controller Console, using the CLI, upgrading the SAN Volume Controller software, and replacing or adding nodes to a cluster are included.	SC23-6628
<i>IBM System Storage SAN Volume Controller CIM Agent Developer's Guide</i>	This guide describes the concepts of the Common Information Model (CIM) environment. Steps about using the CIM agent object class instances to complete basic storage configuration tasks, establishing new Copy Services relationships, and performing CIM agent maintenance and diagnostic tasks are included.	SC23-6665
<i>IBM System Storage SAN Volume Controller Command-Line Interface User's Guide</i>	This guide describes the commands that you can use from the SAN Volume Controller command-line interface (CLI).	SC26-7903
<i>IBM System Storage SAN Volume Controller Host Attachment Guide</i>	This guide provides guidelines for attaching the SAN Volume Controller to your host system.	SC26-7905

Title	Description	Order number
<i>IBM System Storage SAN Volume Controller Troubleshooting Guide</i>	This guide describes the features of each SAN Volume Controller model, explains how to use the front panel, and provides maintenance analysis procedures to help you diagnose and solve problems with the SAN Volume Controller.	GC27-2227
<i>IBM System Storage SAN Volume Controller Hardware Maintenance Guide</i>	This guide provides the instructions that the IBM service representative uses to service the SAN Volume Controller hardware, including the removal and replacement of parts.	GC27-2226
<i>IBM System Storage SAN Volume Controller Models 2145-8F2 and 2145-8F4 Hardware Installation Guide</i>	This guide provides the instructions that the IBM service representative uses to install the hardware for SAN Volume Controller models 2145-8F2 and 2145-8F4.	GC27-2221
<i>IBM System Storage SAN Volume Controller Model 2145-4F2 Hardware Installation Guide</i>	This guide provides the instructions that the IBM service representative uses to install the hardware for SAN Volume Controller model 2145-4F2.	GC27-2222
<i>IBM System Storage SAN Volume Controller Master Console Guide</i>	This guide describes how to install, maintain, and service the master console.	GC27-2223
<i>IBM Systems Safety Notices</i>	This guide contains translated caution and danger statements. Each caution and danger statement in the SAN Volume Controller documentation has a number that you can use to locate the corresponding statement in your language in the <i>IBM Systems Safety Notices</i> document.	G229-9054

Other IBM publications

The following table lists and describes other IBM publications that contain additional information that is related to the SAN Volume Controller.

You can download IBM eServer™ IBM xSeries® and IBM System x™ publications from the following Web site:

Title	Description	Order number
<i>IBM System Storage Productivity Center Introduction and Planning Guide</i>	This guide introduces the IBM System Storage Productivity Center hardware and software.	SC23-8824
<i>Read This First: Installing the IBM System Storage Productivity Center</i>	This guide describes how to install the IBM System Storage Productivity Center hardware.	GI11-8938
<i>IBM System Storage Productivity Center User's Guide</i>	This guide describes how to configure the IBM System Storage Productivity Center software.	SC27-2336
<i>IBM System Storage Multipath Subsystem Device Driver User's Guide</i>	This guide describes the IBM System Storage Multipath Subsystem Device Driver for IBM System Storage products and how to use it with the SAN Volume Controller.	GC52-1309
<i>IBM System Storage DS Storage Manager Version 10.30 Installation and Host Support Guide</i>	This guide provides information about how to plan, install, configure, and work with IBM System Storage DS™ Storage Manager.	GC53-1135
<i>IBM System Storage DS Storage Manager Version 10.30 Copy Services Guide</i>	This guide provides information about setting up, installing, configuring, and working with the three IBM System Storage DS Storage Manager premium features that assist with copy services: FlashCopy®, VolumeCopy, and the Enhanced Remote Mirroring Option.	GC53-1136
<i>IBM System Storage DS4000/DS5000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview</i>	This overview describes how to install the IBM System Storage DS4000/DS5000 Fibre Channel and Serial ATA Intermix Premium Feature.	GC53-1137
<i>IBM System Storage DS5100 and DS5300 Installation, User's and Maintenance Guide</i>	This guide describes how to install and configure the IBM System Storage DS5100 and DS5300.	GC53-1140
<i>IBM System Storage EXP5000 Storage Expansion Enclosure Installation, User's, and Maintenance Guide</i>	This guide describes how to install and configure the IBM System Storage EXP5000 Storage Expansion Enclosure.	GC53-1141
<i>IBM System Storage DS Storage Manager Command-line Programming Guide</i>	This guide describes the commands that you can use from the IBM System Storage DS Storage Manager command-line interface.	GC52-1275

Title	Description	Order number
<i>IBM System Storage DS5000 Quick Start Guide: Quick Reference for the DS5100, DS5300 and EXP5000</i>	This guide provides information about setting up and installing the DS5100, DS5300 and EXP5000.	GC53-1134
<i>IBM TotalStorage DS4300 Fibre Channel Storage Subsystem Installation, User's, and Maintenance Guide</i>	This guide describes how to install and configure the IBM TotalStorage® DS4300 Fibre-Channel Storage Subsystem.	GC26-7722
<i>IBM eServer xSeries 306m (Types 8849 and 8491) Installation Guide</i>	This guide describes how to install the IBM eServer xSeries 306m, which is the hardware delivered for some versions of the hardware master console.	MIGR-61615
<i>IBM xSeries 306m (Types 8849 and 8491) User's Guide</i>	This guide describes how to use the IBM eServer xSeries 306m, which is the hardware delivered for some versions of the hardware master console.	MIGR-61901
<i>IBM xSeries 306m (Types 8849 and 8491) Problem Determination and Service Guide</i>	This guide can help you troubleshoot and resolve problems with the IBM eServer xSeries 306m, which is the hardware delivered for some versions of the hardware master console.	MIGR-62594
<i>IBM eServer xSeries 306 (Type 8836) Installation Guide</i>	This guide describes how to install the IBM eServer xSeries 306, which is the hardware delivered for some versions of the hardware master console.	MIGR-55080
<i>IBM eServer xSeries 306 (Type 8836) User's Guide</i>	This guide describes how to use the IBM eServer xSeries 306, which is the hardware delivered for some versions of the hardware master console.	MIGR-55079
<i>IBM eServer xSeries 306 (Types 1878, 8489 and 8836) Hardware Maintenance Manual and Troubleshooting Guide</i>	This guide can help you troubleshoot problems and maintain the IBM eServer xSeries 306, which is the hardware delivered for some versions of the hardware master console.	MIGR-54820
<i>IBM eServer xSeries 305 (Type 8673) Installation Guide</i>	This guide describes how to install the IBM eServer xSeries 305, which is the hardware delivered for some versions of the hardware master console.	MIGR-44200

Title	Description	Order number
<i>IBM eServer xSeries 305 (Type 8673) User's Guide</i>	This guide describes how to use the IBM eServer xSeries 305, which is the hardware delivered for some versions of the hardware master console.	MIGR-44199
<i>IBM eServer xSeries 305 (Type 8673) Hardware Maintenance Manual and Troubleshooting Guide</i>	This guide can help you troubleshoot problems and maintain the IBM eServer xSeries 305, which is the hardware delivered for some versions of the hardware master console.	MIGR-44094
<i>IBM TotalStorage 3534 Model F08 SAN Fibre Channel Switch User's Guide</i>	This guide introduces the IBM TotalStorage SAN Switch 3534 Model F08.	GC26-7454
<i>IBM System x3250 (Types 4364 and 4365) Installation Guide</i>	This guide describes how to install the IBM System x3250, which is the hardware delivered for some versions of the hardware master console.	MIGR-5069761
<i>IBM System x3250 (Types 4364 and 4365) User's Guide</i>	This guide describes how to use the IBM System x3250, which is the hardware delivered for some versions of the hardware master console.	MIGR-66373
<i>IBM System x3250 (Types 4364 and 4365) Problem Determination and Service Guide</i>	This guide can help you troubleshoot and resolve problems with the IBM System x3250, which is the hardware delivered for some versions of the hardware master console.	MIGR-66374
<i>IBM TotalStorage SAN Switch 2109 Model F16 User's Guide</i>	This guide introduces the IBM TotalStorage SAN Switch 2109 Model F16.	GC26-7439
<i>IBM TotalStorage SAN Switch 2109 Model F32 User's Guide</i>	This guide introduces the IBM TotalStorage SAN Switch 2109 Model F32. It also describes the features of the switch and tells you where to find more information about those features.	GC26-7517

Some related publications are available from the following SAN Volume Controller support Web site:

www.ibm.com/storage/support/2145

Related Web sites

The following Web sites provide information about the SAN Volume Controller or related products or technologies:

Type of information	Web site
SAN Volume Controller support	www.ibm.com/storage/support/2145
Technical support for IBM storage products	www.ibm.com/storage/support/

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SAN Volume Controller installation and configuration overview

The installation and configuration of a SAN Volume Controller cluster requires the completion of various tasks, some of which are normally completed by an IBM service representative.

Additional publications are included with some of the hardware components; however, use the installation and configuration procedures in the documents that are listed here.

When you plan or perform the installation and configuration tasks, have the following SAN Volume Controller publications available:

- *IBM System Storage SAN Volume Controller Planning Guide*
- *IBM System Storage SAN Volume Controller Hardware Installation Guide* for the model that was ordered.
- *IBM System Storage SAN Volume Controller Software Installation and Configuration Guide*

To access the SAN Volume Controller publications, click the product documentation link, and then click your language from the following Web site:

www.ibm.com/storage/support/2145

The IBM System Storage Productivity Center (SSPC) is the management environment for SAN Volume Controller clusters. For SSPC planning, installation, and configuration information, see the following publications:

- *IBM System Storage Productivity Center Introduction and Planning Guide*, SC23-8824
- *Read This First: Installing the IBM System Storage Productivity Center*, GI11-8938
- *IBM System Storage Productivity Center User's Guide*, SC27-2336

To access the SSPC publications, go to the **Printable PDFs** section and click the **IBM System Storage Productivity Center** link from the following Web site:

publib.boulder.ibm.com/infocenter/tivihelp/v4r1/index.jsp

Note: An existing master console can be upgraded to support clusters that are running the latest SAN Volume Controller software. See the *IBM System Storage SAN Volume Controller Master Console Guide* at the following Web site:

www.ibm.com/storage/support/2145

Planning tasks to complete before installing the SAN Volume Controller

Before you install the SAN Volume Controller, you must complete the following planning tasks or have them completed by an IBM service representative or IBM Business Partner:

1. **Verify that all the SAN Volume Controller installation requirements have been met.**

Review Chapter 2 of the *IBM System Storage SAN Volume Controller Planning Guide* to make sure that space and power requirements have been met before you begin the installation. SAN Volume Controller nodes and uninterruptible power supply units are installed in pairs.

2. **Review SAN fabric and zoning guidelines and develop your SAN Volume Controller cluster, host systems, and storage controllers plan.**

This task helps to assure a seamless configuration. For more information, see Chapters 3 and 4 of the *IBM System Storage SAN Volume Controller Planning Guide*.

3. **Complete all physical planning charts.**

Chapter 2 of the *IBM System Storage SAN Volume Controller Planning Guide* provides instructions for accessing and completing the following charts and tables:

- Hardware location chart
- Cable connection table
- Configuration data table
- Redundant ac-power connection chart

The SAN Volume Controller charts and tables are available at the following Web site:

www.ibm.com/storage/support/2145

You can save, edit, and share the charts and tables between members of the installation team.

For the SSPC, complete the planning worksheet in the Appendix of the *IBM System Storage Productivity Center Introduction and Planning Guide*.

Hardware installation tasks that an IBM service representative performs

To install the SAN Volume Controller hardware, an IBM service representative must complete the following tasks:

1. **Verify that you have all of the required parts for the installation.**

Chapter 2 of the *IBM System Storage SAN Volume Controller Hardware Installation Guide* provides a list of all the parts that are required for an installation. The list includes the SAN Volume Controller nodes, uninterruptible power supply units, optional redundant ac-power switches, and associated parts.

2. **Install the SAN Volume Controller hardware.**

Chapter 2 of the *IBM System Storage SAN Volume Controller Hardware Installation Guide* describes the procedures for installing the uninterruptible power supply units, SAN Volume Controller nodes, and the optional redundant ac-power switches.

3. **Install the SSPC server.**

Read This First: Installing the IBM System Storage Productivity Center describes how to install the SSPC server.

Configuration tasks

To configure a SAN Volume Controller cluster, you must complete the following tasks or have them completed by an IBM service representative or IBM Business Partner:

1. **Register your product.**

To receive product support notifications from IBM, you must register your product. To register your product, click **Register** at the following Web site:
www.ibm.com/systems/support/supportsite.wss/brandmain?brandind=5345868

2. **Optionally, check for an updated version of the SAN Volume Controller CIM agent and GUI software.**

For the latest information, click **Install/use**, and then click the link for the appropriate recommended software level from the following Web site:

www.ibm.com/storage/support/2145

Additionally, preinstalled software on the SSPC console might need to be updated to fully support the latest level of SAN Volume Controller. For the latest information, go to the following Web site:

www.ibm.com/systems/support/storage/software/sspc

3. **Configure the IBM System Storage Productivity Center.**

In the *IBM System Storage Productivity Center User's Guide*, the chapter about configuring the SSPC for the SAN Volume Controller describes the procedures for configuring the server and accessing the SAN Volume Controller Console and command-line interface (CLI). This chapter also describes how to use the PuTTY client to generate secure shell (SSH) key pairs that secure data flow between the SAN Volume Controller cluster configuration node and a client.

4. **Create a SAN Volume Controller cluster.**

Chapter 4 of the *IBM System Storage SAN Volume Controller Software Installation and Configuration Guide* describes this procedure, which is completed in two phases:

- a. Use the Create Cluster option on the front panel of one of the SAN Volume Controller nodes that you have installed to create the cluster.

This procedure is usually performed by an IBM representative or IBM Business Partner using information that the customer provides.

- b. Use the Add a Cluster function from the SAN Volume Controller Console.

5. **Complete the initial SAN Volume Controller configuration.**

After you create the SAN Volume Controller cluster, you must perform the configuration procedures that are needed to meet your requirements. You can perform these procedures in stages; for example, add nodes to a cluster, set cluster date and time, and set license features immediately. Later, after your applications are tested and migrated to SAN Volume Controller, create host definitions, assign managed disks (MDisks) to MDisk groups, and set up virtual disks (VDisks) and assign them to hosts.

You can also set up error and event notifications, including Call Home e-mails, to immediately notify you and the IBM Support Center if critical problems occur.

The following chapters include procedures for these tasks:

- Chapter 5 of the *IBM System Storage SAN Volume Controller Software Installation and Configuration Guide* describes how to perform these steps using the SAN Volume Controller Console.
- Chapter 6 of the *IBM System Storage SAN Volume Controller Software Installation and Configuration Guide* describes how to perform these steps using the CLI.

Chapter 1. SAN Volume Controller overview

The SAN Volume Controller combines software and hardware into a comprehensive, modular appliance that uses symmetric virtualization.

Symmetric virtualization is achieved by creating a pool of managed disks (MDisks) from the attached storage systems. Those storage systems are then mapped to a set of virtual disks (VDisks) for use by attached host systems. System administrators can view and access a common pool of storage on the storage area network (SAN). This functionality helps administrators to use storage resources more efficiently and provides a common base for advanced functions.

A SAN is a high-speed fibre-channel network that connects host systems and storage devices. In a SAN, a host system can be connected to a storage device across the network. The connections are made through units such as routers, gateways, hubs, and switches. The area of the network that contains these units is known as the *fabric* of the network.

SAN Volume Controller software

The SAN Volume Controller software performs the following functions for the host systems that attach to SAN Volume Controller over the SAN:

- Creates a single pool of storage
- Provides logical unit virtualization
- Manages logical volumes
- Mirrors logical volumes

The SAN Volume Controller also provides the following functions:

- Large scalable cache
- Copy Services
 - IBM FlashCopy[®] (point-in-time copy)
 - Metro Mirror (synchronous copy)
 - Global Mirror (asynchronous copy)
 - Data migration
- Space management
 - Mapping that is based on desired performance characteristics
 - Metering of service quality
 - Space-efficient logical volumes (thin provisioning)

SAN Volume Controller hardware

Each SAN Volume Controller node is an individual server in a SAN Volume Controller cluster on which the SAN Volume Controller software runs.

The nodes are always installed in pairs, with a minimum of one and a maximum of four pairs of nodes constituting a *cluster*. Each pair of nodes is known as an *I/O group*. All I/O operations that are managed by the nodes in an I/O group are cached on both nodes.

Note: I/O groups take the storage that is presented to the SAN by the storage systems as MDisks and translates the storage into logical disks, known as VDIsks, that are used by applications on the hosts. A node resides in only one I/O group and provides access to the VDIsks in that I/O group.

The SAN Volume Controller 2145-8A4 and the SAN Volume Controller 2145-8G4 models are currently available. In addition, the following models of SAN Volume Controller nodes have been available in previous releases and are still supported with the latest SAN Volume Controller software:

- SAN Volume Controller 2145-8F4
- SAN Volume Controller 2145-8F2
- SAN Volume Controller 2145-4F2

Virtualization

Virtualization is a concept that applies to many areas of the information technology industry.

For data storage, virtualization includes the creation of a pool of storage that contains several disk systems. These systems can be supplied from various vendors. The pool can be split into virtual disks (VDIsks) that are visible to the host systems that use them. Therefore, VDIsks can use mixed back-end storage and provide a common way to manage a storage area network (SAN).

Historically, the term *virtual storage* has described the virtual memory techniques that have been used in operating systems. The term *storage virtualization*, however, describes the shift from managing physical volumes of data to logical volumes of data. This shift can be made on several levels of the components of storage networks. Virtualization separates the representation of storage between the operating system and its users from the actual physical storage components. This technique has been used in mainframe computers for many years through methods such as system-managed storage and products like the IBM Data Facility Storage Management Subsystem (DFSMS). Virtualization can be applied at the following four main levels:

At the server level

Manages volumes on the operating systems servers. An increase in the amount of logical storage over physical storage is suitable for environments that do not have storage networks.

At the storage device level

Uses striping, mirroring and RAIDs to create disk systems. This type of virtualization can range from simple RAID controllers to advanced volume management such as that provided by the IBM TotalStorage Enterprise Storage Server® (ESS) or by Log Structured Arrays (LSA). The Virtual Tape Server (VTS) is another example of virtualization at the device level.

At the fabric level

Enables storage pools to be independent of the servers and the physical components that make up the storage pools. One management interface can be used to manage different storage systems without affecting the servers. The SAN Volume Controller performs virtualization at the fabric level.

At the file system level

Provides the highest benefit because data is shared, allocated, and protected at the data level rather than the volume level.

Virtualization is a radical departure from traditional storage management. In traditional storage management, storage is attached directly to a host system, which controls storage management. SANs introduced the principle of networks of storage, but storage is still primarily created and maintained at the RAID system level. Multiple RAID controllers of different types require knowledge of, and software that is specific to, the given hardware. Virtualization provides a central point of control for disk creation and maintenance.

One problem area that virtualization addresses is unused capacity. Before virtualization, individual host systems each had their own storage, which wasted unused storage capacity. Using virtualization, storage is pooled so that jobs from any attached system that need large amounts of storage capacity can use it as needed. Virtualization makes it easier to regulate the amount of available storage without having to use host system resources or to turn storage devices off and on to add or remove capacity. Virtualization also provides the capability to move storage between storage systems transparently to host systems.

Types of virtualization

Virtualization can be performed either asymmetrically or symmetrically. Figure 1 on page 4 provides a diagram of the levels of virtualization.

Asymmetric

A virtualization engine is outside the data path and performs a metadata style service.

Symmetric

A virtualization engine sits in the data path and presents disks to the hosts, but hides the physical storage from the hosts. Advanced functions, such as cache and Copy Services, can therefore be implemented in the engine itself.

Virtualization at any level provides benefits. When several levels are combined, the benefits of those levels can also be combined. For example, you can combine benefits by attaching a RAID controller to a virtualization engine that provides virtual volumes for a virtual file system.

Note: The SAN Volume Controller implements fabric-level *virtualization*. Within the context of the SAN Volume Controller and throughout this document, *virtualization* refers to symmetric fabric-level virtualization.

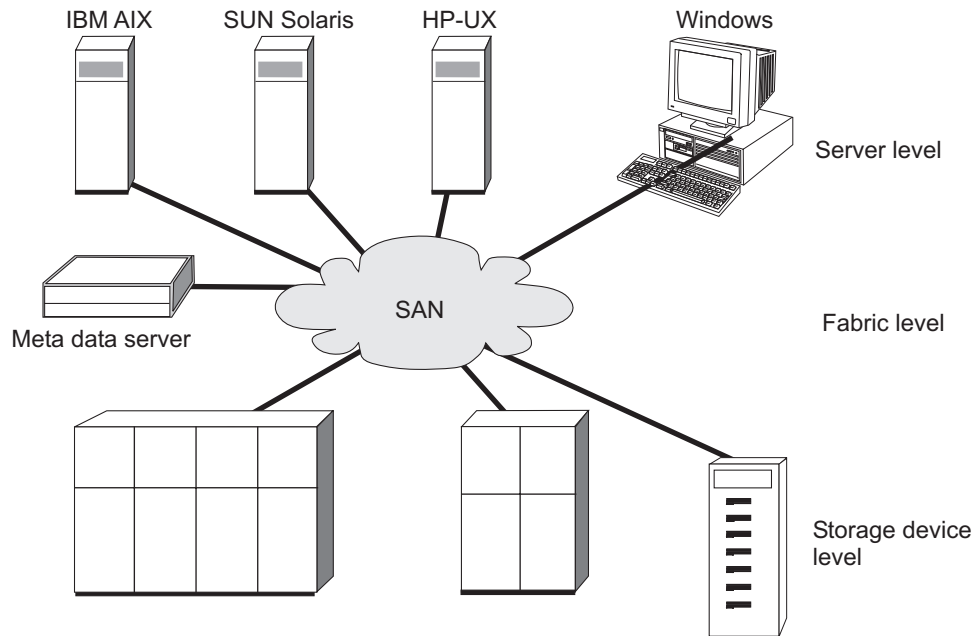


Figure 1. Levels of virtualization

Asymmetric virtualization

With asymmetric virtualization, the virtualization engine is outside the data path and performs a metadata-style service. The metadata server contains all the mapping and the locking tables while the storage devices contain only data.

In asymmetric virtual storage networks, the data flow, (2) in the Figure 2 on page 5, is separated from the control flow, (1). A separate network or SAN link is used for control purposes. The metadata server contains all the mapping and locking tables while the storage devices contain only data. Because the flow of control is separated from the flow of data, I/O operations can use the full bandwidth of the SAN. A separate network or SAN link is used for control purposes. However, there are disadvantages to asymmetric virtualization.

Asymmetric virtualization can have the following disadvantages:

- Data is at risk to increased security exposures, and the control network must be protected with a firewall.
- Metadata can become very complicated when files are distributed across several devices.
- Each host that accesses the SAN must know how to access and interpret the metadata. Specific device drivers or agent software must therefore be running on each of these hosts.
- The metadata server cannot run advanced functions such as caching or Copy Services because it only knows about the metadata and not about the data itself.

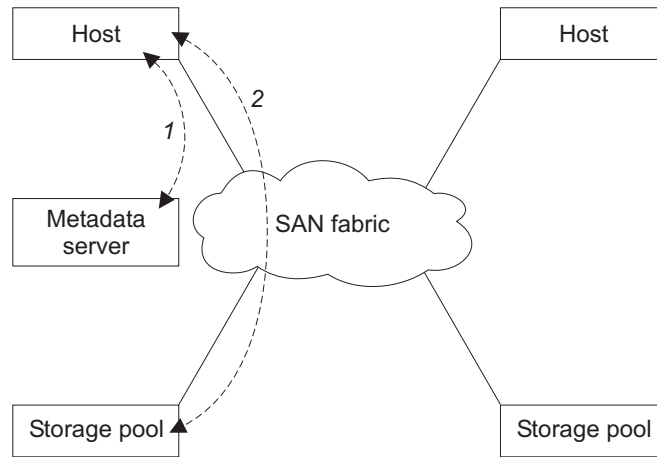


Figure 2. Asymmetrical virtualization

Symmetric virtualization

The SAN Volume Controller provides symmetric virtualization.

Virtualization splits the storage that is presented by the storage systems into smaller chunks that are known as extents. These extents are then concatenated, using various policies, to make virtual disks (VDisks). With symmetric virtualization, host systems can be isolated from the physical storage. Advanced functions, such as data migration, can run without the need to reconfigure the host. With symmetric virtualization, the virtualization engine is the central configuration point for the SAN.

Figure 3 shows that the storage is pooled under the control of the virtualization engine, because the separation of the control from the data occurs in the data path. The virtualization engine performs the logical-to-physical mapping.

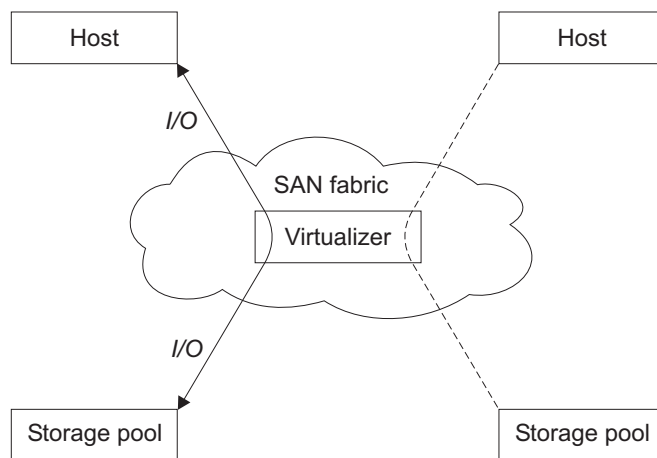


Figure 3. Symmetrical virtualization

The virtualization engine directly controls access to the storage and to the data that is written to the storage. As a result, locking functions that provide data integrity and advanced functions, such as cache and Copy Services, can be run in the

virtualization engine itself. Therefore, the virtualization engine is a central point of control for device and advanced function management. Symmetric virtualization allows you to build a firewall in the storage network. Only the virtualization engine can grant access through the firewall.

Symmetric virtualization can cause some problems. The main problem that is associated with symmetric virtualization is scalability. Scalability can cause poor performance because all input/output (I/O) must flow through the virtualization engine. To solve this problem, you can use an *n-way* cluster of virtualization engines that has failover capacity. You can scale the additional processor power, cache memory, and adapter bandwidth to achieve the desired level of performance. Additional memory and processing power are needed to run advanced services such as Copy Services and caching.

The SAN Volume Controller uses symmetric virtualization. Single virtualization engines, which are known as *nodes*, are combined to create *clusters*. Each cluster can contain between two and eight nodes.

SAN Volume Controller operating environment

To use the SAN Volume Controller, you must meet the minimum hardware and software requirements and ensure that other operating environment criteria are met.

Minimum requirements

You must set up your SAN Volume Controller operating environment according to the following requirements:

- Minimum of one pair of SAN Volume Controller nodes
- Minimum of two uninterruptible power supply units
- One IBM System Storage Productivity Center or one master console per SAN installation for configuration

Features of a SAN Volume Controller 2145-8A4 node

The SAN Volume Controller 2145-8A4 node has the following features:

- A 19-inch rack-mounted enclosure
- One 4-port 4 Gbps fibre-channel adapter (four fibre-channel ports)
- 8 GB cache memory
- One dual-core processor

Features of a SAN Volume Controller 2145-8G4 node

The SAN Volume Controller 2145-8G4 node has the following features:

- A 19-inch rack-mounted enclosure
- One 4-port 4 Gbps fibre-channel adapter (four fibre-channel ports)
- 8 GB cache memory
- Either two dual-core processors or one four-core processor

Supported hosts

In a SAN environment, hosts are the application servers that access their data from the storage controllers that are connected to the SAN. Hosts that are running in a

number of operating environments can connect to the storage through SAN Volume Controller. For a list of the supported host operating systems, go to the following Web site:

www.ibm.com/servers/storage/software/virtualization/svc

From the Web site, take the following steps:

1. In the **Learn more** column, click **Interoperability**.
2. Click **Recommended software levels** for your SAN Volume Controller code version.
3. Click **Multipathing / Host Drivers, Clustering and SAN Boot Support - By Host Operating System** to view a list of supported operating systems and to access host attachment scripts.

Multipathing software

For the most current information, go to the following Web site:

www.ibm.com/servers/storage/software/virtualization/svc

From the Web site, take the following steps:

1. In the **Learn more** column, click **Interoperability**.
2. Click **Recommended software levels** for your SAN Volume Controller code version.
3. Click **Multipathing / Host Drivers, Clustering and SAN Boot Support - By Host Operating System** to view a list of supported operating systems and to access multipath drivers. You can also view **Multipath Driver Co-existence with SDD** information.

User interfaces

The SAN Volume Controller software provides the following user interfaces:

- The SAN Volume Controller Console, a Web-accessible graphical user interface (GUI) that supports flexible and rapid access to storage management information
- A command-line interface (CLI) that uses Secure Shell (SSH)

Application programming interfaces

The SAN Volume Controller software provides an application programming interface called the Common Information Model (CIM) agent, which supports the Storage Management Initiative Specification (SMI-S) of the Storage Network Industry Association.

SAN Volume Controller objects

The SAN Volume Controller solution is based on a group of virtualization concepts. Before setting up your SAN Volume Controller environment, you should understand the concepts and the objects in the environment.

Each SAN Volume Controller is a single processing unit called a *node*. Nodes are deployed in pairs to make up a cluster. A cluster can consist of one to four pairs of nodes. Each pair of nodes is known as an *I/O group* and each node can be in only one I/O group.

Virtual disks (VDisks) are logical disks that are presented by the clusters. Each VDisk is associated with a particular I/O group. The nodes in the I/O group provide access to the VDIs in the I/O group. When an application server performs I/O to a VDisk, it can access the VDisk with either of the nodes in the I/O group. Because each I/O group has only two nodes, the distributed cache is only two-way.

Each node does not contain any internal battery backup units and therefore must be connected to an *uninterruptible power supply*, which provides data integrity in the event of a cluster wide power failure. In such situations, the uninterruptible power supply maintains power to the nodes while the contents of the distributed cache are dumped to an internal drive.

The nodes in a cluster see the storage that is presented by back-end *disk controllers* as a number of disks, known as *managed disks (MDisks)*.

Each MDisk is divided into a number of *extents* which are numbered, from 0, sequentially from the start to the end of the MDisk. MDisks are collected into groups, known as MDisk groups.

Each VDisk is made up of one or two VDisk copies. Each VDisk copy is an independent physical copy of the data that is stored on the VDisk. A VDisk with two copies is known as a *mirrored VDisk*. VDisk copies are made out of MDisk extents. All the MDisks that contribute to a particular VDisk copy must belong to the same MDisk group.

A VDisk can be space-efficient. This means that the capacity of the VDisk as seen by host systems, called the virtual capacity, can be different from the amount of storage that is allocated to the VDisk from MDisks, called the real capacity. Space-efficient VDIs can be configured to automatically expand their real capacity by allocating new extents.

At any one time, a single node in the cluster can manage configuration activity. This node is known as the *configuration node* and manages a cache of the information that describes the cluster configuration and provides a focal point for configuration.

The nodes detect the fibre-channel ports that are connected to the SAN. These correspond to the worldwide port names (WWPNs) of the host bus adapter (HBA) fibre-channels that are present in the application servers. You can create logical host objects that group WWPNs that belong to a single application server or to a set of them.

Application servers can only access VDIs that have been allocated to them. VDIs can be mapped to a host object. Mapping a VDisk to a host object makes the VDisk accessible to the WWPNs in that host object, and hence the application server itself.

The cluster provides block-level aggregation and volume management for disk storage within the SAN. The cluster manages a number of back-end storage controllers and maps the physical storage within those controllers into logical disk images that can be seen by application servers and workstations in the SAN. The SAN is configured in such a way that the application servers cannot see the back-end physical storage. This prevents any possible conflict between the cluster and the application servers both trying to manage the back-end storage.

Nodes and clusters

A SAN Volume Controller node is a single processing unit, which provides virtualization, cache, and copy services for the SAN.

Nodes are deployed in pairs called I/O groups. One node in the cluster is designated the configuration node but each node in the cluster holds a copy of the cluster state information.

Clusters

All of your configuration and service tasks are performed at the cluster level. Therefore, after configuring your cluster, you can take advantage of the virtualization and the advanced features of the SAN Volume Controller.

A cluster can consist of two nodes, with a maximum of eight nodes. Therefore, you can assign up to eight SAN Volume Controller nodes to one cluster.

All configurations are replicated across all nodes in the cluster; however, some service actions can be performed only at the node level. Because configuration is performed at the cluster level, an IP address is assigned to the cluster instead of each node.

Cluster configuration backup:

Cluster configuration backup is the process of extracting configuration data from a cluster and writing it to disk.

Backing up the cluster configuration enables you to restore your cluster configuration in the event that it is lost. Only the data that describes the cluster configuration is backed up. You must back up your application data using the appropriate backup methods.

Configuration restore:

Configuration restore is the process of using a backup cluster configuration data file or files to restore a specific cluster configuration.

Restoring the cluster configuration is an important part of a complete backup and disaster recovery solution. You must also regularly back up your application data using appropriate backup methods because you might need to restore your application data after you have restored your cluster configuration.

Cluster IP failover:

If the configuration node fails, the cluster IP address is transferred to a new node. The cluster services are used to manage the IP address transfer from the failed configuration node to the new configuration node.

The following changes are performed by the cluster service:

- If software on the failed configuration node is still operational, the software shuts down the IP interface. If the software cannot shut down the IP interface, the hardware service forces a shut down.
- When the IP interface shuts down, all remaining nodes choose a new node to host the configuration interface.
- The new configuration node initializes the configuration daemons, `sshd` and `httpd`, and then binds the configuration IP interface to its Ethernet port.

- The router is configured as the default gateway for the new configuration node.
- The new configuration node sends five unsolicited address resolution protocol (ARP) packets to the local subnet broadcast address. The ARP packets contain the cluster IP and the media access control (MAC) address for the new configuration node. All systems that receive ARP packets are forced to update their ARP tables. Once the ARP tables are updated, these systems can connect to the new configuration node.

Note: Some Ethernet devices might not forward ARP packets. If the ARP packets are not forwarded, connectivity to the new configuration node cannot be established automatically. To avoid this problem, configure all Ethernet devices to pass unsolicited ARP packets. You can restore lost connectivity by logging into the SAN Volume Controller and starting a secure copy to the affected system. Starting a secure copy forces an update to the ARP cache for all systems connected to the same switch as the affected system.

Ethernet link failures

If the Ethernet link to the SAN Volume Controller cluster fails because of an event unrelated to the SAN Volume Controller itself, such as a cable being disconnected or an Ethernet router failure, the SAN Volume Controller does not attempt to failover the configuration node to restore IP access to the cluster.

Nodes

A SAN Volume Controller *node* is a single processing unit within a SAN Volume Controller cluster.

For redundancy, nodes are deployed in pairs to make up a cluster. A cluster can have one to four pairs of nodes. Each pair of nodes is known as an I/O group. Each node can be in *only* one I/O group. A maximum of four I/O groups each containing two nodes is supported.

At any one time, a single node in the cluster manages configuration activity. This configuration node manages a cache of the configuration information that describes the cluster configuration and provides a focal point for configuration commands. If the configuration node fails, another node in the cluster takes over its responsibilities.

Table 1 describes the operational states of a node.

Table 1. Node state

State	Description
Adding	The node was added to the cluster but is not yet synchronized with the cluster state (see Note). The node state changes to Online after synchronization is complete.
Deleting	The node is in the process of being deleted from the cluster.
Online	The node is operational, assigned to a cluster, and has access to the fibre-channel SAN fabric.
Offline	The node is not operational. The node was assigned to a cluster but is not available on the fibre-channel SAN fabric. Run the Directed Maintenance Procedures to determine the problem.

Table 1. Node state (continued)

State	Description
Pending	The node is transitioning between states and, in a few seconds, will move to one of the other states.
<p>Note: A node can stay in the Adding state for a long time. You should wait for at least 30 minutes before taking further action, but if after 30 minutes, the node state is still Adding, you can delete the node and add it again. If the node that has been added is at a lower code level than the rest of the cluster, the node is upgraded to the cluster code level, which can take up to 20 minutes. During this time, the node is shown as adding.</p>	

Configuration node:

A *configuration node* is a single node that manages configuration activity of the cluster.

If the configuration node fails, the cluster chooses a new configuration node. This action is called configuration node failover. The switch that contains the new node takes over the cluster IP address. Thus you can access the cluster through the same IP address although the original configuration node has failed. During the failover, there is a short period when you cannot use the command-line tools or SAN Volume Controller Console.

Figure 4 shows an example cluster containing four nodes. Node 1 has been designated the configuration node. User requests (1) are targeted at Node 1.

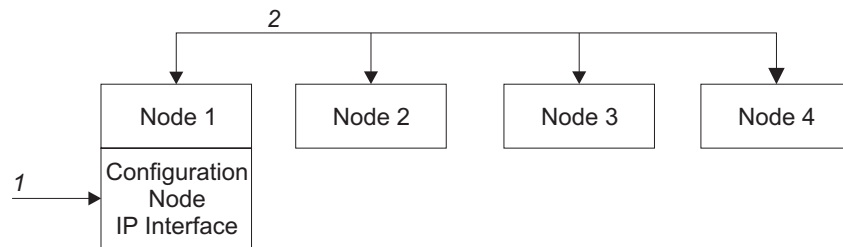


Figure 4. Configuration node

I/O groups and uninterruptible power supply

Nodes are deployed in pairs to make up a cluster. Each pair of nodes is known as an *I/O group*. Each node can only be in one I/O group.

Virtual disks (VDisks) are logical disks that are presented to the SAN by SAN Volume Controller nodes. VDisks are also associated with an I/O group. The SAN Volume Controller does not contain any internal battery backup units and therefore must be connected to an uninterruptible power supply to provide data integrity in the event of a cluster-wide power failure.

I/O groups

An *I/O group* is a group that is defined during the cluster configuration process.

Each node can only be in one I/O group. The I/O groups are connected to the SAN so that all backend storage and all application servers are visible to all of the I/O groups. Each pair of nodes has the responsibility to serve I/O operations on a particular virtual disk (VDisk).

VDisks are logical disks that are presented to the SAN by SAN Volume Controller nodes. VDisks are also associated with an I/O group. Nodes do not contain any internal battery backup units and therefore must be connected to an uninterruptible power supply to provide data integrity in the event of a cluster-wide power failure. The uninterruptible power supply only provides power long enough to enable the SAN Volume Controller cluster to shutdown and save cache data. The uninterruptible power supply is not intended to maintain power and keep the nodes running during an outage.

When an application server performs I/O to a VDisk, it has the choice of accessing the VDisk using either of the nodes in the I/O group. When the VDisk is created, you can specify a preferred node. After a preferred node is specified, you should only access the VDisk through the preferred node. Because each I/O group only has two nodes, the distributed cache in the SAN Volume Controller is 2-way. When I/O is performed to a VDisk, the node that processes the I/O duplicates the data onto the partner node that is in the I/O group.

I/O traffic for a particular VDisk is, at any one time, managed exclusively by the nodes in a single I/O group. Thus, although a cluster can have eight nodes within it, the nodes manage I/O in independent pairs. This means that the I/O capability of the SAN Volume Controller scales well, because additional throughput can be obtained by adding additional I/O groups.

Figure 5 shows a write operation from a host (1), that is targeted for VDisk A. This write is targeted at the preferred node, Node 1 (2). The write is cached and a copy of the data is made in the partner node, Node 2's cache (3). The host views the write as complete. At some later time, the data is written, or de-staged, to storage (4). Figure 5 also shows two uninterruptible power supply units correctly configured so that each node is in a different power domain.

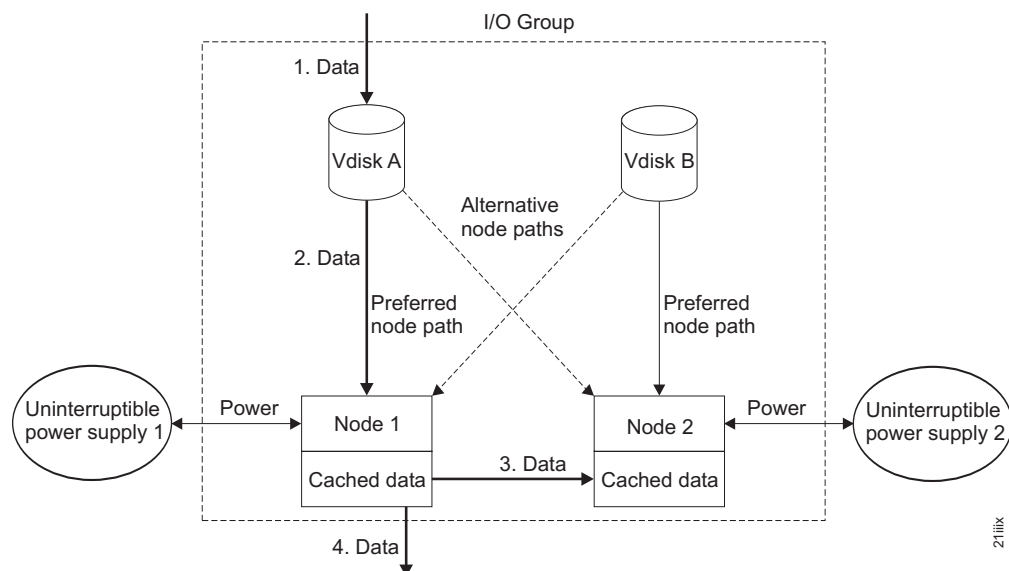


Figure 5. I/O group and uninterruptible power supply

When a node fails within an I/O group, the other node in the I/O group assumes the I/O responsibilities of the failed node. Data loss during a node failure is prevented by mirroring the I/O read and write data cache between the two nodes in an I/O group.

If only one node is assigned to an I/O group or if a node has failed in an I/O group, the cache is flushed to the disk and then goes into write-through mode. Therefore, any writes for the VDIsks that are assigned to this I/O group are not cached; they are sent directly to the storage device. If both nodes in an I/O group go offline, the VDIsks that are assigned to the I/O group cannot be accessed.

When a VDisk is created, the I/O group to provide access to the VDisk must be specified. However, VDIsks can be created and added to I/O groups that contain offline nodes. I/O access is not possible until at least one of the nodes in the I/O group is online.

The cluster also provides a recovery I/O group, which is used when both nodes in the I/O group have experienced multiple failures. I/O access is not possible when VDIsks are assigned to a recovery I/O group.

I/O governing

You can set the maximum amount of I/O activity that a host sends to a virtual disk (VDisk). This amount is known as the *I/O governing rate*. The governing rate can be expressed in I/Os per second or MB per second.

Read, write, and verify commands that access the physical medium are subject to I/O governing.

I/O governing does not effect FlashCopy and data migration I/O rates.

Governing is applied to Metro Mirror and Global Mirror primary and secondary VDIsks as follows:

- If an I/O governing rate is set on a secondary VDisk, the same I/O governing rate is applied to the primary VDisk.
- If you set an I/O governing rate on the primary and the secondary VDisk, the I/O governing rate for the pair is the lowest rate that is set.

2145 UPS-1U

A 2145 UPS-1U is used exclusively to maintain data that is held in the SAN Volume Controller dynamic random access memory (DRAM) in the event of an unexpected loss of external power. This use differs from the traditional uninterruptible power supply that enables continued operation of the device that it supplies when power is lost.

With a 2145 UPS-1U, data is saved to the internal disk of the SAN Volume Controller node. The uninterruptible power supply units are required to power the SAN Volume Controller nodes even when the input power source is considered uninterruptible.

Note: The uninterruptible power supply maintains continuous SAN Volume Controller-specific communications with its attached SAN Volume Controller nodes. A SAN Volume Controller node cannot operate without the uninterruptible power supply. The uninterruptible power supply must be used in accordance with documented guidelines and procedures and must not power any equipment other than a SAN Volume Controller node.

2145 UPS-1U configuration:

A 2145 UPS-1U powers one SAN Volume Controller node.

To make the SAN Volume Controller cluster more resilient against power failure, the 2145 UPS-1U units can be connected to the redundant ac-power switch.

If a redundant ac-power switch is not used, the two uninterruptible power supply units that power an I/O group can be connected to different, independent electrical power sources. In this case, if a single power source fails, only one node in the I/O group stops and the SAN Volume Controller cluster can continue to operate although with reduced performance.

Each uninterruptible power supply must be in the same rack as the node that it powers.

Each 2145 UPS-1U includes one power cord that connects the uninterruptible power supply to a redundant ac-power switch, if one exists, or to a rack power distribution unit (PDU), if one exists. The 2145 UPS-1U also includes an alternative power cable to connect to an external power source that is specific to your geography.

Each 2145 UPS-1U is connected to a SAN Volume Controller node with a power cable and a signal cable. To avoid the possibility of power and signal cables being connected to different uninterruptible power supply units, these cables are wrapped together and supplied as a single field replaceable unit. The signal cable enables the SAN Volume Controller node to read status and identification information from the uninterruptible power supply.

2145 UPS-1U operation:

Each SAN Volume Controller node monitors the operational state of the uninterruptible power supply to which it is attached.

If the 2145 UPS-1U reports a loss of input power, the SAN Volume Controller node stops all I/O operations and dumps the contents of its dynamic random access memory (DRAM) to the internal disk drive. When input power to the 2145 UPS-1U is restored, the SAN Volume Controller node restarts and restores the original contents of the DRAM from the data saved on the disk drive.

A SAN Volume Controller node is not fully operational until the 2145 UPS-1U battery state indicates that it has sufficient charge to power the SAN Volume Controller node long enough to save all of its memory to the disk drive. In the event of a power loss, the 2145 UPS-1U has sufficient capacity for the SAN Volume Controller to save all its memory to disk at least twice. For a fully charged 2145 UPS-1U, even after battery charge has been used to power the SAN Volume Controller node while it saves dynamic random access memory (DRAM) data, sufficient battery charge remains so that the SAN Volume Controller node can become fully operational as soon as input power is restored.

Important: Do not shut down a 2145 UPS-1U without first shutting down the SAN Volume Controller node that it supports. Data integrity can be compromised by pushing the 2145 UPS-1U on/off button when the node is still operating. However, in the case of an emergency, you can manually shut down the 2145 UPS-1U by pushing the 2145 UPS-1U on/off button when the node is still operating. Service actions must then be performed before the node can resume normal operations. If multiple uninterruptible power supply units are shut down before the nodes they support, data can be corrupted.

Storage systems and MDisks

The nodes in a cluster see the storage exported by SAN-attached storage systems as a number of disks, known as managed disks (MDisks). The SAN Volume Controller does not attempt to provide recovery from physical disk failures within the storage system. An MDisk is usually, but not necessarily, a RAID array.

Storage systems

A storage system is a device that coordinates and controls the operation of one or more disk drives. A storage system also synchronizes the operation of the drives with the operation of the system as a whole.

Storage systems that are attached to the SAN fabric provide the physical storage devices that the cluster detects as managed disks (MDisks). These are called RAID because the SAN Volume Controller does not attempt to provide recovery from physical disk failures within the storage system. The nodes in the cluster are connected to one or more fibre-channel SAN fabrics.

Storage systems reside on the SAN fabric and are addressable by one or more fibre-channel ports (target ports). Each port has a unique name known as a worldwide port name (WWPN).

The exported storage devices are detected by the cluster and reported by the user interfaces. The cluster can also determine which MDisks each storage system is presenting and can provide a view of MDisks that is filtered by the storage system. Therefore, you can associate the MDisks with the RAID that the system exports.

The storage system can have a local name for the RAID or single disks that it is providing. However it is not possible for the nodes in the cluster to determine this name, because the namespace is local to the storage system. The storage system makes the storage devices visible with a unique ID, called the logical unit number (LUN). This ID, along with the storage system serial number or numbers (there can be more than one controller in a storage system), can be used to associate the MDisks in the cluster with the RAID exported by the system.

Storage systems export storage to other devices on the SAN. The physical storage that is associated with a system is normally configured into RAID that provide recovery from physical disk failures. Some systems also allow physical storage to be configured as RAID-0 arrays (striping) or as JBODs (just a bunch of disks). However, this does not provide protection against a physical disk failure and, with virtualization, can lead to the failure of many virtual disks (VDisks). To avoid this failure, do not configure your physical storage as RAID-0 arrays or JBODs.

Many storage systems can be used for storage that is provided by a RAID to be divided up into many Small Computer System Interface (SCSI) logical units (LUs) that are presented on the SAN. With the SAN Volume Controller, ensure that the storage systems are configured to present each RAID as a single SCSI LU that are recognized by the SAN Volume Controller as a single MDisk. The virtualization features of the SAN Volume Controller can then be used to divide up the storage into VDisks.

Some storage systems allow the exported storage to be increased in size. The SAN Volume Controller does not use this extra capacity. Instead of increasing the size of an existing MDisk, add a new MDisk to the MDisk group and the extra capacity that are available for the SAN Volume Controller to use.

Attention: If you delete a RAID that is being used by the SAN Volume Controller, the MDisk group goes offline and the data in that group is lost.

The cluster detects and provides a view of the storage systems that the SAN Volume Controller supports. The cluster can also determine which MDisks each system has and can provide a view of MDisks that are filtered by the device. This view enables you to associate the MDisks with the RAID that the system presents.

Note: The SAN Volume Controller supports storage that is internally configured as a RAID. However, it is possible to configure a storage system as a non-RAID device. RAID provides redundancy at the disk level. For RAID devices, a single physical disk failure does not cause an MDisk failure, an MDisk group failure, or a failure in the VDIs that were created from the MDisk group.

MDisks

A *managed disk (MDisk)* is a logical disk (typically a RAID or partition thereof) that a storage system has exported to the SAN fabric to which the nodes in the cluster are attached.

An MDisk might, therefore, consist of multiple physical disks that are presented as a single logical disk to the SAN. An MDisk always provides usable blocks of physical storage to the cluster even if it does not have a one-to-one correspondence with a physical disk.

Each MDisk is divided into a number of extents, which are numbered, from 0, sequentially from the start to the end of the MDisk. The extent size is a property of MDisk groups. When an MDisk is added to an MDisk group, the size of the extents that the MDisk is divided into depends on the attribute of the MDisk group to which it has been added.

Access modes

The access mode determines how the cluster uses the MDisk. The following list provides the three types of possible access modes:

Unmanaged

The MDisk is not used by the cluster.

Managed

The MDisk is assigned to an MDisk group and provides extents that virtual disks (VDIs) can use.

Image The MDisk is assigned directly to a VDI with a one-to-one mapping of extents between the MDisk and the VDI.

Attention: If you add an MDisk that contains existing data to an MDisk group while the MDisk is in unmanaged or managed mode, you lose the data that it contains. The *image mode* is the only mode that preserves this data.

Figure 6 on page 17 shows physical disks and MDisks.

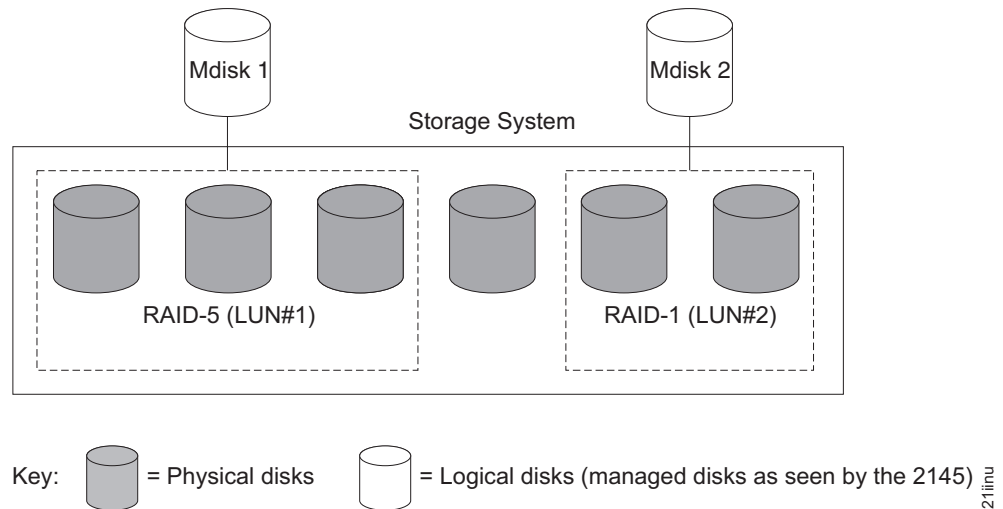


Figure 6. Controllers and MDisks

Table 2 describes the operational states of an MDisk.

Table 2. MDisk status

Status	Description
Online	The MDisk can be accessed by all online nodes. That is, all the nodes that are currently working members of the cluster can access this MDisk. The MDisk is online when the following conditions are met: <ul style="list-style-type: none"> • All timeout error recovery procedures complete and report the disk as online. • Logical unit number (LUN) inventory of the target ports correctly reported the MDisk. • Discovery of this LUN completed successfully. • All of the MDisk target ports report this LUN as available with no fault conditions.
Degraded	The MDisk cannot be accessed by all the online nodes. That is, one or more (but not all) of the nodes that are currently working members of the cluster cannot access this MDisk. The MDisk can be partially excluded; that is, some of the paths to the MDisk (but not all) have been excluded.
Excluded	The MDisk has been excluded from use by the cluster after repeated access errors. Run the Directed Maintenance Procedures to determine the problem.
Offline	The MDisk cannot be accessed by any of the online nodes. That is, all of the nodes that are currently working members of the cluster cannot access this MDisk. This state can be caused by a failure in the SAN, storage system, or one or more physical disks connected to the storage system. The MDisk is reported as offline if all paths to the disk fail.

Extents

Each MDisk is divided into chunks of equal size called *extents*. Extents are a unit of mapping that provides the logical connection between MDisks and VDisk copies.

Attention: If you have observed intermittent breaks in links or if you have been replacing cables or connections in the SAN fabric, you might have one or more MDisks in degraded status. If an I/O operation is attempted when a link is broken and the I/O operation fails several times, the system partially excludes the MDisk and it changes the status of the MDisk to degraded. You must include the MDisk to resolve the problem. You can include the MDisk by either selecting **Work with Managed Disks** → **Managed Disk** → **Include an MDisk** in the SAN Volume Controller Console, or by issuing the following command in the command-line interface (CLI):

```
svctask includemdisk mdiskname/id
```

Where *mdiskname/id* is the name or ID of your MDisk.

MDisk path

Each MDisk has an online path count, which is the number of nodes that have access to that MDisk; this represents a summary of the I/O path status between the cluster nodes and the storage device. The maximum path count is the maximum number of paths that have been detected by the cluster at any point in the past. If the current path count is not equal to the maximum path count, the MDisk might be degraded. That is, one or more nodes might not see the MDisk on the fabric.

MDisk groups and VDIs

Managed disks (MDisks) are collected into groups known as *managed disk groups*. Virtual disks (VDIs) are logical disks that are presented to the SAN by SAN Volume Controller nodes. VDIs, like nodes, are associated with an I/O group.

VDisk copies are created from the extents of MDIs.

MDisk groups

A *managed disk (MDisk) group* is a collection of MDIs that jointly contain all the data for a specified set of virtual disks (VDIs).

Figure 7 shows an MDisk group containing four MDIs.

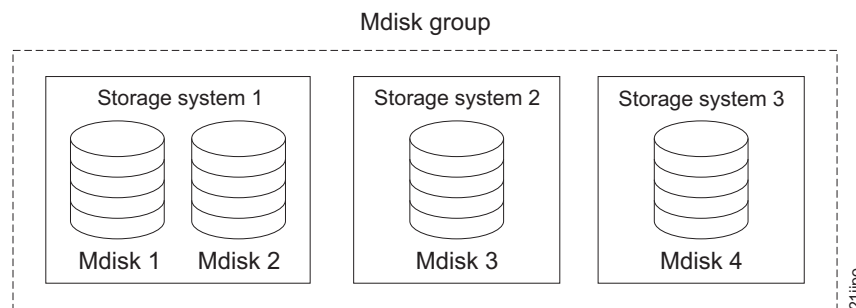


Figure 7. MDisk group

All MDIs in a group are split into extents of the same size. VDIs are created from the extents that are available in the group. You can add MDIs to an MDisk group at any time either to increase the number of extents that are available for new VDisk copies or to expand existing VDisk copies.

You can specify a warning capacity for an MDisk group. A warning event is generated when the amount of space that is used in the MDisk group exceeds the

warning capacity. This is especially useful in conjunction with space-efficient VDIs that have been configured to automatically consume space from the MDisk group.

Note: RAID partitions on HP StorageWorks systems are supported only in single-port attach mode. MDisk groups that consist of single-port attached systems and other storage systems are not supported.

You can add only MDisks that are in unmanaged mode. When MDisks are added to a group, their mode changes from unmanaged to managed.

You can delete MDisks from a group under the following conditions:

- VDIs are not using any of the extents that are on the MDisk.
- Enough free extents are available elsewhere in the group to move any extents that are in use from this MDisk.

Attention:

- If you delete an MDisk group, you destroy all the VDIs that are made from the extents that are in the group.
- If the group is deleted, you cannot recover the mapping that existed between extents that are in the group or the extents that the VDIs use. The MDisks that were in the group are returned to unmanaged mode and can be added to other groups. Because the deletion of a group can cause a loss of data, you must force the deletion if VDIs are associated with it.
- If the VDI is mirrored and the synchronized copies of the VDI are all in the MDisk group, the mirrored VDI is destroyed when the MDisk group is deleted.
- If the VDI is mirrored and there is a synchronized copy in another MDisk group, the VDI remains after the MDisk group is deleted.

Table 3 describes the operational states of an MDisk group.

Table 3. MDisk group status

Status	Description
Online	The MDisk group is online and available. All the MDisks in the group are available.
Degraded	The MDisk group is available; however, one or more nodes cannot access all the MDisks in the group.
Offline	The MDisk group is offline and unavailable. No nodes in the cluster can access the MDisks. The most likely cause is that one or more MDisks are offline or excluded.

Attention: If a single MDisk in an MDisk group is offline and therefore cannot be seen by any of the online nodes in the cluster, then the MDisk group of which this MDisk is a member goes offline. This causes *all* the VDisk copies that are being presented by this MDisk group to go offline. Take care when you create MDisk groups to ensure an optimal configuration.

Consider the following guidelines when you create MDisk groups:

- Allocate your image-mode VDIs between your MDisk groups.
- Ensure that all MDisks that are allocated to a single MDisk group are the same RAID type. This ensures that a single failure of a physical disk in the storage system does not take the entire group offline. For example, if you have three RAID-5 arrays in one group and add a non-RAID disk to this group, you lose access to all the data striped across the group if the non-RAID disk fails. Similarly, for performance reasons, you must not mix RAID types. The performance of all VDIs is reduced to the lowest performer in the group.
- If you intend to keep the VDisk allocation within the storage exported by a storage system, ensure that the MDisk group that corresponds with a single storage system is presented by that storage system. This also enables nondisruptive migration of data from one storage system to another storage system and simplifies the decommissioning process if you want to decommission a controller at a later time.
- Except when you migrate between groups, you must associate a VDisk with just one MDisk group.
- An MDisk can be associated with just one MDisk group.

Extents

To track the space that is available on an MDisk, the SAN Volume Controller divides each MDisk into chunks of equal size. These chunks are called *extents* and are indexed internally. Extent sizes can be 16, 32, 64, 128, 256, 512, 1024, or 2048 MB.

You specify the extent size when you create a new MDisk group. You cannot change the extent size later; it must remain constant throughout the lifetime of the MDisk group.

You cannot use the SAN Volume Controller data migration function to migrate VDIs between MDisk groups that have different extent sizes. However, you can use the following SAN Volume Controller functions to move data to an MDisk that has a different extent size:

- FlashCopy to copy a VDisk between a source and a destination MDisk group that have different extent sizes.
- Intracluster Metro Mirror or Global Mirror to copy a VDisk between a source and a destination MDisk group that have different extent sizes.
- VDisk Mirroring to add a copy of the disk from the destination MDisk group. After the copies are synchronized, you can free up extents by deleting the copy of the data in the source MDisk group.

The choice of extent size affects the total amount of storage that is managed by the cluster. Table 4 on page 21 shows the maximum amount of storage that can be managed by a cluster for each extent size.

Table 4. Capacities of the cluster given extent size

Extent size	Maximum storage capacity of cluster
16 MB	64 TB
32 MB	128 TB
64 MB	256 TB
128 MB	512 TB
256 MB	1 PB
512 MB	2 PB
1024 MB	4 PB
2048 MB	8 PB

A cluster can manage 4 million extents (4 × 1024 × 1024). For example, with a 16 MB extent size, the cluster can manage up to 16 MB × 4 MB = 64 TB of storage.

When you choose an extent size, consider your future needs. For example, if you currently have 40 TB of storage and you specify an extent size of 16 MB, the capacity of the MDisk group is limited to 64 TB of storage in the future. If you select an extent size of 64 MB, the capacity of the MDisk group is 256 TB.

Using a larger extent size can waste storage. When a VDisk is created, the storage capacity for the VDisk is rounded to a whole number of extents. If you configure the system to have a large number of small VDIsks and you use a large extent size, this can cause storage to be wasted at the end of each VDisk.

VDisks

A *virtual disk (VDisk)* is a logical disk that the cluster presents to the storage area network (SAN).

To keep a VDisk accessible even when a managed disk on which it depends has become unavailable, a mirrored copy can be added to a selected VDisk. Each VDisk can have a maximum of two copies. Each VDisk copy is created from a set of extents in an MDisk group.

Application servers on the SAN access VDIsks, not managed disks (MDisks).

There are three types of VDIsks: striped, sequential, and image.

Types

Each VDisk copy can be one of the following types:

Striped

A VDisk copy that has been striped is at the extent level. One extent is allocated, in turn, from each MDisk that is in the group. For example, an MDisk group that has 10 MDisks takes one extent from each MDisk. The 11th extent is taken from the first MDisk, and so on. This procedure, known as a round-robin, is similar to RAID-0 striping.

You can also supply a list of MDisks to use as the stripe set. This list can contain two or more MDisks from the MDisk group. The round-robin procedure is used across the specified stripe set.

Attention: By default, striped VDisk copies are striped across all MDisks in the group. If some of the MDisks are smaller than others, the extents on the smaller MDisks are used up before the larger MDisks run out of extents. Manually specifying the stripe set in this case might result in the VDisk copy not being created.

If you are unsure if there is sufficient free space to create a striped VDisk copy, select one of the following options:

- Check the free space on each MDisk in the group using the **svcinfolsfreeextents** command.
- Let the system automatically create the VDisk copy by not supplying a specific stripe set.

Figure 8 shows an example of an MDisk group that contains three MDisks. This figure also shows a striped VDisk copy that is created from the extents that are available in the group.

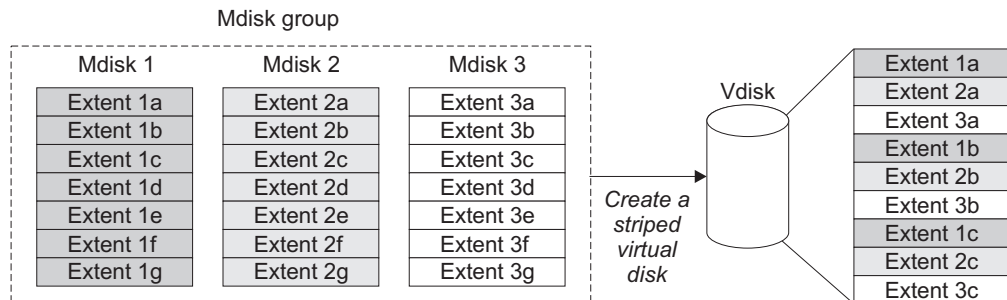


Figure 8. MDisk groups and VDisks

Sequential

When extents are selected, they are allocated sequentially on one MDisk to create the VDisk copy if enough consecutive free extents are available on the chosen MDisk.

Image Image-mode VDisks are special VDisks that have a direct relationship with one MDisk. If you have an MDisk that contains data that you want to merge into the cluster, you can create an image-mode VDisk. When you create an image-mode VDisk, a direct mapping is made between extents that are on the MDisk and extents that are on the VDisk. The MDisk is not virtualized. The logical block address (LBA) x on the MDisk is the same as LBA x on the VDisk.

When you create an image-mode VDisk copy, you must assign it to an MDisk group. An image-mode VDisk copy must be at least one extent in size. The minimum size of an image-mode VDisk copy is the extent size of the MDisk group to which it is assigned.

The extents are managed in the same way as other VDisk copies. When the extents have been created, you can move the data onto other MDisks that are in the group without losing access to the data. After you move one or more extents, the VDisk copy becomes a virtualized disk, and the mode of the MDisk changes from image to managed.

Attention: If you add a managed mode MDisk to an MDisk group, any data on the MDisk is lost. Ensure that you create image-mode VDisks from the MDisks that contain data before you start adding any MDisks to groups.

MDisks that contain existing data have an initial mode of unmanaged, and the cluster cannot determine if it contains partitions or data.

You can use more sophisticated extent allocation policies to create VDisk copies. When you create a striped VDisk, you can specify the same MDisk more than once in the list of MDisks that are used as the stripe set. This is useful if you have an MDisk group in which not all the MDisks are of the same capacity. For example, if you have an MDisk group that has two 18 GB MDisks and two 36 GB MDisks, you can create a striped VDisk copy by specifying each of the 36 GB MDisks twice in the stripe set so that two-thirds of the storage is allocated from the 36 GB disks.

If you delete a VDisk, you destroy access to the data that is on the VDisk. The extents that were used in the VDisk are returned to the pool of free extents that is in the MDisk group. The deletion might fail if the VDisk is still mapped to hosts. The deletion might also fail if the VDisk is still part of a FlashCopy, Metro Mirror or Global Mirror mapping. If the deletion fails, you can specify the force-delete flag to delete both the VDisk and the associated mappings to hosts. Forcing the deletion deletes the Copy Services relationship and mappings.

States

A VDisk can be in one of three states: online, offline, and degraded. Table 5 describes the different states of a VDisk.

Table 5. VDisk states

State	Description
Online	At least one synchronized copy of the VDisk is online and available if both nodes in the I/O group can access the VDisk. A single node can only access a VDisk if it can access all the MDisks in the MDisk group that are associated with the VDisk.
Offline	The VDisk is offline and unavailable if both nodes in the I/O group are missing or none of the nodes in the I/O group that are present can access any synchronized copy of the VDisk. The VDisk can also be offline if the VDisk is the secondary of a Metro Mirror or Global Mirror relationship that is not synchronized.
Degraded	The status of the VDisk is degraded if one node in the I/O group is online and the other node is either missing or cannot access any synchronized copy of the VDisk. Note: If you have a degraded VDisk and all of the associated nodes and MDisks are online, call the IBM Support Center for assistance.

Cache modes

You can select to have read and write operations stored in cache by specifying a cache mode. You must specify the cache mode when you create the VDisk. After the VDisk is created, you cannot change the cache mode.

Table 6 describes the two types of cache modes for a VDisk.

Table 6. VDisk cache modes

Cache mode	Description
readwrite	All read and write I/O operations that are performed by the VDisk are stored in cache. This is the default cache mode for all VDIs.
none	All read and write I/O operations that are performed by the VDisk are not stored in cache.

Using space-efficient Virtual Disks:

When you create a virtual disk (VDisk), you can designate it as space-efficient. A space-efficient VDisk has a virtual capacity and a real capacity.

The VDisk consumes physical storage that is equivalent to the real capacity but appears to host systems to have a different capacity, which is the virtual capacity. Typically the virtual capacity is significantly larger than the real capacity. The SAN Volume Controller cluster uses the real capacity to store data that is written to the virtual capacity and additional information that describes the parts of the virtual capacity that have been written. As more information is written to the virtual capacity, more of the real capacity is used. The SAN Volume Controller cluster identifies reads to unwritten parts of the virtual capacity and returns zeroes to the server without using any of the real capacity.

The SAN Volume Controller must maintain extra metadata that describes the contents of space-efficient VDIs. This means the I/O rates that are obtained from space-efficient VDIs are slower than those obtained from fully allocated VDIs that are allocated on the same MDIs.

Space-efficient VDIs can also simplify server administration. Instead of assigning a VDisk with some capacity to an application and increasing that capacity as the application's needs change, you can configure a VDisk with a large virtual capacity for the application and then increase or shrink the real capacity as the application needs change, without disrupting the application or server.

You can specify to autoexpand space-efficient VDIs. The real capacity is then expanded as the capacity is used. During this process, a fixed amount of unused real capacity is maintained. This amount is known as the *contingency capacity*. When you create a space-efficient VDisk, the contingency capacity is initially set to the same amount as the real capacity. If you manually change the real capacity, the contingency capacity becomes the difference between the used capacity and the new real capacity.

A space-efficient VDisk can be configured to generate a warning event when the used real capacity exceeds a specified amount or percentage of the virtual capacity. You can use the warning event to trigger other actions, such as taking low-priority applications offline or migrating data into other MDI groups.

If a space-efficient VDisk does not have enough real capacity for a write operation, the VDisk is taken offline and an error is logged (error ID 060001). Access to the VDisk can be restored by increasing its real capacity. Then, when sufficient real capacity is available, the error is automatically marked as fixed and access is restored. However, if that VDisk is configured to automatically expand its real capacity, you must mark the error as fixed before access is restored.

When you create a space-efficient VDisk, you can choose the grain size for allocating space in 32 KB, 64 KB, 128 KB, or 256 KB chunks. Generally, smaller grain sizes save space but require more metadata access, which can adversely impact performance. If you are configuring the FlashCopy feature on a space-efficient VDisk, specify the same grain size for the VDisk and for the FlashCopy feature.

Image mode space-efficient VDIsks:

When you create an image mode virtual disk (VDisk), you can designate it as space-efficient. An image mode space-efficient VDisk has a virtual capacity and a real capacity.

An image mode space-efficient VDisk has a direct relationship with a single MDisk where the contents of the MDisk map to the real capacity that is used by the space-efficient VDisk. Unlike fully-allocated VDIsks, the logical block address (LBA) on the MDisk is not necessarily the same as the LBA on the VDisk. You cannot change the real capacity of an image mode space-efficient VDisk, manually or by using the autoexpand feature. To use the autoexpand feature, the VDisk must be in managed mode.

You can use an image mode VDisk to move a space-efficient VDisk between two SAN Volume Controller clusters using the following procedure. The procedure is similar to that used for fully-allocated VDIsks, but has an extra step during the import process to specify the existing space-efficient metadata, rather than to create a new, empty VDisk.

1. If the VDisk is not already in image mode, migrate the VDisk to image mode and wait for the migration to complete.
2. Delete the VDisk from the exporting cluster.
3. Disconnect the MDisk from the exporting cluster and connect the MDisk to the importing cluster.
4. Create a new image mode space-efficient VDisk using the MDisk. You must specify the **import** option.
5. Optionally, migrate the VDisk to managed mode.

The **import** option is only valid for SAN Volume Controller space-efficient VDIsks. You cannot import a space-efficient volume created by RAID controllers into a cluster and retaining its space-efficiency.

Converting space-efficient VDIsks:

You can convert space-efficient VDIsks into a fully-allocated VDIsks.

You can non-disruptively convert a space-efficient VDisk into a fully-allocated VDisk by using the following VDisk mirroring procedure:

1. Start with a single-copy space-efficient VDisk
2. Add a fully-allocated copy to the VDisk
3. Allow the VDisk to sync
4. When the VDisk has synced, remove the space-efficient copy from the VDisk.

You can use a similar procedure to convert a fully-allocated VDisk to a space-efficient VDisk. In this case, the real capacity of the resulting space-efficient VDisk is completely allocated.

Virtual Disk Mirroring feature:

The VDisk Mirroring feature allows a VDisk to have two physical copies. Each VDisk copy can belong to a different MDisk group. Each copy has the same virtual capacity as the VDisk.

When a server writes to a mirrored VDisk, the SAN Volume Controller cluster writes the data to both copies. When a server reads a mirrored VDisk, the SAN Volume Controller cluster picks one of the copies to read. If one of the mirrored VDisk copies is temporarily unavailable; for example, because the RAID controller that provides the MDisk group is unavailable, the VDisk remains accessible to servers. The SAN Volume Controller cluster remembers which areas of the VDisk are written and resynchronizes these areas when both copies are available.

You can create a VDisk with one or two copies and convert a non-mirrored VDisk into a mirrored VDisk by adding a copy. When a copy is added in this way, the SAN Volume Controller cluster synchronizes the new copy so that it is the same as the existing VDisk. Servers can access the VDisk during this synchronization process.

You can convert a mirrored VDisk into a non-mirrored VDisk by deleting one copy or by splitting one copy to create a new non-mirrored VDisk.

The VDisk copy can be any type: image, striped, sequential, and space-efficient or not. The two copies can be of completely different types.

VDisk Mirroring can be used for the following applications:

- Improve availability of VDIs by protecting them from a single storage controller failure.
- Allow concurrent maintenance of a storage controller that does not natively support concurrent maintenance.
- Provide an alternative method of data migration with better availability characteristics. While a VDisk is being migrated using the data migration feature, it is vulnerable to failures on both the source and target MDisk group. VDisk Mirroring provides an alternative because you can start with a non-mirrored VDisk in the source MDisk group and then add a copy to that VDisk in the destination MDisk group. When the VDisk is synchronized, you can delete the original copy that is in the source MDisk group. During the synchronization process, the VDisk remains available even if there is a problem with the destination MDisk group.

When you use VDisk Mirroring, consider how quorum candidate disks are allocated. VDisk Mirroring maintains some state data on the quorum disks. If the quorum disks are not accessible and VDisk Mirroring is unable to update the state information, a mirrored VDisk might need to be taken offline to maintain data integrity. To ensure the high availability of the system, ensure that multiple quorum candidate disks, allocated on different controllers, are configured.

Host objects

A *host system* is an open-systems computer that is connected to the switch through a fibre-channel interface.

A *host object* is a logical object that groups one or more worldwide port names (WWPNs) of the host bus adapters (HBAs) that the cluster has detected on the SAN. A typical configuration has one host object for each host that is attached to

the SAN. If a cluster of hosts accesses the same storage, you can add HBA ports from several hosts to one host object to make a simpler configuration.

The cluster does not automatically present virtual disks (VDisks) on the fibre-channel ports. You must map each VDisk to a particular set of ports to enable the VDisk to be accessed through those ports. The mapping is made between a host object and a VDisk.

When you create a new host object, the configuration interfaces provide a list of unconfigured WWPNs. These WWPNs represent the fibre-channel ports that the cluster has detected.

The cluster can detect only ports that are logged into the fabric. Some HBA device drivers do not let the ports remain logged in if no disks are visible on the fabric. This condition causes a problem when you want to create a host because, at this time, no VDIs are mapped to the host. The configuration interface provides a method that allows you to manually type the port names.

Attention: You must not include a node port in a host object.

A port can be added to only one host object. When a port has been added to a host object, that port becomes a configured WWPN, and is not included in the list of ports that are available to be added to other hosts.

Port masks

You can use a port mask to control the node target ports that a host can access. The port mask applies to logins from the host initiator port that are associated with the host object.

For each login between a host HBA port and node port, the node examines the port mask that is associated with the host object for which the host HBA is a member and determines if access is allowed or denied. If access is denied, the node responds to SCSI commands as if the HBA port is unknown.

The port mask is four binary bits. Valid mask values range from 0000 (no ports enabled) to 1111 (all ports enabled). For example, a mask of 0011 enables port 1 and port 2. The default value is 1111.

Multiple target ports

When you create a VDisk-to-host mapping, the host ports that are associated with the host object can see the LUN that represents the VDisk on up to eight fibre-channel ports. Nodes follow the American National Standards Institute (ANSI) Fibre Channel (FC) standards for SCSI LUs that are accessed through multiple node ports. However, you must coordinate the nodes in an I/O group to present a consistent SCSI LU across all ports that can access it. The ANSI FC standards do not require that the same LUN is used on all ports; however, nodes always present the LU that represents a specific VDisk with the same LUN on all ports in an I/O group.

Node login counts

The number of nodes that can see each port is reported on a per node basis and is known as the node login count. If the count is less than that expected for the current SAN zoning rules, then you can have a fabric problem.

VDisk-to-host mapping

Virtual disk (VDisk)-to-host mapping is the process of controlling which hosts have access to specific VDIs within the SAN Volume Controller cluster.

VDisk-to-host mapping is similar in concept to logical unit number (LUN) mapping or masking. LUN mapping is the process of controlling which hosts have access to specific logical units (LUs) within the disk controllers. LUN mapping is typically done at the disk controller level. VDisk-to-host mapping is done at the SAN Volume Controller level.

Application servers can only access VDIs that have been made accessible to them. The SAN Volume Controller detects the fibre-channel ports that are connected to the SAN. These correspond to the host bus adapter (HBA) worldwide port names (WWPNs) that are present in the application servers. The SAN Volume Controller enables you to create logical hosts that group together WWPNs that belong to a single application server. VDIs can then be mapped to a host. The act of mapping a VDisk to a host makes the VDisk accessible to the WWPNs in that host and the application server itself.

VDIs and host mappings

LUN masking usually requires device driver software on each host. The device driver software masks the LUNs. After the masking is complete, only some disks are visible to the operating system. The SAN Volume Controller performs a similar function, but, by default, it presents to the host only those VDIs that are mapped to that host. Therefore, you must map the VDIs to the hosts to access those disks.

Each host mapping associates a VDisk with a host object and allows all HBA ports in the host object to access the VDisk. You can map a VDisk to multiple host objects. When a mapping is created, multiple paths might exist across the SAN fabric from the hosts to the SAN Volume Controller nodes that are presenting the VDisk. Most operating systems present each path to a VDisk as a separate storage device. The SAN Volume Controller, therefore, requires that multipathing software be running on the host. The multipathing software manages the many paths that are available to the VDisk and presents a single storage device to the operating system.

When you map a VDisk to a host, you can optionally specify a SCSI ID for the VDisk. This ID controls the sequence in which the VDIs are presented to the host. For example, if you present three VDIs to the host, and those VDIs have SCSI IDs of 0, 1, and 3, the VDisk that has an ID of 3 might not be found because no disk is mapped with an ID of 2. The cluster automatically assigns the next available SCSI ID if none is entered.

Figure 9 on page 29 and Figure 10 on page 29 show two VDIs, and the mappings that exist between the host objects and these VDIs.

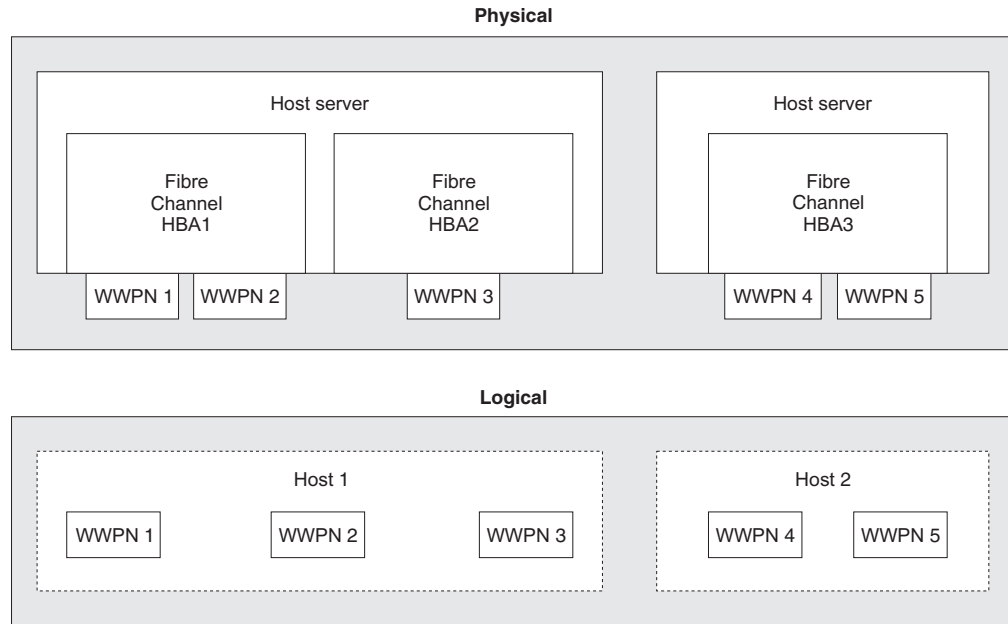


Figure 9. Hosts, WWPNs, and VDisks

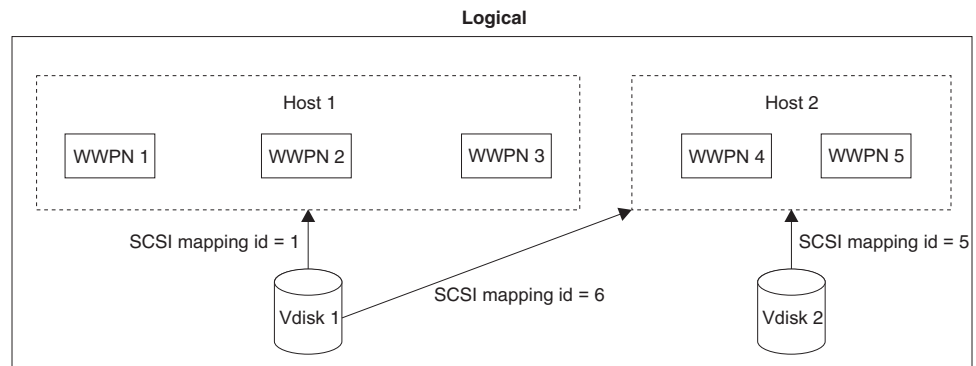


Figure 10. Hosts, WWPNs, VDisks and SCSI mappings

Standard and persistent reserves

The SCSI Reserve command and the SCSI Persistent Reserve command are specified by the SCSI standards. Servers can use these commands to prevent HBA ports in other servers from accessing the LUN.

This prevents accidental data corruption that is caused when a server overwrites data on another server. The Reserve and Persistent Reserve commands are often used by clustering software to control access to SAN Volume Controller virtual disks (VDisks).

If a server is not shut down or removed from the server cluster in a controlled way, the server reserves and persistent reserves are maintained. This prevents other servers from accessing data that is no longer in use by the server that holds the reservation. In this situation, you might want to release the reservation and allow a new server to access the VDisk.

When possible, you should have the server that holds the reservation explicitly release the reservation to ensure that the server cache is flushed and the server

software is aware that access to the VDisk has been lost. In circumstances where this is not possible, you can use operating system specific tools to remove reservations. Consult the operating system documentation for details.

When you use the **svctask rmvdiskhostmap** CLI command or the SAN Volume Controller Console to remove VDisk-to-host mappings, SAN Volume Controller nodes with a software level of 4.1.0 or later can remove the server reservations and persistent reservations that the host has on the VDisk.

SAN Volume Controller maximum configuration

Ensure that you are familiar with the maximum configurations of the SAN Volume Controller.

See the following Web site for the latest maximum configuration support:

www.ibm.com/storage/support/2145

SAN Volume Controller cluster high availability

A SAN Volume Controller cluster has several features that can be used to deploy a high availability storage system with no single point of failure.

Each I/O group within a cluster consists of a pair of nodes. If a node fails within an I/O group, the other node in the I/O group assumes the I/O responsibilities of the failed node.

If a cluster of SAN Volume Controller nodes is split into two partitions (for example due to a SAN fabric fault), the partition with the majority of nodes continues to process I/O operations. If a cluster is split into two equal-sized partitions, a quorum disk is accessed to determine which half of the cluster continues to read and write data.

Each SAN Volume Controller node has four fibre-channel ports, which can be used to attach the node to multiple SAN fabrics. For high availability, attach the nodes in a cluster to at least two fabrics. SAN Volume Controller software incorporates multipathing software that is used for communication among SAN Volume Controller nodes and for I/O operations among SAN Volume Controller nodes and storage systems. If a SAN fabric fault disrupts communication or I/O operations, the multipathing software recovers and retries the operation through an alternative communication path. Also for high availability, configure your host systems to use multipathing software. Then if a SAN fabric fault or node failure occurs, I/O operations among host systems and SAN Volume Controller nodes are retried. Subsystem device driver (SDD), which is multipathing software, is available from IBM at no additional charge for use with SAN Volume Controller. For additional information about subsystem device driver (SDD), go to the following Web site:

www.ibm.com/systems/support

The SAN Volume Controller Virtual Disk Mirroring feature can be used to mirror data across storage systems. This feature provides protection against a storage system failure. Although VDisk Mirroring provides additional protection against disk failures, it is not intended to be used as a substitute for a Redundant Array of Independent Disks (RAID) in storage systems.

The SAN Volume Controller Metro Mirror and Global Mirror features can be used to mirror data between two clusters at different physical locations for disaster recovery.

For very short distances, it is possible to split a cluster between two locations and to use VDisk Mirroring to mirror the data. However, there are configuration restrictions on how a cluster can be split. If one half of the cluster fails, performance is likely to be substantially reduced.

You must configure split clusters so that the following conditions are met:

- Avoid having any interswitch links (ISLs) in the paths between SAN Volume Controller nodes and storage controllers. If it is necessary to have ISLs between SAN Volume Controller nodes and storage controllers, the ISLs should not be oversubscribed as there will be substantial fibre-channel traffic across the ISLs. For most configurations, trunking is required. Because ISL problems are difficult to diagnose, switch-port error statistics must be collected and regularly monitored to detect failures.
- Avoid having any ISLs in the paths between SAN Volume Controller nodes in the same cluster. If it is necessary to have ISLs between SAN Volume Controller nodes in the same cluster, follow these guidelines:
 - At least some ports on each node in the same I/O group must be connected to the same switch in each redundant fabric that is used. Connecting to different blades in a director-class switch is permitted. SAN Volume Controller node-to-node communication in the same I/O group across ISLs is not supported.
 - There should be no more than one ISL hop between SAN Volume Controller nodes in different I/O groups.
 - The ISLs should not be oversubscribed as there will be substantial fibre-channel traffic across the ISLs. For most configurations, trunking is required. Because ISL problems are difficult to diagnose, switch-port error statistics must be collected and regularly monitored to detect failures.
- Use switch zoning to prevent node-to-node traffic using an ISL hop where there are multiple paths across a fabric between SAN Volume Controller nodes, some of which involve an ISL and some of which do not.
- It is best to locate all SAN Volume Controller nodes that are in a cluster in the same rack or adjacent racks. If it is necessary to separate the SAN Volume Controller nodes, follow these rules:
 - All SAN Volume Controller nodes in the same cluster must be connected to the same Ethernet subnet.
 - Some service actions require access to all SAN Volume Controller nodes in a cluster. Therefore, SAN Volume Controller nodes in the same cluster must be reasonably accessible and physically not more than 100 meters apart. Any exceptions must be requested by contacting your IBM representative.
 - A node must be placed in the same rack as the SAN Volume Controller uninterruptible power supply that supplies power to it.

Node management and support tools

The SAN Volume Controller solution offers several management and support tools for you to maintain and manage your nodes.

The following node management tools are available with the SAN Volume Controller solution:

- Master console
Although it can no longer be purchased, the master console can be upgraded to support clusters running the latest SAN Volume Controller software.
- IBM System Storage Productivity Center that has the SAN Volume Controller Console, including the CIM agent, installed.

Both solutions incorporate the following SAN Volume Controller applications:

- Secure Shell
- Assist On-site

IBM System Storage Productivity Center

The IBM System Storage Productivity Center (SSPC) is an integrated hardware and software solution that provides a single point of entry for managing SAN Volume Controller clusters, IBM System Storage DS8000 systems, and other components of your data storage infrastructure.

SSPC simplifies storage management in the following ways:

- Centralizing the management of storage network resources with IBM storage management software
- Providing greater synergy between storage management software and IBM storage devices
- Reducing the number of servers that are required to manage your software infrastructure
- Providing simple migration from basic device management to storage management applications that provide higher-level functions

SSPC includes the following software components:

- SAN Volume Controller Console, including the CIM agent
- PuTTY (SSH client software)
- IBM TotalStorage Productivity Center Basic Edition, which can be used to access the IBM System Storage DS8000 Storage Manager
- DB2 Enterprise Server Edition

Figure 11 on page 33 shows an overview of how SSPC and the components of IBM TotalStorage Productivity Center, IBM System Storage DS8000, and SAN Volume Controller interrelate with each other.

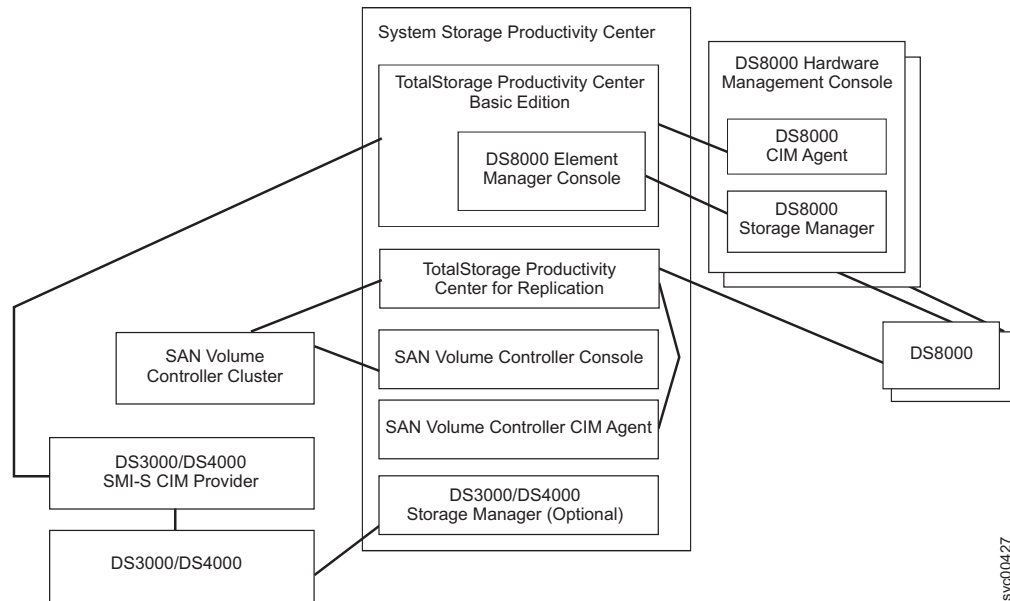


Figure 11. Overview of the IBM System Storage Productivity Center

For more information on SSPC, see the *IBM System Storage Productivity Center Introduction and Planning Guide*.

Secure Shell protocol through PuTTY

Secure Shell (SSH) software is a client-server protocol that can be used from the IBM System Storage Productivity Center or from a host server to enable you to control the SAN Volume Controller through a command-line interface (CLI).

SSH provides a secure communications channel between systems. You can configure SSH to use a key pair (a private key and a public key) to establish the secure connection to a remote system. If you want to create an SSH connection (such as to the SAN Volume Controller cluster), you must place the public key on every system. The SAN Volume Controller provides a command to distribute a key to each node in the cluster.

Assist On-site and remote service

When you contact IBM to help you resolve a problem with your SAN Volume Controller environment, the IBM service representative might suggest using the IBM Assist On-site tool to remotely access the IBM System Storage Productivity Center (SSPC) or master console. This type of remote service can help you reduce service costs and shorten repair times.

The IBM Assist On-site tool is a remote desktop-sharing solution that is offered through the IBM Web site. With it, the IBM service representative can remotely view your system to troubleshoot a problem. You can maintain a chat session with the IBM service representative so that you can monitor the activity and either understand how to fix the problem yourself or allow the representative to fix it for you.

To use the IBM Assist On-site tool, the SSPC or master console must be able to access the Internet. The following Web site provides further information about this tool:

www.ibm.com/support/assistsite/

When you access the Web site, you sign in and enter a code that the IBM service representative provides to you. This code is unique to each IBM Assist On-site session. A plug-in is downloaded onto your SSPC or master console to connect you and your IBM service representative to the remote service session. The IBM Assist On-site contains several layers of security to protect your applications and your computers. You can also use security features to restrict access by the IBM service representative.

Your IBM service representative can provide you with more detailed instructions for using the tool.

Data and event notifications

The SAN Volume Controller can use Simple Network Management Protocol (SNMP) traps, Call Home e-mail, and Inventory Information e-mail to provide necessary data and event notifications to you and to the IBM Support Center.

The following types of information are sent from the SAN Volume Controller:

- SNMP traps
- Call Home e-mail
- Inventory information

SNMP traps

SNMP is the standard protocol for managing networks and exchanging messages. SNMP enables the SAN Volume Controller to send external messages that notify personnel about an event. You can use an SNMP manager to view the messages that the SNMP agent sends. You can use the SAN Volume Controller Console or the SAN Volume Controller command-line interface to configure and modify your SNMP settings. SNMP traps and Call Home e-mail can be sent simultaneously.

Call Home e-mail

The Call Home feature transmits operational and error-related data to you and IBM through a Simple Mail Transfer Protocol (SMTP) server connection in the form of an event notification e-mail. When configured, this function alerts IBM service personnel about hardware failures and potentially serious configuration or environmental issues.

You must configure an SMTP server to be able to send e-mail outside of your local area network. The SMTP server must allow the relaying of e-mail from the SAN Volume Controller cluster IP address. You can then use the SAN Volume Controller Console or the SAN Volume Controller command-line interface to configure the e-mail settings, including contact information and e-mail recipients. Set the reply address to a valid e-mail address. Send a test e-mail to check that all connections and infrastructure are set up correctly. You can disable the Call Home function at any time using the SAN Volume Controller Console or the SAN Volume Controller command-line interface.

Inventory information e-mail

Inventory information e-mail is a type of Call Home notification. Inventory information can be sent to IBM to assist IBM service personnel in evaluating your SAN Volume Controller system. Because inventory information is sent using the

Call Home e-mail function, you must meet the Call Home function requirements and enable the Call Home e-mail function before you can attempt to send inventory information e-mail. You can adjust the contact information, adjust the frequency of inventory e-mail, or manually send an inventory e-mail using the SAN Volume Controller Console or the SAN Volume Controller command-line interface. Inventory information is automatically reported to IBM when you activate error reporting.

Chapter 2. Copy Services features

The SAN Volume Controller provides Copy Services features that enable you to copy virtual disks (VDisks).

The following Copy Services features are available for all supported hosts that are connected to the SAN Volume Controller:

FlashCopy

Makes an instant, point-in-time copy from a source VDisk to a target VDisk.

Metro Mirror

Provides a consistent copy of a source VDisk on a target VDisk. Data is written to the target VDisk synchronously after it is written to the source VDisk, so that the copy is continuously updated.

Global Mirror

Provides a consistent copy of a source VDisk on a target VDisk. Data is written to the target VDisk asynchronously, so that the copy is continuously updated, but the copy might not contain the last few updates in the event that a disaster recovery operation is performed.

FlashCopy

FlashCopy is a Copy Services feature that is available with the SAN Volume Controller.

In its basic mode, the FlashCopy feature copies the contents of a source virtual disk (VDisk) to a target VDisk. Any data that existed on the target VDisk is lost and is replaced by the copied data. After the copy operation has completed, the target VDisks contain the contents of the source VDisks as they existed at a single point in time unless target writes have been performed. The FlashCopy feature is sometimes described as an instance of a time-zero copy (T 0) or point-in-time copy technology. Although the FlashCopy operation takes some time to complete, the resulting data on the target VDisk is presented so that the copy appears to have occurred immediately.

Although it is difficult to make a consistent copy of a data set that is constantly updated, point-in-time copy techniques help solve this problem. If a copy of a data set is created using a technology that does not provide point-in-time techniques and the data set changes during the copy operation, the resulting copy might contain data that is not consistent. For example, if a reference to an object is copied earlier than the object itself and the object is moved before it is copied, the copy contains the referenced object at its new location but the copied reference still points to the old location.

More advanced FlashCopy features allow operations to occur on multiple source and target VDisks. FlashCopy management operations are coordinated to allow a common single point in time for copying target VDisks from their respective source VDisks. This allows a consistent copy of data that spans multiple VDisks. The FlashCopy feature also allows multiple target VDisks to be copied from each source VDisk. This can be used to create images from different points in time for each source VDisk.

The Cascaded FlashCopy feature also allows a FlashCopy target VDisk to be the source VDisk of another FlashCopy mapping. You also have the option of using the Incremental FlashCopy feature, which potentially reduces the amount of time to complete the copy operation after the initial copy has completed. Only the differences are copied when the FlashCopy mapping restarts.

FlashCopy associates a source VDisk and a target VDisk in a FlashCopy Mapping. The source VDIsks and target VDIsks must meet the following requirements:

- They must be the same size.
- The same cluster must manage them.

Any VDisk that is part of a FlashCopy operation can be space-efficient. Using a space-efficient FlashCopy target can reduce the amount of storage that is required to maintain a point-in-time copy. The source VDIsks and target VDIsks can also be mirrored to improve availability of the VDIsks.

FlashCopy applications

You can use the FlashCopy feature to create consistent backups of dynamic data, test applications, and create copies for auditing purposes and for data mining.

To create consistent backups of dynamic data, use the FlashCopy feature to capture the data at a particular time. The resulting image of the data can be backed up, for example, to a tape device. When the copied data is on tape, the data on the FlashCopy target disks become redundant and can now be discarded. Usually in this backup condition, the target data can be managed as read-only.

It is often very important to test a new version of an application with real business data before the existing production version of the application is updated or replaced. This testing reduces the risk that the updated application fails because it is not compatible with the actual business data that is in use at the time of the update. Such an application test might require write access to the target data.

You can also use the FlashCopy feature to create restart points for long running batch jobs. This means that if a batch job fails several days into its run, it might be possible to restart the job from a saved copy of its data rather than rerunning the entire multiday job.

Host considerations for FlashCopy integrity

The SAN Volume Controller FlashCopy feature transfers a point-in-time copy of a source virtual disk (VDisk) onto a designated target VDisk. You must create or already have an existing target VDisk before you can transfer the copy. You must also ensure the target VDisk has enough space available to support the amount of data that is being transferred.

After the mapping is started, all of the data that is stored on the source VDisk can be accessed through the target VDisk. This includes any operating system control information, application data, and metadata that was stored on the source VDisk. Because of this, some operating systems do not allow a source VDisk and a target VDisk to be addressable on the same host.

In order to ensure the integrity of the copy that is made, it is necessary to completely flush the host cache of any outstanding reads or writes before you

proceed with the FlashCopy operation. You can flush the host cache by unmounting the source VDisks from the source host before you start the FlashCopy operation.

Because the target VDisks are overwritten with a complete image of the source VDisks, it is important that any data held on the host operating system (or application) caches for the target VDisks is discarded before the FlashCopy mappings are started. The easiest way to ensure that no data is held in these caches is to unmount the target VDisks prior to starting the FlashCopy operation.

Some operating systems and applications provide facilities to stop I/O operations and to ensure that all data is flushed from caches on the host. If these facilities are available, they can be used to prepare and start a FlashCopy operation. See your host and application documentation for details.

Some operating systems are unable to use a copy of a VDisk without *synthesis*. Synthesis performs a transformation of the operating system metadata on the target VDisk to allow the operating system to use the disk. See your host documentation on how to detect and mount the copied VDisks.

Flushing data from the host volumes

All outstanding read and write operations must be flushed from the host cache before you use the FlashCopy feature.

Perform the following steps to flush data from your host volumes and start a FlashCopy operation:

1. If you are using UNIX[®] or Linux[®] operating systems, perform the following steps:
 - a. Quiesce all applications to the source volumes that you want to copy.
 - b. Use the **umount** command to unmount the designated drives.
 - c. Prepare and start the FlashCopy operation for those unmounted drives.
 - d. Remount your volumes with the mount command and resume your applications.
2. If you are using the Windows[®] operating system using drive letter changes, perform the following steps:
 - a. Quiesce all applications to the source volumes that you want to copy.
 - b. Go into your disk management window and remove the drive letter on each drive that you want to copy. This unmounts the drive.
 - c. Prepare and start the FlashCopy operation for those unmounted drives.
 - d. Remount your volumes by restoring the drive letters and resume your applications.

If you are using the **chkdsk** command, perform the following steps:

- a. Quiesce all applications to the source volumes that you want to copy.
- b. Issue the **chkdsk /x** command on each drive you want to copy. The **/x** option unmounts, scans, and remounts the volume.
- c. Ensure that all applications to the source volumes are still quiesced.
- d. Prepare and start the FlashCopy operation for those unmounted drives.

Note: If you can ensure that no reads and writes are issued to the source volumes after you unmount the drives, you can immediately remount and then start the FlashCopy operation.

FlashCopy mappings

A FlashCopy mapping defines the relationship between a source virtual disk (VDisk) and a target VDisk.

The FlashCopy feature makes an instant copy of a VDisk at the time that it is started. To create an instant copy of a VDisk, you must first create a mapping between the source VDisk (the disk that is copied) and the target VDisk (the disk that receives the copy). The source and target VDIsks must be of equal size.

A mapping can be created between any two VDIsks in a cluster. The VDIsks do not have to be in the same I/O group or managed disk (MDisk) group. When a FlashCopy operation starts, a checkpoint is made of the source VDisk. No data is actually copied at the time a start occurs. Instead, the checkpoint creates a bitmap that indicates that no part of the source VDisk has been copied. Each bit in the bitmap represents one region of the source VDisk. Each region is called a *grain*.

After a FlashCopy operation starts, read operations to the source VDisk continue to occur. If new data is written to the source or target VDisk, the existing data on the source is copied to the target VDisk before the new data is written to the source or target VDisk. The bitmap is updated to mark that the grain of the source VDisk has been copied so that later write operations to the same grain do not recopy the data.

During a read operation to the target VDisk, the bitmap is used to determine if the grain has been copied. If the grain has been copied, the data is read from the target VDisk. If the grain has not been copied, the data is read from the source VDisk.

When you create a mapping, you also specify a clean rate. The clean rate is used to control the rate that data is copied from the target VDisk of the mapping to the target VDisk of a mapping that is either the latest copy of the target VDisk, or is the next oldest copy of the source VDisk. The clean rate is used in the following situations:

- The mapping is in the stopping state
- The mapping is in the copying state and has a copy rate of zero
- The mapping is in the copying state and the background copy has completed

You can use the clean rate to minimize the amount of time that a mapping is in the stopping state. If the mapping has not completed, the target VDisk is offline while the mapping is stopping. The target VDisk remains offline until the mapping is restarted.

When you create a mapping, you specify a copy rate. When the mapping is in the copying state, the copy rate determines the priority that is given to the background copy process. If you want a copy of the whole source VDisk so that a mapping can be deleted and still be accessed from the target VDisk, you must copy all the data that is on the source VDisk to the target VDisk.

The default values for both the clean rate and the copy rate is 50.

When a mapping is started and the copy rate is greater than zero (or a value other than NOCOPY), the unchanged data is copied to the target VDisk, and the bitmap is updated to show that the copy has occurred. After a time, the length of which depends on the priority that was determined by the copy rate and the size of the

VDisk, the whole VDisk is copied to the target. The mapping returns to the `idle_or_copied` state and you can now restart the mapping at any time to create a new copy at the target.

While the mapping is in the copying state, you can set the copy rate to zero and the clean rate to a value other than zero to minimize the amount of time a mapping is in the stopping state.

If you use multiple target mappings, the mapping can stay in the copying state after all of the source data is copied to the target (the progress is 100%). This situation can occur if mappings that were started earlier and use the same source disk are not yet 100% copied.

If the copy rate is zero (or `NOCOPY`), only the data that changes on the source is copied to the target. The target never contains a copy of the whole source unless every extent is overwritten at the source. You can use this copy rate when you require a temporary copy of the source.

You can stop the mapping at any time after it has been started. Unless the target VDisk already contains a complete copy of the source VDisk, this action makes the target inconsistent and the target VDisk is taken offline. The target VDisk remains offline until the mapping is restarted.

You can also set the `autodelete` attribute. If this attribute is set to on, the mapping is automatically deleted when the mapping reaches the `idle_or_copied` state and the progress is 100%.

FlashCopy mapping states

At any point in time, a mapping is in one of the following states:

Idle or copied

The source and target VDIsks act as independent VDIsks even if a mapping exists between the two. Read and write caching is enabled for both the source and the target VDIsks.

If the mapping is incremental and the background copy is complete, the mapping only records the differences between the source and target VDIsks. If the connection to both nodes in the I/O group that the mapping is assigned to is lost, the source and target VDIsks will be offline.

Copying

The copy is in progress. Read and write caching is enabled on the source and the target VDIsks.

Prepared

The mapping is ready to start. The target VDisk is online, but is not accessible. The target VDisk cannot perform read or write caching. Read and write caching is failed by the SCSI front-end as a hardware error. If the mapping is incremental and a previous mapping has completed, the mapping only records the differences between the source and target VDIsks. If the connection to both nodes in the I/O group that the mapping is assigned to is lost, the source and target VDIsks will be offline.

Preparing

The target VDisk is online, but not accessible. The target VDisk cannot perform read or write caching. Read and write caching is failed by the SCSI front-end as a hardware error. Any changed write data for the source

VDisk is flushed from the cache. Any read or write data for the target VDisk is discarded from the cache. If the mapping is incremental and a previous mapping has completed, the mapping records only the differences between the source and target VDIs. If the connection to both nodes in the I/O group that the mapping is assigned to is lost, the source and target VDIs will be offline.

Stopped

The mapping is stopped because either you issued a stop command or an I/O error occurred. The target VDisk is offline and its data is lost. To access the target VDisk, you must restart or delete the mapping. The source VDisk is accessible and the read and write cache is enabled. If the mapping is incremental, the mapping is recording write operations to the source VDisk. If the connection to both nodes in the I/O group that the mapping is assigned to is lost, the source and target VDIs will be offline.

Stopping

The mapping is in the process of copying data to another mapping.

- If the background copy process is complete, the target VDisk is online while the stopping copy process completes.
- If the background copy process is not complete, data is discarded from the target VDisk cache. The target VDisk is offline while the stopping copy process runs.

The source VDisk is accessible for I/O operations.

Suspended

The mapping started, but it did not complete. Access to the metadata is lost, which causes both the source and target VDisk to go offline. When access to the metadata is restored, the mapping returns to the copying or stopping state and the source and target VDIs return online. The background copy process resumes. Any data that has not been flushed and has been written to the source or target VDisk before the suspension, is in cache until the mapping leaves the suspended state.

Notes:

1. If a FlashCopy source VDisk goes offline, any FlashCopy target VDIs that depend on that VDisk also go offline.
2. If a FlashCopy target VDisk goes offline, any FlashCopy target VDIs that depend on that VDisk also go offline. The source VDisk remains online.

Before you start the mapping, you must prepare it. Preparing the mapping ensures that the data in the cache is de-staged to disk and a consistent copy of the source exists on disk. At this time, the cache goes into write-through mode. Data that is written to the source is not cached in the SAN Volume Controller nodes; it passes straight through to the MDIs. The prepare operation for the mapping might take some time to complete; the actual length of time depends on the size of the source VDisk. You must coordinate the prepare operation with the operating system. Depending on the type of data that is on the source VDisk, the operating system or application software might also cache data write operations. You must flush, or synchronize, the file system and application program before you prepare and start the mapping.

Note: The `svctask startfcmap` and `svctask startfcconsistgrp` commands can take some time to process.

If you do not want to use consistency groups, the SAN Volume Controller allows a mapping to be treated as an independent entity. In this case, the mapping is known as a stand-alone mapping. For mappings which have been configured in this way, use the `svctask prestartfcmap` and `svctask startfcmap` commands rather than the `svctask prestartfcconsistgrp` and `svctask startfcconsistgrp` commands.

Multiple target FlashCopy mappings

You can copy up to 256 target VDIs from a single source VDisk. Each relationship between a source and target VDisk is managed by a unique mapping such that a single VDisk can be the source VDisk in up to 256 mappings.

Each of the mappings from a single source can be started and stopped independently. If multiple mappings from the same source are active (in the copying or stopping states), a dependency exists between these mappings.

Example 1

Mapping A depends on mapping B if the following is true:

- Mapping A and mapping B both have the same source VDisk
- Mapping A and mapping B are both in the copying or stopping state
- Mapping B was started more recently than mapping A

Note: If both mappings were in the same consistency group and therefore started at the same time, the order of dependency is decided internally when the consistency group is started.

- Mapping A does not have a complete copy of the source because the copying progress for the mapping is less than 100.
- A mapping does not exist from the same source started more recently than A and later than B which has a complete copy of the source because the copying progress of the mapping is less than 100.

Example 2

Target VDisk A depends on target VDisk B if the mapping that VDisk A belongs to depends on the mapping that target VDisk B belongs to. The target VDisk of the most recently started mapping from the source VDisk depends on the source VDisk until there is a complete copy of the source (progress is 100%).

Incremental FlashCopy mappings

With incremental FlashCopy mappings, the background copy process copies only the parts of the source or target VDisk that have changed since the last FlashCopy process. This reduces the amount of time that it takes to recreate an independent FlashCopy image.

Cascaded FlashCopy mappings

With cascaded FlashCopy mappings, target VDIs can be the source of other mappings.

Up to 256 mappings can exist in a cascade. If cascaded mappings and multiple target mappings are used, a tree of up to 256 mappings can be created.

Veritas Volume Manager

For FlashCopy target VDisks, the SAN Volume Controller sets a bit in the inquiry data for those mapping states where the target VDisk could be an exact image of the source VDisk. Setting this bit enables the Veritas Volume Manager to distinguish between the source and target VDisks and provide independent access to both.

FlashCopy mapping events

FlashCopy mapping events detail the events that modify the state of a FlashCopy mapping.

Table 7 provides a description of each FlashCopy mapping event.

Table 7. FlashCopy mapping events

Create	<p>A new FlashCopy mapping is created between the specified source virtual disk (VDisk) and the specified target VDisk. The operation fails if any of the following is true:</p> <ul style="list-style-type: none">• For SAN Volume Controller software version 4.1.0 or earlier, the source or target VDisk is already a member of a FlashCopy mapping.• For SAN Volume Controller software version 4.2.0 or later, the source or target VDisk is already a target VDisk of a FlashCopy mapping.• For SAN Volume Controller software version 4.2.0 or later, the source VDisk is already a member of 16 FlashCopy mappings.• For SAN Volume Controller software version 4.3.0 or later, the source VDisk is already a member of 256 FlashCopy mappings.• The node has insufficient bitmap memory.• The source and target VDisks are different sizes.
Prepare	<p>The prepare command is directed to either a consistency group for FlashCopy mappings that are members of a normal consistency group or to the mapping name for FlashCopy mappings that are stand-alone mappings. The prepare command places the FlashCopy mapping into the preparing state.</p> <p>Attention: The prepare command can corrupt any data that previously resided on the target VDisk because cached writes are discarded. Even if the FlashCopy mapping is never started, the data from the target might have logically changed during the act of preparing to start the FlashCopy mapping.</p>
Flush done	<p>The FlashCopy mapping automatically moves from the preparing state to the prepared state after all cached data for the source is flushed and all cached data for the target is no longer valid.</p>

Table 7. FlashCopy mapping events (continued)

Start	<p>When all the FlashCopy mappings in a consistency group are in the prepared state, the FlashCopy mappings can be started.</p> <p>To preserve the cross volume consistency group, the start of all of the FlashCopy mappings in the consistency group must be synchronized correctly with respect to I/Os that are directed at the VDIs. This is achieved during the start command.</p> <p>The following occurs during the start command:</p> <ul style="list-style-type: none"> • New reads and writes to all source VDIs in the consistency group are paused in the cache layer until all ongoing reads and writes below the cache layer are completed. • After all FlashCopy mappings in the consistency group are paused, the internal cluster state is set to allow FlashCopy operations. • After the cluster state is set for all FlashCopy mappings in the consistency group, read and write operations are unpaused on the source VDIs. • The target VDIs are brought online. <p>As part of the start command, read and write caching is enabled for both the source and target VDIs.</p>
Modify	<p>The following FlashCopy mapping properties can be modified:</p> <ul style="list-style-type: none"> • FlashCopy mapping name • Clean rate • Consistency group • Copy rate (for background copy or stopping copy priority) • Automatic deletion of the mapping when the background copy is complete
Stop	<p>There are two separate mechanisms by which a FlashCopy mapping can be stopped:</p> <ul style="list-style-type: none"> • You have issued a command • An I/O error has occurred
Delete	<p>This command requests that the specified FlashCopy mapping is deleted. If the FlashCopy mapping is in the stopped state, the force flag must be used.</p>
Flush failed	<p>If the flush of data from the cache cannot be completed, the FlashCopy mapping enters the stopped state.</p>
Copy complete	<p>After all of the source data has been copied to the target and there are no dependent mappings, the state is set to copied. If the option to automatically delete the mapping after the background copy completes is specified, the FlashCopy mapping is automatically deleted. If this option is not specified, the FlashCopy mapping is not automatically deleted and can be reactivated by preparing and starting again.</p>
Bitmap Online/Offline	<p>The node has failed.</p>

Space-efficient FlashCopy

You can have a mix of space-efficient and fully allocated VDIs in FlashCopy mappings. One common combination is a fully allocated source with a space-efficient target, which allows the target to consume a smaller amount of real storage than the source.

For best performance, the grain size of the space-efficient VDisk must match the grain size of the FlashCopy mapping. However, if the grain sizes are different, the mapping still proceeds.

Consider the following information when you create your FlashCopy mappings:

- If you are using a fully allocated source with a space-efficient target, disable background copy and cleaning mode on the FlashCopy map by setting both the background copy rate and cleaning rate to zero. Otherwise, if these features are enabled, all the source is copied onto the target VDisk. This causes the space-efficient VDisk to either go offline or to grow as large as the source.
- If you are using only space-efficient source, only the space that is used on the source VDisk is copied to the target VDisk. For example, if the source VDisk has a virtual size of 800 GB and a real size of 100 GB of which 50 GB have been used, only the used 50 GB are copied.

FlashCopy consistency groups

A *consistency group* is a container for mappings. You can add many mappings to a consistency group.

The consistency group is specified when the mapping is created. You can also change the consistency group later. When you use a consistency group, you prepare and start that group instead of the individual mappings. This ensures that a consistent copy is made of all the source virtual disks (VDisks). Mappings to control at an individual level are known as stand-alone mappings. Do not place stand-alone mappings into a consistency group because they become controlled as part of that consistency group.

When you copy data from one VDisk to another, the data might not include all that you need to enable you to use the copy. Many applications have data that spans multiple VDIsks and requires that data integrity is preserved across VDIsks. For example, the logs for a particular database usually reside on a different VDisk than the VDisk that contains the data.

Consistency groups address the problem when applications have related data that spans multiple VDIsks. In this situation, FlashCopy operations must be performed in a way that preserves data integrity across the multiple VDIsks. One requirement for preserving the integrity of data being written is to ensure that dependent writes are run in the intended sequence of the application.

You can set the autodelete attribute for FlashCopy consistency groups. If this attribute is set to on, the consistency group is automatically deleted when the last mapping in the group is deleted or moved out of the consistency group.

Multiple target FlashCopy mappings

Consistency groups aggregate FlashCopy mappings, not the VDIsks themselves. Therefore, a source VDisk with multiple FlashCopy mappings can be in different consistency groups. If a VDisk is the source VDisk for several FlashCopy mappings that are in the same consistency group, multiple identical copies of the source VDisk are created when the consistency group is started.

Cascaded FlashCopy mappings

To create a FlashCopy mapping in a consistency group, the source VDisk cannot be the target of a mapping in the same consistency group. In addition, the target

VDisk cannot be the source of another FlashCopy mapping in the same consistency group. You cannot move a FlashCopy mapping into a consistency group that contains similar FlashCopy mappings in the cascade.

FlashCopy consistency group states

At any point in time, a FlashCopy consistency group is in one of the following states:

Idle_or_Copied

All FlashCopy Mappings in this consistency group are in the Idle or Copied state.

Preparing

At least one FlashCopy mapping in this consistency group is in the Preparing state.

Prepared

The consistency group is ready to start. While in this state, the target VDIs of all FlashCopy mappings in this consistency group are not accessible.

Copying

At least one FlashCopy mapping in the consistency group is in the Copying state and no FlashCopy mappings are in the Suspended state.

Stopping

At least one FlashCopy mapping in the consistency group is in the Stopping state and no FlashCopy mappings are in the Copying or Suspended state.

Stopped

The consistency group is stopped because either you issued a command or an I/O error occurred.

Suspended

At least one FlashCopy mapping in the consistency group is in the Suspended state.

Empty The consistency group does not have any FlashCopy mappings.

Dependent writes

To preserve the integrity of data that is being written, ensure that dependent writes are run in the intended sequence of the application.

The following list is a typical sequence of write operations for a database update transaction:

1. A write operation updates the database log so that it indicates that a database update is about to take place.
2. A second write operation updates the database.
3. A third write operation updates the database log so that it indicates that the database update has completed successfully.

The database ensures correct ordering of these writes by waiting for each step to complete before starting the next. However, if the database log (updates 1 and 3) and the database itself (update 2) are on different virtual disks (VDIs) and a FlashCopy mapping is started during this update, the possibility that the database itself is copied slightly before the database log resulting in the target VDIs seeing writes (1) and (3) but not (2) must be excluded. In this case, if the database is

restarted from a backup made from the FlashCopy target disks, the database log indicates that the transaction has completed successfully when, in fact, that is not the case. The transaction is lost and the integrity of the database is compromised.

You can perform a FlashCopy operation on multiple VDisks as an atomic operation to create a consistent image of user data. To use FlashCopy this way, the SAN Volume Controller supports the concept of a consistency group. A consistency group can contain an arbitrary number of FlashCopy mappings, up to the maximum number of FlashCopy mappings that are supported by a SAN Volume Controller cluster. You can use the command-line interface (CLI) **svctask startfcconsistgrp** command to start the point-in-time copy for the entire consistency group. All of the FlashCopy mappings in the consistency group are started at the same time, resulting in a point-in-time copy that is consistent across all of the FlashCopy mappings that are contained in the consistency group.

See the following Web site for the latest maximum configuration support:

www.ibm.com/storage/support/2145

Grains and the FlashCopy bitmap

When data is copied between virtual disks (VDisks), it is copied in units of address space known as *grains*.

The grain size is 64 KB or 256 KB. The FlashCopy bitmap contains one bit for each grain. The bit records whether the associated grain has been split by copying the grain from the source to the target.

Write to target VDisk

A write to the newest target VDisk must consider the state of the grain for its own mapping and the grain of the next oldest mapping.

- If the grain of the intermediate mapping or the next oldest mapping has not been copied, it must be copied before the write is allowed to proceed. This is done to preserve the contents of the next oldest mapping. The data written to the next oldest mapping can come from a target or source.
- If the grain of the target that is being written has not been copied, the grain is copied from the oldest already copied grain in the mappings that are newer than the target (or the source if no targets are already copied). After the copy is complete, the write can be applied to the target.

Read to target VDisk

If the grain that is being read has been split, the read returns data from the target that is being read. If the read is to an uncopied grain on an intermediate target VDisk, each of the newer mappings are examined to determine if the grain has been split. The read is surfaced from the first split grain found or from the source VDisk if none of the newer mappings have a split grain.

FlashCopy indirection layer

The FlashCopy feature provides the semantics of a point-in-time copy by using an indirection layer which intercepts I/Os that are targeted at both the source and target virtual disks (VDisks).

Starting a FlashCopy mapping causes this indirection layer to become active in the I/O path. This occurs as an atomic command across all FlashCopy mappings that are in the consistency group.

The indirection layer makes a determination about each I/O. This determination is based upon the following criteria:

- The VDisk and LBA to which the I/O is addressed,
- Its direction (read or write)
- The state of an internal data structure, the FlashCopy bitmap.

The indirection layer either allows the I/O through to the underlying storage, redirects the I/O from the target VDisk to the source VDisk or stalls the I/O while it arranges for data to be copied from the source VDisk to the target VDisk.

The following table provides an overview of the FlashCopy I/O path actions:

VDisk	Grain already copied?	Host I/O operation	
		Read	Write
Source	No	Read from source	Copies the grain to the most recently started target VDisk for this source VDisk and then writes to the source VDisk.
	Yes	Read from source	Write to source

VDisk	Grain already copied?	Host I/O operation	
Target	No	<p>When the grain has been copied, you can use the following algorithm to determine the VDisk that is being read:</p> <ol style="list-style-type: none"> 1. If newer target VDIsks exist for this source VDisk and the grain has already been copied, the read comes from the oldest target VDisk. 2. If there are no newer target VDIsks, the read comes from the source VDisk. <p>When the grain has not been copied, you can use the following algorithm to determine the VDisk that is being read:</p> <ol style="list-style-type: none"> 1. If newer target VDIsks exist for the source VDisk of the FlashCopy mapping that is the target VDisk being written to and the data has already been copied, the read is from the target VDisk. 2. If the source VDisk is not a target of another FlashCopy mapping, the read is from the source VDisk. 3. If newer target VDIsks exist for the source VDisk of the FlashCopy mapping that is the source VDisk being written to and the data has already been copied, the read is from the target VDisk. 	<ol style="list-style-type: none"> 1. If newer target VDIsks exist for this source VDisk and the grain has already been copied, the read comes from the oldest target VDisk. If there are no newer target VDIsks, the read comes from the source VDisk. 2. If the grain has not already been copied to the next oldest target VDisk for this source VDisk, the same data is also copied to the next oldest target VDisk. 3. Writes to target <p>When the grain has not been copied or overwritten, you can use the following algorithm:</p> <ol style="list-style-type: none"> 1. Use the algorithm for the corresponding read to determine the VDisk to read. 2. If there is an older target VDisk and the data has not been copied to this VDisk, the data is written to this VDisk. 3. If there is a target VDisk for this VDisk and the data has not been copied to this VDisk, the data is written to this VDisk. 4. Writes to target.
	Yes	Read from target	Write to target

Note: For cascaded FlashCopy operations, a VDisk can be both the source and the target. When the VDisk is both the source and target, the I/O path actions are handled as described for a target VDisk.

Source reads

Source reads are always passed through to the underlying source VDisk.

Target reads

To process a read from the target VDisk, the FlashCopy mapping must consult the FlashCopy bitmap. If the data has already been copied to the target VDisk, the read is sent to the target VDisk. If the data has not already been copied, the target read is either sent to the source VDisk, or to another target VDisk if multiple target FlashCopy mappings exist for the source VDisk. While the target read is outstanding, no writes that change the data that is being read are allowed to run.

Background copy and cleaning rates

FlashCopy mapping copy *rate* values can be between 1 and 100 and can be changed when the FlashCopy mapping is in any state.

If NOCOPY is specified, background copy is disabled. You can specify NOCOPY for short-lived FlashCopy mappings that are only used for backups, for example. Because the source data set is not expected to significantly change during the lifetime of the FlashCopy mapping, it is more efficient in terms of managed disk (MDisk) I/Os to not perform a background copy.

Note: For the command-line interface (CLI), the value NOCOPY is equivalent to setting the copy rate to 0 (zero).

Table 8 provides the relationship of the copy and cleaning *rate* values to the attempted number of grains to be split per second. A grain is the unit of data represented by a single bit.

Table 8. Relationship between the rate, data rate and grains per second values

User-specified <i>rate</i> attribute value	Data copied/sec	256 KB grains/sec	64 KB grains/sec
1 - 10	128 KB	0.5	2
11 - 20	256 KB	1	4
21 - 30	512 KB	2	8
31 - 40	1 MB	4	16
41 - 50	2 MB	8	32
51 - 60	4 MB	16	64
61 - 70	8 MB	32	128
71 - 80	16 MB	64	256
81 - 90	32 MB	128	512
91 - 100	64 MB	256	1024

The data copied/sec and the grains/sec numbers represent standards that the SAN Volume Controller tries to achieve. The SAN Volume Controller is unable to achieve these standards if insufficient bandwidth is available from the nodes to the physical disks that make up the managed disks (MDisks) after taking into account the requirements of foreground I/O. If this situation occurs, background copy I/O contends for resources on an equal basis with I/O that arrives from hosts. Both tend to see an increase in latency and consequential reduction in throughput with respect to the situation had the bandwidth not been limited.

Degradation runs smoothly. Background copy, stopping copy, and foreground I/O continue to make forward progress and do not stop, hang or cause the node to fail.

The background copy is performed by one of the nodes that belong to the I/O group in which the source VDisk resides. This responsibility is moved to the other node in the I/O group in the event of the failure of the node that performs the background and stopping copy.

The background copy starts with the grain that contains the highest logical block numbers (LBAs) and works in reverse towards the grain that contains LBA 0. The background copy is performed in reverse to avoid any unwanted interactions with sequential write streams from the application.

The stopping copy operation copies every grain that is split on the stopping map to the next map (if one exists) which is dependent on that grain. The operation starts searching with the grain that contains the highest LBAs and works in reverse towards the grain that contains LBA 0. Only those grains that other maps are dependent upon are copied.

Cleaning mode

When you create or modify a FlashCopy mapping, you can specify a cleaning rate for the FlashCopy mapping that is independent of the background copy rate. The cleaning rates shown in Table 8 on page 51 controls the rate at which the cleaning process operates. The cleaning process copies data from the target VDisk of a mapping to the target VDIsks of other mappings that are dependent on this data. The cleaning process must complete before the FlashCopy mapping can go to the stopping state.

Cleaning mode allows you to activate the cleaning process when the FlashCopy mapping is in the copying state. This keeps your target VDisk accessible while the cleaning process is running. When operating in this mode, it is possible that host I/O operations can prevent the cleaning process from reaching 100% if the I/O operations continue to copy new data to the target VDIsks. However, it is possible to minimize the amount of data that requires cleaning while the mapping is stopping.

Cleaning mode is active if the background copy progress has reached 100% and the mapping is in the copying state, or if the background copy rate is set to 0.

Metro Mirror and Global Mirror

The Metro Mirror and Global Mirror Copy Services features enable you to set up a relationship between two virtual disks (VDIsks), so that updates that are made by an application to one VDisk are mirrored on the other VDisk.

Although the application only writes to a single VDisk, the SAN Volume Controller maintains two copies of the data. If the copies are separated by a significant distance, the Metro Mirror and Global Mirror copies can be used as a backup for disaster recovery. A prerequisite for the SAN Volume Controller Metro Mirror and Global Mirror operations between two clusters is that the SAN fabric to which they are attached provides adequate bandwidth between the clusters.

For both Metro Mirror and Global Mirror copy types, one VDisk is designated the primary and the other VDisk is designated the secondary. Host applications write data to the primary VDisk, and updates to the primary VDisk are copied to the secondary VDisk. Normally, host applications do not perform I/O operations to the secondary VDisk.

The Metro Mirror feature provides a *synchronous*-copy process. When a host writes to the primary VDisk, it does not receive confirmation of I/O completion until the write operation has completed for the copy on both the primary VDisk and the secondary VDisk. This ensures that the secondary VDisk is always up-to-date with the primary VDisk in the event that a failover operation must be performed. However, the host is limited to the latency and bandwidth limitations of the communication link to the secondary VDisk.

The Global Mirror feature provides an *asynchronous*-copy process. When a host writes to the primary VDisk, confirmation of I/O completion is received before the write operation has completed for the copy on the secondary VDisk. If a failover operation is performed, the application must recover and apply any updates that were not committed to the secondary VDisk. If I/O operations on the primary VDisk are paused for a small length of time, the secondary VDisk can become an exact match of the primary VDisk.

The Metro Mirror and Global Mirror operations support the following functions:

- Intracluster copying of a VDisk, in which both VDIsks belong to the same cluster and I/O group within the cluster.
- Intercluster copying of a VDisk, in which one VDisk belongs to a cluster and the other VDisk belongs to a different cluster.

Note: A cluster can only participate in active Metro Mirror and Global Mirror relationships with itself and one other cluster.

- Intercluster and intracluster Metro Mirror and Global Mirror relationships can be used concurrently within a cluster.
- The intercluster link is bidirectional. This means that it can copy data from cluster A to cluster B for one pair of VDIsks while copying data from cluster B to cluster A for a different pair of VDIsks.
- The copy direction can be reversed for a consistent relationship.
- Consistency groups are supported to manage a group of relationships that must be kept synchronized for the same application. This also simplifies administration, because a single command that is issued to the consistency group is applied to all the relationships in that group.

Metro Mirror and Global Mirror relationships

Metro Mirror and Global Mirror relationships define the relationship between two virtual disks (VDIsks): a master VDisk and an auxiliary VDisk.

Typically, the master VDisk contains the production copy of the data and is the VDisk that the application normally accesses. The auxiliary VDisk typically contains a backup copy of the data and is used for disaster recovery.

The master and auxiliary VDIsks are defined when the relationship is created, and these attributes never change. However, either VDisk can operate in the primary or secondary role as necessary. The primary VDisk contains a valid copy of the application data and receives updates from the host application, analogous to a source VDisk. The secondary VDisk receives a copy of any updates to the primary VDisk, because these updates are all transmitted across the Mirror link. Therefore, the secondary VDisk is analogous to a continuously updated target VDisk. When a relationship is created, the master VDisk is assigned the role of primary VDisk and the auxiliary VDisk is assigned the role of secondary VDisk. Therefore, the initial copying direction is from master to auxiliary. When the relationship is in a

consistent state, you can reverse the copy direction from the command-line interface (CLI) or the SAN Volume Controller Console.

The two VDisks in a relationship must be the same size. When the two VDisks are in the same cluster, they must be in the same I/O group.

A relationship can be added to a consistency group, for ease of application management.

Note: Membership of a consistency group is an attribute of the relationship, not the consistency group. Therefore, issue the **svctask chrrelationship** command to add or remove a relationship to or from a consistency group. See the *IBM System Storage SAN Volume Controller Command-Line Interface User's Guide*.

Copy types

A Metro Mirror copy ensures that updates are committed to both the primary and secondary VDisks before sending confirmation of I/O completion to the host application. This ensures that the secondary VDisk is synchronized with the primary VDisk in the event that a failover operation is performed.

A Global Mirror copy allows the host application to receive confirmation of I/O completion before the updates are committed to the secondary VDisk. If a failover operation is performed, the host application must recover and apply any updates that were not committed to the secondary VDisk.

States

When a Metro Mirror or Global Mirror relationship is created with two VDisks in different clusters, the distinction between the connected and disconnected states is important. These states apply to both clusters, the relationships, and the consistency groups. The following Metro Mirror and Global Mirror relationship states are possible:

Inconsistent (Stopped)

The primary VDisk is accessible for read and write I/O operations but the secondary VDisk is not accessible for either. A copy process must be started to make the secondary VDisk consistent.

Inconsistent (Copying)

The primary VDisk is accessible for read and write I/O operations but the secondary VDisk is not accessible for either. This state is entered after an **svctask startrelationship** command is issued to a consistency group in the InconsistentStopped state. This state is also entered when an **svctask startrelationship** command is issued, with the force option, to a consistency group in the Idling or ConsistentStopped state.

Consistent (Stopped)

The secondary VDisk contains a consistent image, but it might be out of date with respect to the primary VDisk. This state can occur when a relationship was in the ConsistentSynchronized state and experiences an error that forces a freeze of the consistency group. This state can also occur when a relationship is created with the CreateConsistentFlag set to TRUE.

Consistent (Synchronized)

The primary VDisk is accessible for read and write I/O operations. The secondary VDisk is accessible for read-only I/O operations.

Idling A master VDisk and an auxiliary VDisk operates in the primary role. Consequently the VDisk is accessible for write I/O operations.

Idling (Disconnected)

The VDIs in this half of the consistency group are all operating in the primary role and can accept read or write I/O operations.

Inconsistent (Disconnected)

The VDIs in this half of the consistency group are all operating in the secondary role and cannot accept read or write I/O operations.

Consistent (Disconnected)

The VDIs in this half of the consistency group are all operating in the secondary role and can accept read I/O operations but not write I/O operations.

Metro Mirror and Global Mirror relationships between two clusters

Metro Mirror and Global Mirror relationships can exist simultaneously between two clusters. In this type of configuration, there can be impacts to performance because write data from both Metro Mirror and Global Mirror relationships is transported over the same intercluster links.

Metro Mirror and Global Mirror relationships manage heavy workload differently. Metro Mirror typically maintains the relationships that are in the copying or synchronized states, which causes the primary host applications to see degraded performance. Global Mirror requires a higher level of write performance to primary host applications. If the link performance is severely degraded, the link tolerance feature automatically stops Global Mirror relationships when the link tolerance threshold is exceeded. As a result, Global Mirror writes can suffer degraded performance if Metro Mirror relationships use most of the capability of the intercluster link.

Metro Mirror and Global Mirror partnerships

Metro Mirror and Global Mirror partnerships define an association between a local cluster and a remote cluster.

SAN Volume Controller nodes must know not only about the relationship between the two VDIs but also about an association between two clusters.

To establish a Metro Mirror and Global Mirror partnership between two clusters, you must run the **svctask mkpartnership** command from both clusters. For example, to establish a partnership between clusterA and clusterB, you must run the **svctask mkpartnership** command from clusterA and specify clusterB as the remote cluster. At this point the partnership is partially configured and is sometimes described as one-way communication. Next, you must run the **svctask mkpartnership** command from clusterB and specify clusterA as the remote cluster. When this command completes, the partnership is fully configured for two-way communication between the clusters. You can also use the SAN Volume Controller Console to create Metro Mirror and Global Mirror partnerships.

To change Metro Mirror and Global Mirror partnerships, use the **svctask chpartnership** command. To delete Metro Mirror and Global Mirror partnerships, use the **svctask rmpartnership** command.

| **Attention:** Before you run the `svctask rmpartnership` command, you must remove
| all relationships and groups that are defined between the two clusters.
| To display cluster relationships and groups, run the `svcinfo`
| `lsrrelationship` and `svcinfo lsrconsistgrp` commands. To remove the
| relationships and groups that are defined between the two clusters, run
| the `svctask rmrrelationship` and `svctask rmrconsistgrp` commands.
| See the *IBM System Storage SAN Volume Controller Command-Line*
| *Interface User's Guide* for detailed command usage information.

Background copy management

You can specify the rate at which the initial background copy from the local cluster to the remote cluster is performed. The bandwidth parameter controls this rate.

Configuration requirements

To use the Global Mirror feature, all components in the SAN must be capable of sustaining the workload that is generated by application hosts and the Global Mirror background copy process. If all of the components in the SAN cannot sustain the workload, the Global Mirror relationships are automatically stopped to protect your application hosts from increased response times.

When using the Global Mirror feature, follow these best practices:

- Use IBM TotalStorage Productivity Center or an equivalent SAN performance analysis tool to monitor your SAN environment. The IBM TotalStorage Productivity Center provides an easy way to analyze the SAN Volume Controller performance statistics.
- Analyze the SAN Volume Controller performance statistics to determine the peak application write workload that the link must support. Gather statistics over a typical application I/O workload cycle.
- Set the background copy rate to a value that supports the intercluster link and the backend storage controllers at the remote cluster.
- Do not use cache-disabled VDisks in Global Mirror relationships.
- Set the `gmlinktolerance` parameter to an appropriate value. The default value is 300 seconds (5 minutes).
- When you perform SAN maintenance tasks, take one of the following actions:
 - Reduce the application I/O workload for the duration of the maintenance task.
 - Disable the `gmlinktolerance` feature or increase the `gmlinktolerance` value.

Note: If the `gmlinktolerance` value is increased during the maintenance task, do not set it to the normal value until the maintenance task is complete. If the `gmlinktolerance` feature is disabled for the duration of the maintenance task, enable it after the maintenance task is complete.

- Stop the Global Mirror relationships.
- Evenly distribute the preferred nodes for the Global Mirror VDisks between the nodes in the clusters. Each VDisk in an I/O group has a preferred node property that can be used to balance the I/O load between nodes in the I/O group. The preferred node property is also used by the Global Mirror feature to route I/O operations between clusters. A node that receives a write for a VDisk is normally the preferred node for that VDisk. If the VDisk is in a Global Mirror relationship, the node is responsible for sending the write to the preferred node of the secondary VDisk. The preferred node property alternates between the nodes of an I/O group as VDisks are created within the I/O group. Each node

in the remote cluster has a set pool of Global Mirror system resources for each node in the local cluster. To maximize Global Mirror performance, set the preferred nodes for the VDisks of the remote cluster to use every combination of primary nodes and secondary nodes.

Long distance links for Metro Mirror and Global Mirror partnerships

For intracenter partnerships, all clusters can be considered as candidates for Metro Mirror or Global Mirror operations. For intercenter partnerships, cluster pairs must be separated by a number of moderately high bandwidth links.

Figure 12 shows an example of a configuration that uses dual redundant fabrics. Part of each fabric is located at the local cluster and the remote cluster. There is no direct connection between the two fabrics.

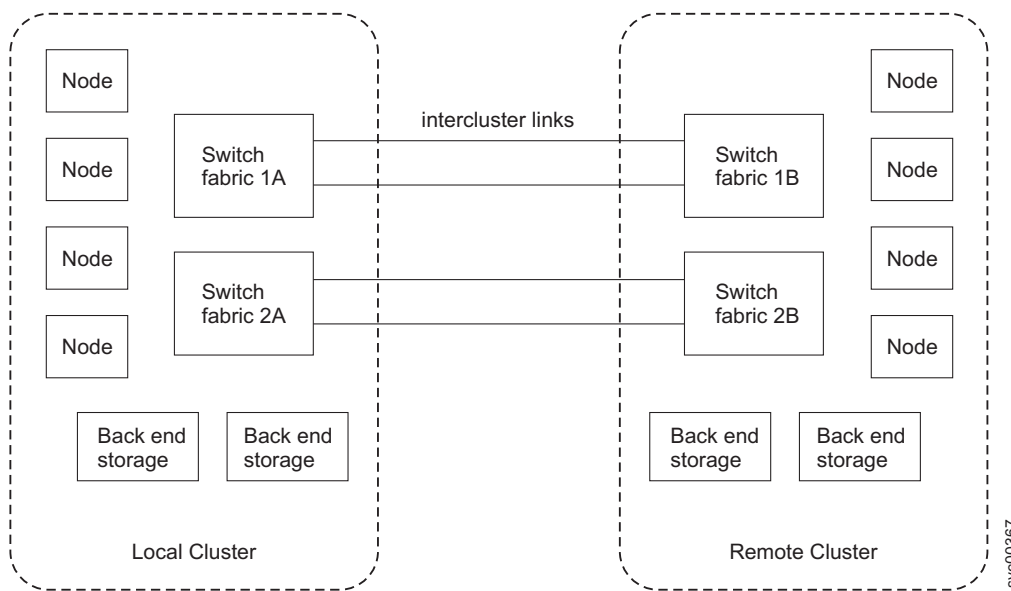


Figure 12. Redundant fabrics

You can use fibre-channel extenders or SAN routers to increase the distance between two clusters. Fibre-channel extenders transmit fibre-channel packets across long links without changing the contents of the packets. SAN routers provide virtual nPorts on two or more SANs to extend the scope of the SAN. The SAN router distributes the traffic from one virtual nPort to the other virtual nPort. The two fibre-channel fabrics are independent of each other. Therefore, nPorts on each of the fabrics cannot directly log into each other. See the following Web site for specific firmware levels and the latest supported hardware:

www.ibm.com/storage/support/2145

If you use fibre-channel extenders or SAN routers, you must meet the following requirements:

- For SAN Volume Controller software level 4.1.0, the round-trip latency between sites cannot exceed 68 ms for fibre-channel extenders or 20 ms for SAN routers.
- For SAN Volume Controller software level 4.1.1 or higher, the round-trip latency between sites cannot exceed 80 ms for either fibre-channel extenders or SAN routers.

- The configuration must be tested with the expected peak workloads.
- Metro Mirror and Global Mirror require a specific amount of bandwidth for intercluster heartbeat traffic. The amount of traffic depends on the number of nodes that are in both the local cluster and the remote cluster. Table 9 lists the intercluster heartbeat traffic for the primary cluster and the secondary cluster. These numbers represent the total traffic between two clusters when there are no I/O operations running on the copied VDisks. Half of the data is sent by the primary cluster and half of the data is sent by the secondary cluster so that traffic is evenly divided between all of the available intercluster links. If you have two redundant links, half of the traffic is sent over each link.

Table 9. Intercluster heartbeat traffic in Mbps

Cluster 1	Cluster 2			
	2 nodes	4 nodes	6 nodes	8 nodes
2 nodes	2.6	4.0	5.4	6.7
4 nodes	4.0	5.5	7.1	8.6
6 nodes	5.4	7.1	8.8	10.5
8 nodes	6.7	8.6	10.5	12.4

- The bandwidth between two sites must meet the peak workload requirements and maintain the maximum round-trip latency between the sites. When you evaluate the workload requirement, you must consider the average write workload over a period of one minute or less and the required synchronization copy bandwidth. If there are no active synchronization copies and no write I/O operations for VDisks that are in the Metro Mirror or Global Mirror relationship, the SAN Volume Controller protocols operate with the bandwidth that is indicated in Table 9. However, you can only determine the actual amount of bandwidth that is required for the link by considering the peak write bandwidth to VDisks that are participating in Metro Mirror or Global Mirror relationships and then adding the peak write bandwidth to the peak synchronization bandwidth.
- If the link between two sites is configured with redundancy so that it can tolerate single failures, the link must be sized so that the bandwidth and latency statements are correct during single failure conditions.
- The channel must not be used for links between nodes in a single cluster. Configurations that use long distance links in a single cluster are not supported and can cause I/O errors and loss of access.
- The configuration is tested to confirm that any failover mechanisms in the intercluster links interoperate satisfactorily with the SAN Volume Controller.
- All other SAN Volume Controller configuration requirements are met.

Limitations on host to cluster distances

There is no limit on the fibre-channel optical distance between SAN Volume Controller nodes and host servers. You can attach a server to an edge switch in a core-edge configuration with the SAN Volume Controller cluster at the core. SAN Volume Controller clusters support up to three ISL hops in the fabric. This means that the host server and the SAN Volume Controller cluster can be separated by up to five fibre-channel links. If you use longwave SFPs, four of the fibre-channel links can be 10 km long.

Using the intercluster link for host traffic

If you use the intercluster link for host traffic, ensure that you have sufficient bandwidth to support all sources of load.

Scenario: The hosts in a local cluster can read and write to the VDisks in a remote cluster

In this scenario, the hosts in the local cluster also exchange heartbeats with the hosts that are in the remote cluster. Because the intercluster link is being used for multiple purposes, you must have sufficient bandwidth to support the following sources of load:

- Global Mirror or Metro Mirror data transfers and the SAN Volume Controller cluster heartbeat traffic.
- Local host to remote VDisk I/O traffic or remote host to local VDisk I/O traffic.
- Local host to remote host heartbeat traffic. If the local host to remote VDisk I/O traffic is allowed to consume a high percentage of intercluster link bandwidth, the latency seen by the hosts that access SAN Volume Controller VDisks that are participating in Metro Mirror or Global Mirror operations can be impacted. The bandwidth congestion can cause the Global Mirror link tolerance threshold to be exceeded. When the Global Mirror link tolerance threshold is exceeded, Global Mirror relationships are stopped.

Metro Mirror and Global Mirror consistency groups

You can group Metro Mirror or Global Mirror relationships into a consistency group so that they can be updated at the same time. A command that is issued to the consistency group is simultaneously applied to all of the relationships in the group.

Relationships can be based on “loose” or “tight” associations. A more significant use arises when the relationships contain virtual disks (VDisks) with a tight association. A simple example of a tight association is the spread of data for an application across more than one VDisk. A more complex example is when multiple applications run on different host systems. Each application has data on different VDisks, and these applications exchange data with each other. In both examples, specific rules exist as to how the relationships can be updated. This ensures that the set of secondary VDisks contain usable data. The key property is that these relationships are consistent.

Relationships can only belong to one consistency group; however, they do not have to belong to a consistency group. Relationships that are not part of a consistency group are called stand-alone relationships. A consistency group can contain zero or more relationships. All the relationships in a consistency group must have matching primary and secondary clusters, sometimes referred to as master and auxiliary clusters. All relationships in a consistency group must also have the same copy direction and state.

Metro Mirror and Global Mirror relationships cannot belong to the same consistency group. A copy type is automatically assigned to a consistency group when the first relationship is added to the consistency group. After the consistency group is assigned a copy type, only relationships of that copy type can be added to the consistency group. Each cluster can have a maximum of six different types of consistency groups. The following types of consistency groups are possible:

- Intracluster Metro Mirror
- Intercluster Metro Mirror from the local cluster to remote cluster

- Intercluster Metro Mirror from the remote cluster to local cluster
- Intracluster Global Mirror
- Intercluster Global Mirror from the local cluster to remote cluster
- Intercluster Global Mirror from the remote cluster to local cluster

States

A consistency group can be in one of the following states:

Inconsistent (stopped)

The primary VDisks are accessible for read and write I/O operations but the secondary VDisks are not accessible for either. A copy process must be started to make the secondary VDisks consistent.

Inconsistent (copying)

The primary VDisks are accessible for read and write I/O operations but the secondary VDisk are not accessible for either. This state is entered after the **svctask startrcconsistgrp** command is issued to a consistency group in the InconsistentStopped state. This state is also entered when the **svctask startrcconsistgrp** command is issued, with the force option, to a consistency group in the Idling or ConsistentStopped state.

Consistent (stopped)

The secondary VDisks contain a consistent image, but it might be out-of-date with respect to the primary VDisks. This state can occur when a relationship was in the ConsistentSynchronized state and experiences an error that forces a freeze of the consistency group. This state can also occur when a relationship is created with the CreateConsistentFlag set to TRUE.

Consistent (synchronized)

The primary VDisks are accessible for read and write I/O operations. The secondary VDisks are accessible for read-only I/O operations.

Idling Both the primary VDisks and the secondary VDisks are operating in the primary role. Consequently the VDisks are accessible for write I/O operations.

Idling (disconnected)

The VDisks in this half of the consistency group are all operating in the primary role and can accept read or write I/O operations.

Inconsistent (disconnected)

The VDisks in this half of the consistency group are all operating in the secondary role and cannot accept read or write I/O operations.

Consistent (disconnected)

The VDisks in this half of the consistency group are all operating in the secondary role and can accept read I/O operations but not write I/O operations.

Empty The consistency group does not contain any relationships.

Background copy bandwidth impact on foreground I/O latency

The background copy bandwidth determines the rate at which the background copy for Metro Mirror or Global Mirror Copy Services are attempted.

The background copy bandwidth can affect foreground I/O latency in one of three ways:

- If the background copy bandwidth is set too high for the intercluster link capacity, the following results can occur:
 - The background copy I/Os can back up on the intercluster link
 - For Metro Mirror, there is a delay in the synchronous secondary writes of foreground I/Os
 - For Global Mirror, the work is backlogged, which delays the processing of writes and causes the relationship to stop
 - The foreground I/O latency increases as perceived by applications
- If the background copy bandwidth is set too high for the storage at the *primary* site, background copy read I/Os overload the primary storage and delay foreground I/Os.
- If the background copy bandwidth is set too high for the storage at the *secondary* site, background copy writes at the secondary overload the secondary storage and again delay the synchronous secondary writes of foreground I/Os.
 - For Global Mirror, the work is backlogged and again the relationship is stopped

In order to set the background copy bandwidth optimally, you must consider all three resources (the primary storage, the intercluster link bandwidth and the secondary storage). Provision the most restrictive of these three resources between the background copy bandwidth and the peak foreground I/O workload. You must also consider concurrent host I/O because if other writes arrive at the primary cluster for copy to the remote site, these writes can be delayed by a high level of background copy and the hosts at the primary site receive poor write response times.

This provisioning can be done by the calculation above or by determining how much background copy can be allowed before the foreground I/O latency becomes unacceptable and then backing off to allow for peaks in workload and some safety margin.

Example

If the bandwidth setting at the primary site for the secondary cluster is set to 200 MBps (megabytes per second) and the relationships are not synchronized, the SAN Volume Controller attempts to resynchronize the relationships at a maximum rate of 200 MBps with a 25 MBps restriction for each individual relationship. The SAN Volume Controller cannot resynchronize the relationship if the throughput is restricted. The following can restrict throughput:

- The read response time of backend storage at the primary cluster
- The write response time of the backend storage at the secondary site
- Intercluster link latency

Migrating a Metro Mirror relationship to a Global Mirror relationship

You can migrate a Metro Mirror relationship to a Global Mirror relationship.

Scenario: I/O operations to the secondary VDisk can be stopped during the migration

In this scenario, you have the ability to stop I/O operations to the secondary VDisk during the migration process.

To stop I/O operations to the secondary VDisk while migrating a Metro Mirror relationship to a Global Mirror relationship, you must specify the synchronized option when you create the Global Mirror relationship.

1. Stop all host I/O operations to the primary VDisk.
2. Verify that the Metro Mirror relationship is consistent.

Important: If the Metro Mirror relationship is not consistent when it is stopped, or if any host I/O operations run between the Metro Mirror relationship being stopped and the Global Mirror relationship being created, the updates are not copied to the secondary VDisk.

3. Delete the Metro Mirror relationship.
4. Create the Global Mirror relationship between the same two VDIs.

After the Global Mirror relationship is created, you can start the relationship and resume host I/O operations.

Scenario: I/O operations to the secondary VDisk cannot be stopped during the migration

In this scenario, you do not have the ability to stop I/O operations to the secondary VDisk during the migration process.

If I/O operations to the secondary VDisk cannot be stopped, the data on the secondary VDisk becomes out-of-date. When the Global Mirror relationship is started, the secondary VDisk is inconsistent until all of the recent updates are copied to the remote site.

If you do not require a consistent copy of the VDisk at the secondary site, perform the following steps to migrate from a Metro Mirror relationship to a Global Mirror relationship:

Important: The data on the secondary VDisk is not usable until the synchronization process is complete. Depending on your link capabilities and the amount of data that is being copied, this process can take an extended period of time. You must set the background copy bandwidth for the intercluster partnerships to a value that does not overload the intercluster link.

1. Delete the Metro Mirror relationship.
2. Create and start the Global Mirror relationship between the same two VDIs.

If you require a consistent copy of the VDisk at the secondary site, perform the following steps to migrate from a Metro Mirror relationship to a Global Mirror relationship:

1. Delete the Metro Mirror relationship.
2. Create a Global Mirror relationship between VDIs that were not used for the Metro Mirror relationship. This preserves the VDisk so that you can use it if you require a consistent copy at a later time.

Alternatively, you can use the FlashCopy feature to maintain a consistent copy. Perform the following steps to use the FlashCopy feature to maintain a consistent copy:

1. Start a FlashCopy operation for the Metro Mirror VDisk.

2. Wait for the FlashCopy operation to complete.
3. Create and start the Global Mirror relationship between the same two VDisks. The FlashCopy VDisk is now your consistent copy.

Using FlashCopy to create a consistent image before restarting a Global Mirror relationship

For disaster recovery purposes, you can use the FlashCopy feature to create a consistent copy of an image before you restart a Global Mirror relationship.

When a consistent relationship is stopped, the relationship enters the `consistent_stopped` state. While in this state, I/O operations at the primary site continue to run. However, updates are not copied to the secondary site. When the relationship is restarted, the synchronization process for new data is started. During this process, the relationship is in the `inconsistent_copying` state. The secondary VDisk for the relationship cannot be used until the copy process completes and the relationship returns to the consistent state. When this occurs, start a FlashCopy operation for the secondary VDisk before you restart the relationship. While the relationship is in the copying state, the FlashCopy feature can provide a consistent copy of the data. If the relationship does not reach the synchronized state, you can use the FlashCopy target VDisk at the secondary site.

The SVCTools package that is available on the IBM Alphasworks Web site provides an example script that demonstrates how to manage the FlashCopy process. See the `copymanager` script that is available in the SVCTools package. You can download the SVCTools package from the following Web site:

www.alphaworks.ibm.com/tech/svctools/download

Monitoring Global Mirror performance with the IBM System Storage Productivity Center

You can use the IBM System Storage Productivity Center (SSPC) to monitor key Global Mirror performance measurements.

It is important to use a Storage Area Network (SAN) performance monitoring tool to ensure that all SAN components are performing correctly. This is particularly important when you use an asynchronous copying solution such as the SAN Volume Controller Global Mirror feature. SSPC monitors key performance measures and alerts you when thresholds are exceeded.

Note: If your VDisk or MDisk configuration changes, restart the SSPC performance report to ensure that performance is monitored for the new configuration.

Use SSPC to check the following measurements:

- The *Port to Remote Node Send Response Time* measurement is less than 80 milliseconds. If this measurement is greater than 80 milliseconds during monitoring, the long-distance link has excessive latency. Ensure that the link is operating at its maximum bandwidth.
- The sum of the *Port to Local Node Send Response Time* measurement and the *Port to Local Node Send Queue* measurement is less than 1 millisecond for the primary cluster and the CPU Utilization Percentage is below 50%. A value that exceeds these amounts can indicate that an I/O group is reaching the I/O throughput limit, which can limit performance.

- The sum of the *Backend Write Response Time* measurement and the *Write Queue Time for Global Mirror MDisks* measurement of the secondary cluster is less than 100 milliseconds. A longer response time can indicate that the storage controller is overloaded.
- The sum of the *Backend Write Response Time* measurement and the *Write Queue Time for Global Mirror MDisks* measurement of the primary cluster is less than 100 milliseconds. If the response time is greater than 100 milliseconds, application hosts might see extended response times when the SAN Volume Controller cluster cache is full.
- The *Write Data Rate for Global Mirror MDisk groups* measurement of the secondary cluster indicates the amount of data that is being written by Global Mirror operations. If this value approaches either the intercluster link bandwidth or the storage controller throughput limit, further increases can cause overloading of the system. Monitor for this condition in a way that is appropriate for your network.

The gmlinktolerance feature

You can use the `svctask chcluster` CLI command or the SAN Volume Controller Console to set the `gmlinktolerance` feature. The `gmlinktolerance` feature represents the number of seconds that the primary SAN Volume Controller cluster tolerates slow response times from the secondary cluster.

If the poor response extends past the specified tolerance, a 1920 error is logged and one or more Global Mirror relationships are automatically stopped. This protects the application hosts at the primary site. During normal operation, application hosts see a minimal impact to response times because the Global Mirror feature uses asynchronous replication. However, if Global Mirror operations experience degraded response times from the secondary cluster for an extended period of time, I/O operations begin to queue at the primary cluster. This results in an extended response time to application hosts. In this situation, the `gmlinktolerance` feature stops Global Mirror relationships and the application hosts response time returns to normal. After a 1920 error has occurred, the Global Mirror auxiliary VDisks are no longer in the `consistent_synchronized` state until you fix the cause of the error and restart your Global Mirror relationships. For this reason, ensure that you monitor the cluster to track when this occurs.

You can disable the `gmlinktolerance` feature by setting the `gmlinktolerance` value to 0 (zero). However, the `gmlinktolerance` cannot protect applications from extended response times if it is disabled. It might be appropriate to disable the `gmlinktolerance` feature in the following circumstances:

- During SAN maintenance windows where degraded performance is expected from SAN components and application hosts can withstand extended response times from Global Mirror VDisks.
- During periods when application hosts can tolerate extended response times and it is expected that the `gmlinktolerance` feature might stop the Global Mirror relationships. For example, if you are testing using an I/O generator which is configured to stress the backend storage, the `gmlinktolerance` feature might detect the high latency and stop the Global Mirror relationships. Disabling `gmlinktolerance` prevents this at the risk of exposing the test host to extended response times.

Diagnosing and fixing 1920 errors

A 1920 error indicates that one or more of the SAN components are unable to provide the performance that is required by the application hosts. This can be temporary (for example, a result of maintenance activity) or permanent (for example, a result of a hardware failure or unexpected host I/O workload). If you are experiencing 1920 errors, set up a SAN performance analysis tool, such as the IBM TotalStorage Productivity Center, and make sure that it is correctly configured and monitoring statistics when the problem occurs. Set your SAN performance analysis tool to the minimum available statistics collection interval. For the IBM TotalStorage Productivity Center, the minimum interval is five minutes. If several 1920 errors have occurred, diagnose the cause of the earliest error first. The following questions can help you determine the cause of the error:

- Was maintenance occurring at the time of the error? This might include replacing a storage controller's physical disk, upgrading a storage controller's firmware, or performing a code upgrade on one of the SAN Volume Controller clusters. You must wait until the maintenance procedure is complete and then restart the Global Mirror relationships. You must wait until the maintenance procedure is complete to prevent a second 1920 error because the system has not yet returned to a stable state with good performance.
- Were there any unfixed errors on either the source or target system? If yes, analyze them to determine if they might have been the reason for the error. In particular, see if they either relate to the VDisk or MDisks that are being used in the relationship, or if they would have caused a reduction in performance of the target system. Ensure that the error is fixed before you restart the Global Mirror relationship.
- Is the long distance link overloaded? If your link is not capable of sustaining the short-term peak Global Mirror workload, a 1920 error can occur. Perform the following checks to determine if the long distance link is overloaded:
 - Look at the total Global Mirror auxiliary VDisk write throughput before the Global Mirror relationships were stopped. If this is approximately equal to your link bandwidth, your link might be overloaded. This might be due to application host I/O operations or a combination of host I/O and background (synchronization) copy activities.
 - Look at the total Global Mirror source VDisk write throughput before the Global Mirror relationships were stopped. This represents the I/O operations that are being performed by the application hosts. If these operations are approaching the link bandwidth, upgrade the link's bandwidth, reduce the I/O operations that the application is attempting to perform, or use Global Mirror to copy fewer VDIs. If the auxiliary disks show significantly more write I/O operations than the source VDIs, there is a high level of background copy. Decrease the Global Mirror partnership's background copy rate parameter to bring the total application I/O bandwidth and background copy rate within the link's capabilities.
 - Look at the total Global Mirror source VDisk write throughput after the Global Mirror relationships were stopped. If write throughput increases by 30% or more when the relationships are stopped, the application hosts are attempting to perform more I/O operations than the link can sustain. While the Global Mirror relationships are active, the overloaded link causes higher response times to the application host, which decreases the throughput it can achieve. After the Global Mirror relationships have stopped, the application host sees lower response times. In this case, the link bandwidth must be increased, the application host I/O rate must be decreased, or fewer VDIs must be copied using Global Mirror.

- Are the storage controllers at the secondary cluster overloaded? If one or more of the MDisk on a storage controller are providing poor service to the SAN Volume Controller cluster, a 1920 error occurs if this prevents application I/O operations from proceeding at the rate that is required by the application host. If the backend storage controller requirements have been followed, the error might have been caused by a decrease in controller performance. Use IBM TotalStorage Productivity Center to obtain the backend write response time for each MDisk at the secondary cluster. If the response time for any individual MDisk exhibits a sudden increase of 50 ms or more or if the response time is above 100 ms, this indicates a problem. Perform the following checks to determine if the storage controllers are overloaded:
 - Check the storage controller for error conditions such as media errors, a failed physical disk, or associated activity such as RAID array rebuilding. If there is an error, you should fix the problem and then restart the Global Mirror relationships.
 - If there is no error, determine if the secondary controller is capable of processing the required level of application host I/O operations. It might be possible to improve the performance of the controller by adding more physical disks to a RAID array, changing the RAID level of the array, changing the controller's cache settings and checkin the cache battery to ensure it is operational, or changing other controller-specific configuration parameters.
- Are the storage controllers at the primary cluster overloaded? Analyze the performance of the primary backend storage using the same steps as for the secondary backend storage. If performance is bad, limit the amount of I/O operations that can be performed by application hosts. Monitor the backend storage at the primary site even if the Global Mirror relationships have not been affected. If bad performance continues for a prolonged period, a 1920 error occurs and the Global Mirror relationships are stopped.
- Is one of your SAN Volume Controller clusters overloaded? Use IBM TotalStorage Productivity Center to obtain the port to local node send response time and the port to local node send queue time. If the total of these two statistics for either cluster is above 1 millisecond, the SAN Volume Controller might be experiencing a very high I/O load. Also check the SAN Volume Controller node CPU utilization. If this figure is above 50%, this can also be contributing to the problem. In either case, contact your IBM service representative for further assistance. If CPU utilization is much higher for one node than for the other node in the same I/O group, this might be caused by having different node hardware types within the same I/O group. For example, a SAN Volume Controller 2145-8F4 in the same I/O group as a SAN Volume Controller 2145-8G4. If this is the case, contact your IBM service representative.
- Do you have FlashCopy operations in the prepared state at the secondary cluster? If the Global Mirror auxiliary VDisks are the sources of a FlashCopy mapping and that mapping is in the prepared state for an extended time, performance to those VDisks can be impacted because the cache is disabled. Start the FlashCopy mapping to enable the cache and improve performance for Global Mirror I/O operations.

Valid combinations of FlashCopy and Metro Mirror or Global Mirror functions

The following table outlines the combinations of FlashCopy and Metro Mirror or Global Mirror functions that are valid for a single virtual disk (VDisk).

FlashCopy	Metro Mirror or Global Mirror Primary	Metro Mirror or Global Mirror Secondary
FlashCopy source	Supported	Supported
FlashCopy target	Not supported	Not supported

Chapter 3. SAN fabric configuration

Ensure that you understand the rules and requirements when you are configuring the SAN fabric.

Table 10 provides terms and definitions that can guide your understanding of the rules and requirements.

Table 10. Configuration terms and definitions

Term	Definition
ISL hop	A hop on an interswitch link (ISL). With reference to all pairs of N-ports or end-nodes that are in a fabric, the number of ISL hops is the number of links that are crossed on the shortest route between the node pair whose nodes are farthest apart from each other. The distance is measured only in terms of the ISL links that are in the fabric.
Oversubscription	The ratio of the sum of the traffic that is on the initiator N-node connections to the traffic that is on the most heavily-loaded ISLs or where more than one ISL is in parallel between these switches. This definition assumes a symmetrical network and a specific workload that is applied equally from all initiators and sent equally to all targets. A symmetrical network means that all initiators are connected at the same level and all the controllers are connected at the same level. Note: The SAN Volume Controller puts its back-end traffic onto the same symmetrical network. The back-end traffic can vary by workload. Therefore, the oversubscription that a 100% read hit gives is different from the oversubscription that 100% write-miss gives. If you have an oversubscription of 1 or less, the network is nonblocking.
Virtual SAN (VSAN)	A VSAN is a virtual storage area network (SAN).
Redundant SAN	A SAN configuration in which if any one component fails, connectivity between the devices that are in the SAN is maintained, possibly with degraded performance. Create a redundant SAN by splitting the SAN into two independent counterpart SANs.
Counterpart SAN	A non-redundant portion of a redundant SAN. A counterpart SAN provides all the connectivity of the redundant SAN, but without the redundancy. The SAN Volume Controller is typically connected to a redundant SAN that is made out of two counterpart SANs.
Local fabric	The fabric that consists of those SAN components (switches and cables) that connect the components (nodes, hosts, and switches) of the local cluster. Because the SAN Volume Controller supports Metro and Global Mirror, significant distances might exist between the components of the local cluster and those of the remote cluster.
Remote fabric	The fabric that consists of those SAN components (switches and cables) that connect the components (nodes, hosts, and switches) of the remote cluster. Because the SAN Volume Controller supports Metro Mirror and Global Mirror, significant distances might exist between the components of the local cluster and those of the remote cluster.

Table 10. Configuration terms and definitions (continued)

Term	Definition
Local/remote fabric interconnect	The SAN components that connect the local fabrics to the remote fabrics. There might be significant distances between the components in the local cluster and those in the remote cluster. These components might be single-mode optical fibers that are driven by gigabit interface converters (GBICs), or they might be other, more advanced components, such as channel extenders
SAN Volume Controller fibre-channel port fan in	The number of hosts that can see any one port. Some controllers recommend that the number of hosts using each port be limited to prevent excessive queuing at that port. If the port fails or the path to that port fails, the host might failover to another port, and the fan in requirements might be exceeded in this degraded mode.
Not valid configuration	The current SAN configuration is not correct. An attempted operation failed and generated an error code to indicate what caused it to become not valid. The most likely cause is that either a device has failed, or a device has been added to the SAN that has caused the configuration to be marked as not valid.
Unsupported configuration	A configuration that might operate successfully, but for which IBM does not guarantee the solution for problems that might occur. Usually this type of configuration does not create an error log entry.
Valid configuration	A configuration that consists of devices and connections that are identified as a valid and supported configuration. Neither of the following two conditions exist with the current configuration: <ul style="list-style-type: none"> • Not valid • Unsupported configuration
Degraded	A valid configuration that has had a failure, but continues to be neither invalid nor unsupported. Typically, a repair action is required to restore the degraded configuration to a valid configuration.
Fibre channel extender	A device for long distance communication that connects other SAN fabric components. Generally these components might involve protocol conversion to ATM, IP, or some other long-distance communication protocol.
Mesh configuration	A network that contains a number of small SAN switches that are configured to create a larger switched network. With this configuration, four or more switches are connected in a loop with some of the paths short circuiting the loop. An example of this configuration is four switches that are connected in a loop with ISLs for one of the diagonals.

SAN fabric overview

The SAN fabric is an area of the network that contains routers, gateways, hubs, and switches. A SAN is configured into a number of zones. A device using the SAN can only communicate with devices that are included in the same zones that it is in. A SAN Volume Controller cluster requires two distinct types of zones: a host zone and a disk zone.

In the host zone, the host systems can identify and address the SAN Volume Controller nodes. You can have more than one host zone and more than one disk zone. Generally, you create one host zone for each host type. In the disk zone, the SAN Volume Controller nodes identify the disk drives. Host systems cannot operate on the disk drives directly; all data transfer occurs through the SAN

Volume Controller nodes. Figure 13 shows several host systems that are connected in a SAN fabric.

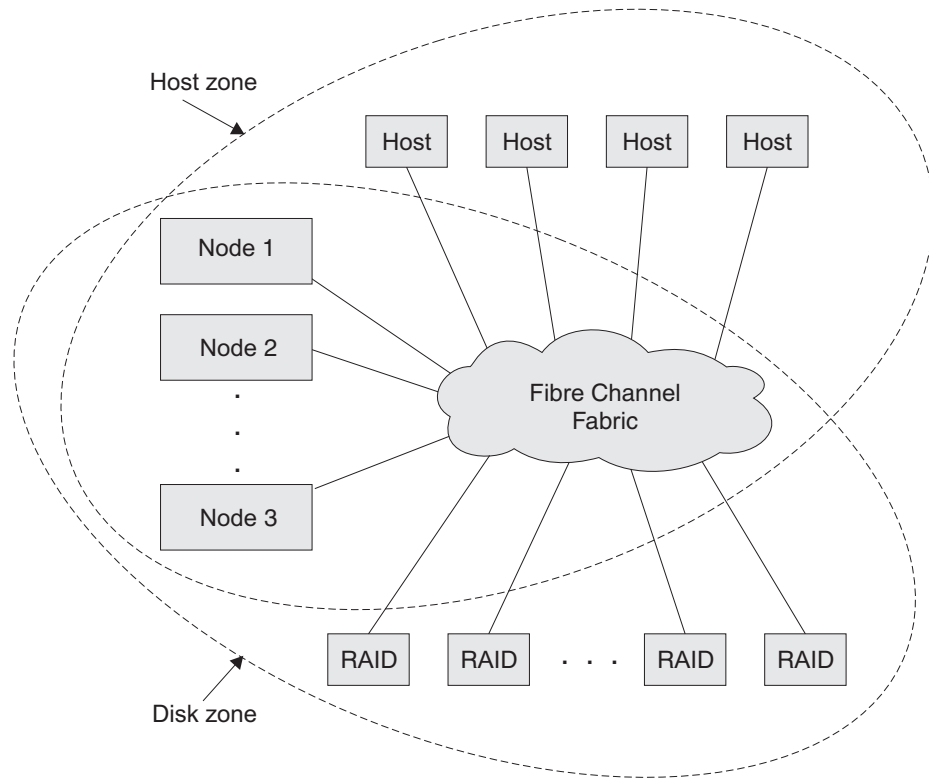


Figure 13. Example of a SAN Volume Controller cluster in a fabric

A cluster of SAN Volume Controller nodes is connected to the fibre-channel fabric and presents virtual disks (VDisks) to the host systems. You create these VDisks from units of space within a managed disk (MDisk) group. An MDisk group is a collection of MDisks that are presented by the storage systems (RAID controllers). The MDisk group provides a storage pool. You specify how each group is created, and you can combine MDisks from different manufacturers' controllers in the same MDisk group. However, to optimize the use of resources, it is recommended that all MDisks in an MDisk group have similar performance characteristics.

Note: Some operating systems cannot tolerate other operating systems in the same host zone, although you might have more than one host type in the SAN fabric. For example, you can have a SAN that contains one host that runs on an IBM AIX® operating system and another host that runs on a Microsoft® Windows operating system.

Cluster configuration information is stored on every SAN Volume Controller node that is in the cluster to allow concurrent replacement of field replaceable units (FRUs). You can remove one SAN Volume Controller node in each I/O group from a cluster when hardware service or maintenance is required. After you remove the SAN Volume Controller node, you can replace the FRUs in the SAN Volume Controller node. When a new FRU is installed and when the SAN Volume Controller node is added back into the cluster, the configuration information that is required by that SAN Volume Controller node is read from other SAN Volume Controller nodes in the cluster.

All communication between disk drives and all communication between SAN Volume Controller nodes is performed through the SAN. All SAN Volume Controller node configuration and service commands are sent to the cluster through an Ethernet network.

Each SAN Volume Controller node contains its own vital product data (VPD). Each cluster contains VPD that is common to all the SAN Volume Controller nodes in the cluster, and any system, with the correct access authority, that is connected to the Ethernet network can access this VPD.

Configuration rules

Storage area network (SAN) configurations that contain SAN Volume Controller nodes can be configured in various ways.

A SAN configuration that contains SAN Volume Controller nodes must follow the rules for the following components:

- Storage systems
- Host bus adapters
- Nodes
- Fibre-channel switches
- Fabrics
- Zoning

Storage-system configuration rules

Follow these rules when you are planning the configuration of storage systems for use with SAN Volume Controller clusters.

See the following Web site for the latest support information:

www.ibm.com/storage/support/2145

All SAN Volume Controller nodes in a cluster must be able to see the same set of storage system ports on each device. Any operation that is in this mode in which two nodes do not see the same set of ports on the same device is degraded, and the system logs errors that request a repair action. This rule can have important effects on a storage system such as an IBM System Storage DS4000™ series controller, which has exclusion rules that determine to which host bus adapter (HBA) worldwide node names (WWNNs) a storage partition can be mapped.

The SAN Volume Controller clusters must not share storage-system logical units (LUs) with hosts. A storage system can be shared with a host under certain conditions as described in this topic.

You can configure certain storage controllers to safely share resources between the SAN Volume Controller cluster and direct attached hosts. This type of configuration is described as a split controller. In all cases, it is critical that you configure the controller and SAN so that the SAN Volume Controller cluster cannot access logical units (LUs) that a host or another SAN Volume Controller cluster can also access. This split controller configuration can be arranged by controller logical unit number (LUN) mapping and masking. If the split controller configuration is not guaranteed, data corruption can occur.

Besides a configuration where a controller is split between a SAN Volume Controller cluster and a host, the SAN Volume Controller cluster also supports configurations where a controller is split between two SAN Volume Controller clusters. In all cases, it is critical that you configure the controller and SAN so that the SAN Volume Controller cluster cannot access LUs that a host or another SAN Volume Controller cluster can also access. This can be arranged by controller LUN mapping and masking. If this is not guaranteed, data corruption can occur. Do not use this configuration because of the risk of data corruption.

Avoid configuring one storage system device to present the same LU to more than one SAN Volume Controller cluster. This configuration is not supported and is very likely to cause undetected data loss or corruption.

The SAN Volume Controller cluster must be configured to manage only LUNs that are presented by supported disk controller systems. Operation with other devices is not supported.

Unsupported storage system (generic device) rules

When a storage system is detected on the SAN, the SAN Volume Controller attempts to recognize it using its Inquiry data. If the device is recognized as one of the explicitly supported storage models, the SAN Volume Controller uses error recovery procedures that are potentially tailored to the known needs of the storage system. If the device is not recognized, the SAN Volume Controller configures the device as a generic device. A generic device might not function correctly when it is addressed by a SAN Volume Controller cluster. In any event, the SAN Volume Controller cluster does not regard accessing a generic device as an error condition and, consequently, does not log an error. Managed disks (MDisks) that are presented by generic devices are not eligible to be used as quorum disks.

Split controller configurations rules

The SAN Volume Controller cluster is configured to manage LUs that are exported only by RAID controllers. Operation with other RAID controllers is illegal. While it is possible to use the SAN Volume Controller cluster to manage JBOD (just a bunch of disks) LUs that are presented by supported RAID controllers, the SAN Volume Controller cluster itself does not provide RAID functions, so these LUs are exposed to data loss in the event of a disk failure.

If a single RAID controller presents multiple LUs, either by having multiple RAID configured or by partitioning one or more RAID into multiple LUs, each LU can be owned by either the SAN Volume Controller cluster or a directly attached host. Suitable LUN masking must be in place to ensure that LUs are not shared between SAN Volume Controller nodes and direct attached hosts.

In a split controller configuration, a RAID presents some of its LUs to a SAN Volume Controller cluster (which treats the LU as an MDisk) and the remaining LUs to another host. The SAN Volume Controller cluster presents virtual disks (VDisks) that are created from the MDisk to another host. There is no requirement for the multipathing driver for the two hosts to be the same. Figure 14 on page 74 shows that the RAID controller is an IBM DS4000, with RDAC used for pathing on the directly attached host, and SDD used on the host that is attached with the SAN Volume Controller. Hosts can simultaneously access LUs that are provided by the SAN Volume Controller cluster and directly by the device.

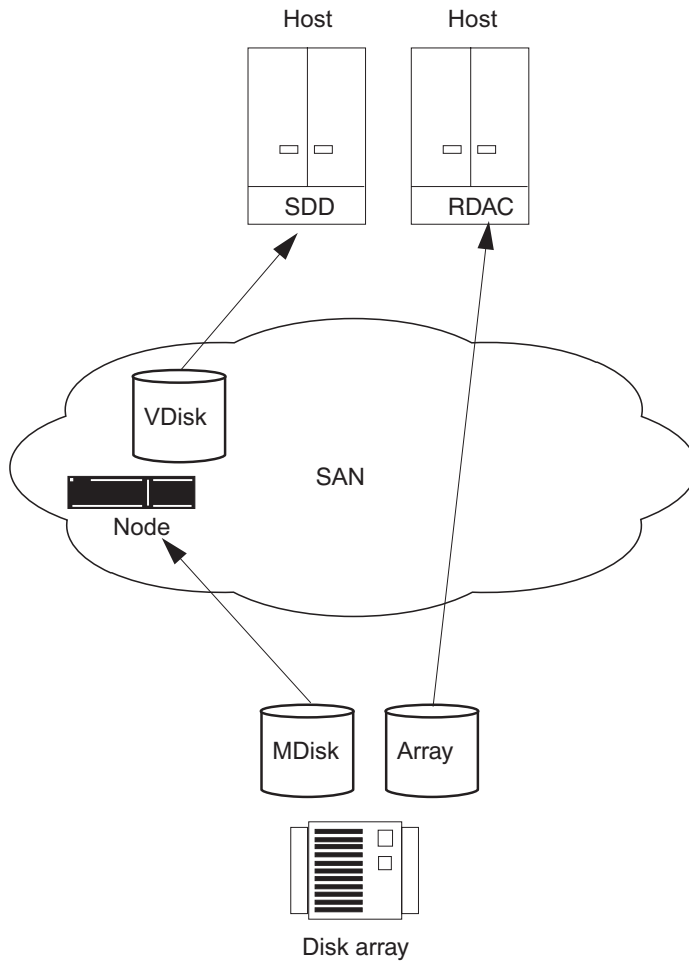


Figure 14. Disk controller system shared between SAN Volume Controller node and a host

It is also possible to split a host so that it accesses some of its LUNs through the SAN Volume Controller cluster and some directly. In this case, the multipathing software that is used by the controller must be compatible with the SAN Volume Controller multipathing software. Figure 15 on page 75 is a supported configuration because the same multipathing driver is used for both directly accessed LUNs and VDIs.

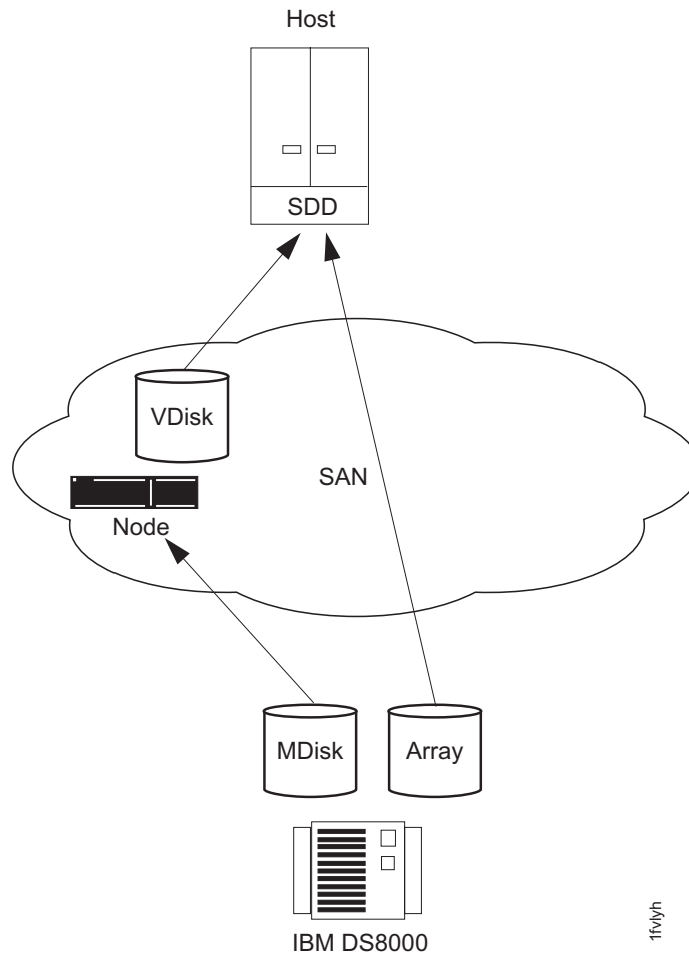


Figure 15. IBM System Storage DS8000 LUs accessed directly with a SAN Volume Controller node

In the case where the RAID controller uses multipathing software that is compatible with SAN Volume Controller multipathing software (see Figure 16 on page 76), it is possible to configure a system where some LUNs are mapped directly to the host and others are accessed through the SAN Volume Controller. An IBM TotalStorage Enterprise Storage Server (ESS) that uses the same multipathing driver as a SAN Volume Controller node is one example.

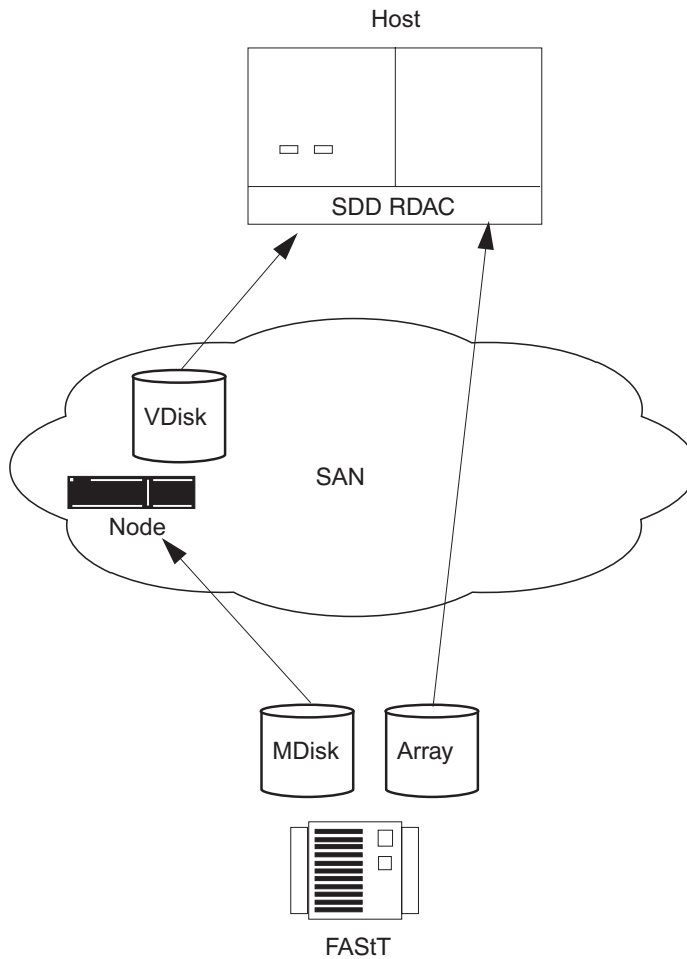


Figure 16. IBM DS4000 direct connection with a SAN Volume Controller node on one host

Host bus adapter configuration rules

Ensure that you are familiar with the configuration rules for host bus adapters (HBAs). You must abide by the configuration rules for HBAs to ensure that you have a valid configuration.

The SAN Volume Controller must be configured to export virtual disks (VDisks) only to host fibre-channel ports that are on the supported HBAs. See the following Web site for specific firmware levels and the latest supported hardware:

www.ibm.com/storage/support/2145

Operation with other HBAs is not supported.

The SAN Volume Controller does not specify the number of host fibre-channel ports or HBAs that a host or a partition of a host can have. The number of host fibre-channel ports or HBAs are specified by the host multipathing device driver. The SAN Volume Controller supports this number; however it is subject to the configuration rules for the SAN Volume Controller. To obtain optimal performance and to prevent overloading, the workload to each SAN Volume Controller port

must be equal. You can achieve an even workload by zoning approximately the same number of host fibre-channel ports to each SAN Volume Controller fibre-channel port.

You can attach the SAN Volume Controller to open-systems hosts that use the Small Computer System Interface-Fibre Channel Protocol (SCSI-FCP). You can also attach the SAN Volume Controller to Small Computer System Interface Over Internet Protocol (iSCSI) hosts using FCIP ports in your SAN fabric. iSCSI hosts are supported only in non-failover configurations.

The SAN Volume Controller supports configurations that use N-port virtualization in the host bus adapter or SAN switch.

Node configuration rules

You must follow the configuration rules for SAN Volume Controller nodes to ensure that you have a valid configuration.

Host bus adapters and nodes

SAN Volume Controller 2145-4F2 and SAN Volume Controller 2145-8F2 nodes contain two 2-port host bus adapters (HBAs). If one HBA fails, the node operates in degraded mode. If an HBA is physically removed, the configuration is not supported.

SAN Volume Controller 2145-8F4, SAN Volume Controller 2145-8G4, and SAN Volume Controller 2145-8A4 nodes contain one 4-port HBA.

VDisks

Each node presents a virtual disk (VDisk) to the SAN through four ports. Each VDisk is accessible from the two nodes in an I/O group. Each HBA port can recognize up to eight paths to each logical unit (LU) that is presented by the cluster. The hosts must run a multipathing device driver before the multiple paths can resolve to a single device. You can use fabric zoning to reduce the number of paths to a VDisk that are visible by the host.

The number of paths through the network from an I/O group to a host must not exceed eight; configurations that exceed eight paths are not supported. Each node has four ports and each I/O group has two nodes. Therefore, without any zoning, the number of paths to a VDisk is eight multiplied by the number of host ports.

Optical connections

Valid optical connections are based on the fabric rules that the manufacturers impose for the following connection methods:

- Host to a switch
- Back end to a switch
- Interswitch links (ISLs)

Short-wave optical fiber connections must be used between a node and its switches. Clusters that use the intercluster Metro Mirror or Global Mirror features can use short or long wave optical fiber connections between the switches, or they can use distance-extender technology that is supported by the switch manufacturer.

Ethernet connection

To ensure cluster failover operations, all nodes in a cluster must be connected to the same IP subnet.

Physical location

The physical distance between SAN Volume Controller nodes in the same cluster is limited to 100 meters due to connectivity requirements and servicing requirements. Several of the SAN Volume Controller service actions in problem situations require that the manipulations be done to both SAN Volume Controller nodes within an I/O group or a cluster within one minute of each other. Set up your cluster environment to enable IBM service personnel to easily perform actions that are almost simultaneous in the required timeframe.

A SAN Volume Controller node must be in the same rack as the uninterruptible power supply from which it is supplied.

The depth of the SAN Volume Controller 2145-8A4 node is less than other components or nodes by approximately 127 mm or 5 inches. The 2145-8A4 node should not be located in the rack between components or nodes with greater depths; otherwise, it will not be possible to attach cables to the 2145-8A4 node.

Fibre-channel connection

The SAN Volume Controller supports short-wave, small-form factor pluggable (SFP) transceivers (850 nm with 50 μm or 62.5 μm multimode cables) between the SAN Volume Controller nodes and the switch to which they are connected. The transceivers can run at up to 500 m and are limited by the pulse spreading that is caused by the multimode nature of the transmission.

To avoid communication between nodes that are being routed across interswitch links (ISLs), connect all SAN Volume Controller nodes to the same fibre-channel switches.

No ISL hops are permitted among the SAN Volume Controller nodes within the same I/O group. However, one ISL hop is permitted among SAN Volume Controller nodes that are in the same cluster though different I/O groups. If your configuration requires more than one ISL hop for SAN Volume Controller nodes that are in the same cluster but in different I/O groups, contact your IBM service representative.

To avoid communication between nodes and storage systems that are being routed across ISLs, connect all storage systems to the same fibre-channel switches as the SAN Volume Controller nodes. One ISL hop between the SAN Volume Controller nodes and the storage controllers is permitted. If your configuration requires more than one ISL, contact your IBM service representative.

In larger configurations, it is common to have ISLs between host systems and the SAN Volume Controller nodes.

Port speed

You can change the operational port speed for SAN Volume Controller 2145-4F2 and SAN Volume Controller 2145-8F2 nodes to 1 Gbps or 2 Gbps. However, the optical fiber connections between the fibre-channel switches and all SAN Volume

Controller 2145-4F2 and SAN Volume Controller 2145-8F2 nodes in a cluster must run at the same speed. The fibre-channel ports on SAN Volume Controller 2145-8F4 , SAN Volume Controller 2145-8G4, and SAN Volume Controller 2145-8A4 nodes autonegotiate the operational port speed independently, which results in these nodes operating at different speeds. SAN Volume Controller 2145-8F4, SAN Volume Controller 2145-8G4, and SAN Volume Controller 2145-8A4 nodes can operate at 1 Gbps, 2 Gbps, or 4 Gbps. If these nodes are connected to a 4 Gbps capable switch, the port attempts to operate at 4 Gbps; however, if there is a large number of link error rates, the adapter negotiates a lower speed.

SAN hardware configuration

Ensure that you are familiar with the configuration rules for fibre-channel switches. You must follow the configuration rules for fibre-channel switches to ensure that you have a valid configuration.

The SAN must contain only supported switches.

See the following Web site for specific firmware levels and the latest supported hardware:

www.ibm.com/storage/support/2145

The SAN should consist of at least two independent switches (or networks of switches) so that the SAN includes a redundant fabric, and has no single point of failure. If one SAN fabric fails, the configuration is in a degraded mode, but it is still valid. If the SAN contains only one fabric, it is still a valid configuration, but a failure of the fabric might cause a loss of access to data. Therefore, SANs with one fabric are considered to have a possible single point of failure.

Configurations with more than four SANs are not supported.

The SAN Volume Controller nodes must always be connected to SAN switches only. Each node must be connected to each of the counterpart SANs that are in the redundant fabric. Any configuration that uses a direct physical connection between the host and the SAN Volume Controller node is not supported.

All back-end storage must always be connected to SAN switches only. Multiple connections are permitted from the redundant controllers of the back-end storage to improve data bandwidth performance. It is not necessary to have a connection between each redundant disk-controller system of the back-end storage and each counterpart SAN. For example, in an IBM System Storage DS4000 configuration in which the IBM DS4000 contains two redundant controllers, only two controller minihubs are usually used. Controller A of the IBM DS4000 is connected to counterpart SAN A, and controller B of the IBM DS4000 is connected to counterpart SAN B. Any configuration that uses a direct connection between the host and the controller is not supported.

When you attach a node to a SAN fabric that contains core directors and edge switches, connect the node ports to the core directors and connect the host ports to the edge switches. In this type of fabric, the next priority for connection to the core directors is the storage controllers, leaving the host ports connected to the edge switches.

The switch configuration of a SAN Volume Controller SAN must observe the switch manufacturer's configuration rules. These rules might put restrictions on the switch configuration. Any configuration that runs outside the manufacturer's configuration rules is not supported.

Mixing manufacturer switches in a single SAN fabric

Within an individual SAN fabric, switches must have the same manufacturer, with the following exceptions:

- IBM BladeCenter® products. The documentation that is provided with your BladeCenter unit has more information.
- Where one pair of counterpart fabrics (for example, Fabric A and Fabric B) provide a redundant SAN, different manufacturer's switches can be mixed in a SAN Volume Controller configuration, provided that each fabric contains only switches from a single manufacturer. Thus, the two counterpart SANs can have different manufacturer's switches.
- SAN Volume Controller supports interoperability between McData and Brocade products. For further details, refer to switch vendor documentation.

For additional information on BladeCenter support and other current interoperability information, see the following Web site:

www.ibm.com/storage/support/2145

Brocade core-edge fabrics

Brocade core-edge fabrics can have up to 1024 hosts under the following conditions:

- The core switches must have at least 64 ports.

Note: The Brocade M12 is not supported as a core switch.

- SAN Volume Controller ports and storage system ports must be connected to the core switch.
- The M48 and B64 models must be running the firmware level 5.1.0c, or later.
- The M14 models must be running the firmware level 5.0.5a, or later.

Fibre-channel switches and interswitch links

The SAN Volume Controller supports distance-extender technology, including DWDM (dense wavelength division multiplexing) and FCIP (Fibre Channel over IP) extenders, to increase the overall distance between local and remote clusters. If this extender technology involves a protocol conversion, the local and remote fabrics are regarded as independent fabrics, limited to three ISL hops each.

Note: Where multiple ISL hops are used between switches, follow the fabric manufacturer's recommendations for trunking.

With ISLs between nodes in the same cluster, the ISLs are considered a single point of failure. This is illustrated in Figure 17 on page 81.

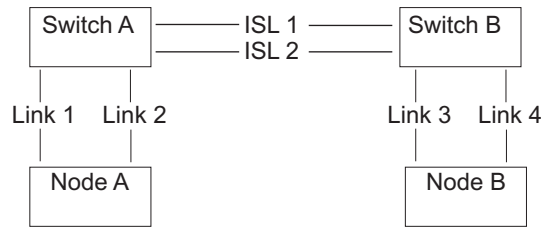


Figure 17. Fabric with ISL between nodes in a cluster

If Link 1 or Link 2 fails, the cluster communication does not fail.

If Link 3 or Link 4 fails, the cluster communication does not fail.

If ISL 1 or ISL 2 fails, the communication between Node A and Node B fails for a period of time, and the node is not recognized, even though there is still a connection between the nodes.

To ensure that a fibre-channel link failure does not cause nodes to fail when there are ISLs between nodes, it is necessary to use a redundant configuration. This is illustrated in Figure 18.

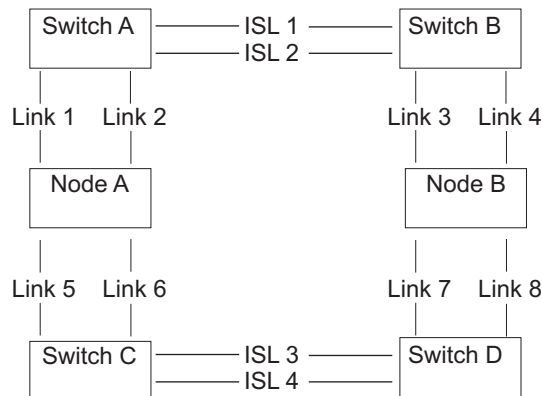


Figure 18. Fabric with ISL in a redundant configuration

With a redundant configuration, if any one of the links fails, communication on the cluster does not fail.

ISL oversubscription

Perform a thorough SAN design analysis to avoid ISL congestion. Do not configure the SAN to use SAN Volume Controller to SAN Volume Controller traffic or SAN Volume Controller to storage system traffic across ISLs that are oversubscribed. For host to SAN Volume Controller traffic, do not use an ISL oversubscription ratio that is greater than 7 to 1. Congestion on the ISLs can result in severe SAN Volume Controller performance degradation and I/O errors on the host.

When you calculate oversubscription, you must account for the speed of the links. For example, if the ISLs run at 4 Gbps and the host runs at 2 Gbps, calculate the port oversubscription as $7 \times (4/2)$. In this example, the oversubscription can be 14 ports for every ISL port.

Note: The SAN Volume Controller port speed is not used in the oversubscription calculation.

SAN Volume Controller in a SAN with director class switches

You can use director class switches within the SAN to connect large numbers of RAID controllers and hosts to a SAN Volume Controller cluster. Because director class switches provide internal redundancy, one director class switch can replace a SAN that uses multiple switches. However, the director class switch provides only network redundancy; it does not protect against physical damage (for example, flood or fire), which might destroy the entire function. A tiered network of smaller switches or a core-edge topology with multiple switches in the core can provide comprehensive redundancy and more protection against physical damage for a network in a wide area.

Example SAN Volume Controller configurations

These examples show typical ways to configure your SAN Volume Controller.

Figure 19 illustrates a small SAN configuration. Two fibre-channel switches are used to provide redundancy. Each host system, SAN Volume Controller node, and storage system is connected to both fibre-channel switches.

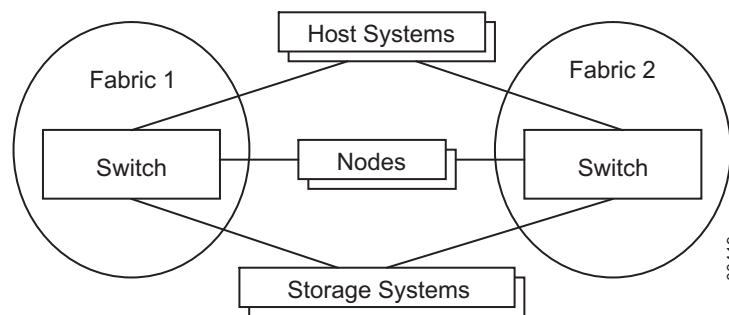


Figure 19. Simple SAN configuration

Figure 20 on page 83 illustrates a medium-sized fabric that consists of three fibre-channel switches. These switches are interconnected with interswitch links (ISLs). For redundancy, use two fabrics with each host system, SAN Volume Controller node, and storage system that are being connected to both fabrics. The example fabric attaches the SAN Volume Controller nodes and the storage systems to the core switch. There are no ISL hops between SAN Volume Controller nodes or between nodes and the storage systems.

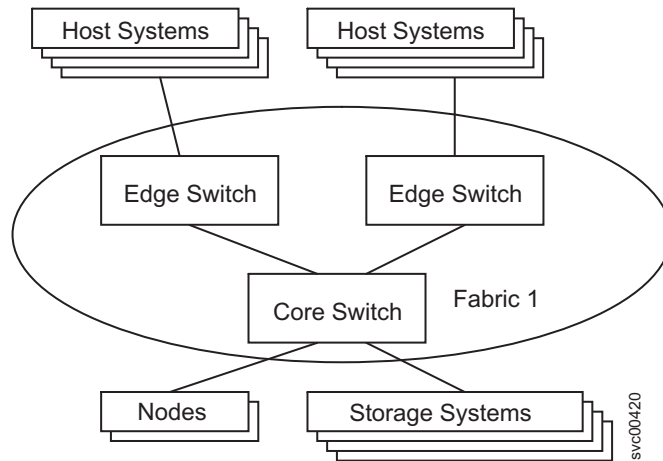


Figure 20. SAN configuration with a medium-sized fabric

Figure 21 illustrates a large fabric that consists of two core fibre-channel switches and edge switches that are interconnected with ISLs. For redundancy, use two fabrics with each host system, SAN Volume Controller node, and storage system that is being connected. Both fabrics attach the SAN Volume Controller nodes to both core fabrics and distribute the storage systems between the two core switches. This ensures that no ISL hops exist between SAN Volume Controller nodes or between nodes and the storage systems.

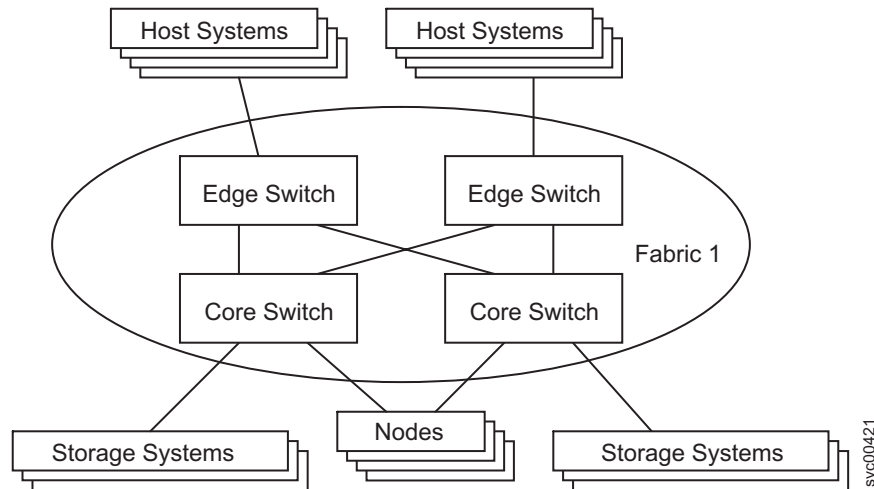


Figure 21. SAN configuration with a large fabric

Figure 22 on page 84 illustrates a fabric where the host systems are located at two different sites. A long-wave optical link is used to interconnect switches at the different sites. For redundancy, use two fabrics and at least two separate long-distance links. If a large number of host systems are at the remote site, use ISL trunking to increase the available bandwidth between the two sites.

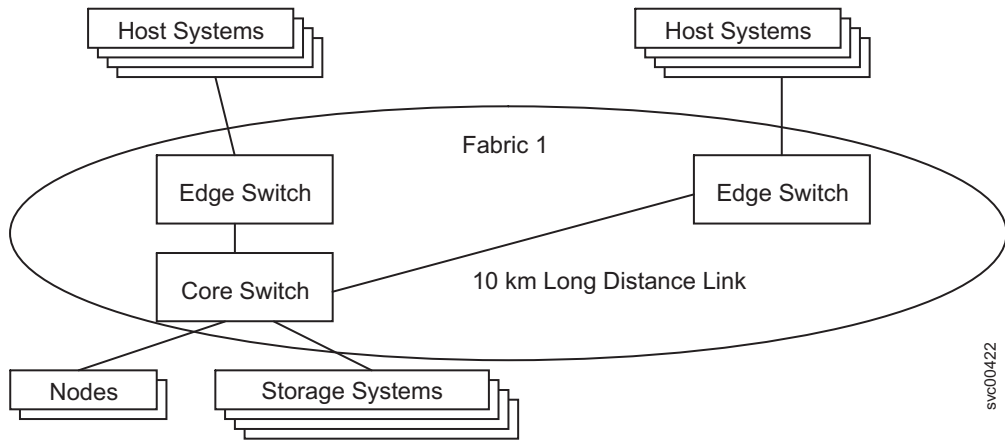


Figure 22. SAN configuration across two sites

Example split-cluster configurations

To provide protection against failures that affect an entire location (for example, a power failure), you can use a configuration that splits a single cluster between two physical locations that are located within 100 meters of each other. These configurations are used for disaster recovery purposes only with substantially reduced performance.

Figure 23 illustrates a split-cluster configuration that is not valid. A cluster of two SAN Volume Controller nodes and the associated storage systems, fibre-channel fabrics, and host systems is split between two physical locations. For example, two different racks in the same machine room or two machine rooms located in close proximity are in the cluster. One node of the I/O group is located at each physical location. The configuration is not valid because an ISL is between SAN Volume Controller nodes in the same I/O group. The configuration also has only one fibre-channel fabric that could act as a single point of failure.

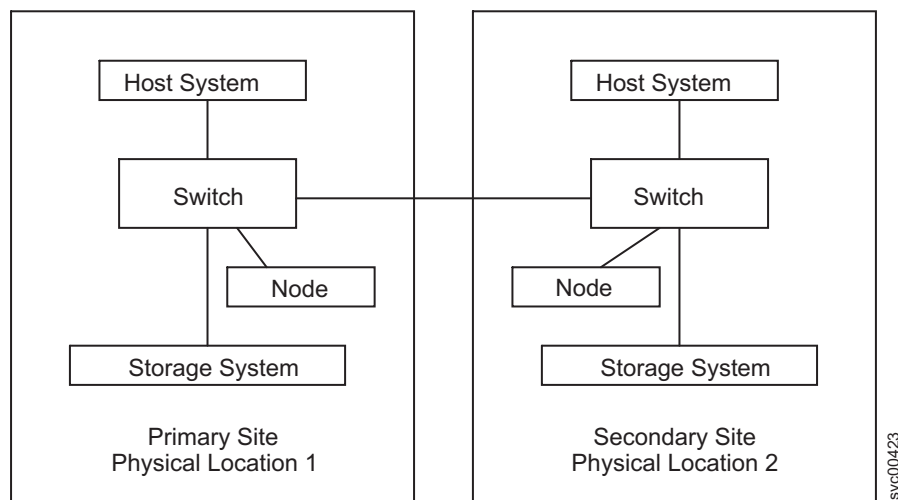


Figure 23. Split-cluster configuration that is not valid

Figure 24 on page 85 illustrates a valid configuration where a cluster of two SAN Volume Controller nodes and the associated storage systems, fibre-channel fabrics,

and host systems are split between two physical locations. Each SAN Volume Controller node and storage system is connected directly to a switch at each location to avoid any ISLs between SAN Volume Controller nodes. To protect against the failure of a storage system, either VDisk mirroring or the intracluster Metro Mirror feature could be used to mirror VDisks across both storage systems. This configuration allows for disaster recovery. If the primary site fails, a live I/O group can still perform the I/O workload in degraded mode at the secondary site.

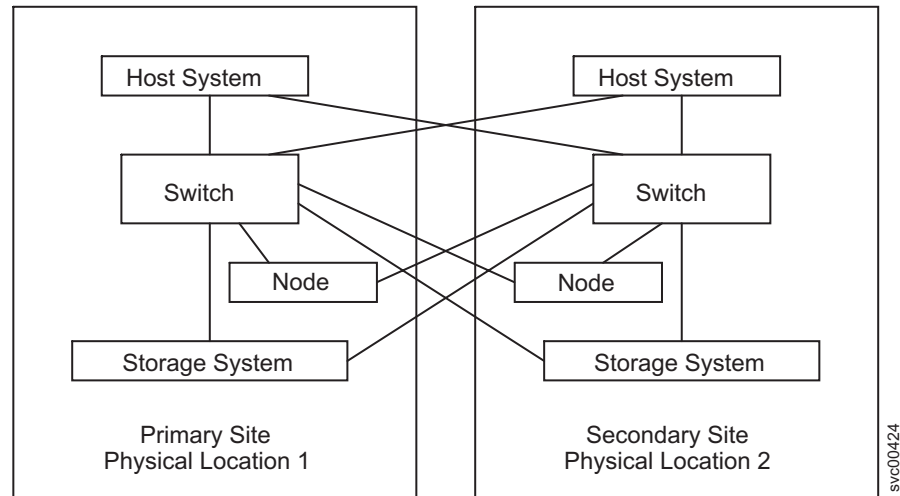


Figure 24. Valid split-cluster configuration

This configuration introduces the following situations:

- If either site fails, only a degraded I/O group at the other site is available to continue I/O operations. As a result, performance is significantly impacted. The throughput of the cluster is reduced and the cluster caching is disabled.
- The disaster recovery solution is asymmetric. It is not possible to configure the system so that the system continues to operate if either site has a failure. The cluster uses a quorum disk to determine which half of the cluster continues to operate if the cluster is partitioned into two halves. If the quorum disk is located at the secondary site and the primary site fails, the secondary site retains the quorum disk and can proceed to act as a disaster recovery site. If the secondary site fails, the primary site cannot act as a disaster recovery site because the primary site can see only half of the nodes in the cluster and cannot see the quorum disk. The cluster components at the primary site cannot form an active cluster (error code 550). It is not possible to communicate with the nodes at the primary site in this state, and all I/O operations immediately cease. If the quorum disk reappears or if a node from the secondary site becomes visible, an active cluster can start operating only at the primary site.

Note: Although a cluster of SAN Volume Controller nodes can be configured to use up to three quorum disks, only one quorum disk is elected to resolve a tie-break situation when the cluster is partitioned into two sets of nodes of equal size. The purpose of the other quorum disks is to provide redundancy if a quorum disk fails before the cluster is partitioned. If the other site fails without locating the quorum disks at a third site, it is not possible to mirror the quorum disk or to otherwise arrange for both sites to be able to continue operation.

Figure 25 on page 86 illustrates a valid configuration where a quorum disk is located at a third site. When used in conjunction with VDisk mirroring or the

intracluster Metro Mirror feature, this configuration provides a disaster recovery solution that can be tolerant of a failure at a single site. If either the primary site or the secondary site fails, the remaining sites can continue performing I/O operations.

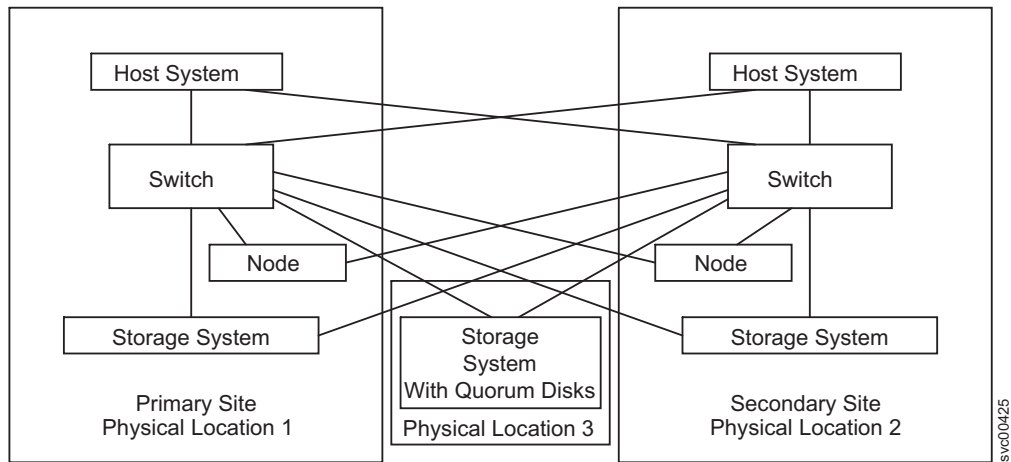


Figure 25. Valid split-cluster configuration with quorum disk

The storage system that hosts the quorum disks is attached directly to a switch at both the primary site and the secondary site. If either the primary site or the secondary site fails, you need to ensure that the remaining site still has direct access to the storage system that hosts the quorum disks. An alternative valid configuration could use an additional fibre-channel switch at the third site with connections from this switch to the primary site and secondary site.

This type of split-site configuration is supported only when the storage system that hosts the quorum disks is an IBM storage system. Although SAN Volume Controller can use other types of storage systems for providing quorum disks, access to these quorum disks is always through a single path. In the example configuration, if a non-IBM storage system is used to host the quorum disks and the cluster chooses to access the quorum disk through the left-hand connection, a failure of the primary site prevents the secondary site from accessing the quorum disk.

If you want to set up a split-cluster configuration for disaster recovery purposes, contact your IBM regional advanced technical specialist for more information.

Zoning guidelines

Ensure that you are familiar with the zoning guidelines for controller and host zones.

Paths to hosts

- The number of paths through the network from the SAN Volume Controller nodes to a host must not exceed eight. Configurations in which this number is exceeded are not supported.
 - Each node has four ports and each I/O group has two nodes. Therefore, without any zoning, the number of paths to a VDisk would be $8 \times$ the number of host ports.
 - This rule exists to limit the number of paths that must be resolved by the multipathing device driver.

If you want to restrict the number of paths to a host, zone the switches so that each HBA port is zoned with one SAN Volume Controller port for each node in the cluster. If a host has multiple HBA ports, zone each port to a different set of SAN Volume Controller ports to maximize performance and redundancy.

Storage controller zones

Switch zones that contain controller ports must not have more than 40 ports. A configuration that exceeds 40 ports is not supported.

SAN Volume Controller zones

The switch fabric must be zoned so that the SAN Volume Controller nodes can see the back-end storage and the front-end host HBAs. Typically, the front-end host HBAs and the back-end storage are not in the same zone. The exception to this is where split host and split controller configuration is in use. All nodes in a cluster must be able to see the same set of back-end storage ports on each back-end controller. Operation in a mode where two nodes see a different set of ports on the same controller is degraded and the system logs errors that request a repair action. This can occur if inappropriate zoning was applied to the fabric or if inappropriate LUN masking is used. This rule has important implications for back-end storage, such as an IBM DS4000, which imposes exclusive rules for mappings between HBA worldwide node names (WWNNs) and storage partitions.

It is possible to zone the switches in such a way that a SAN Volume Controller port is used solely for internode communication, or for communication to a host, or for communication to back-end storage. This is possible because each node contains four ports. Each node must still remain connected to the full SAN fabric. Zoning cannot be used to separate the SAN into two parts.

It is critical that you configure the controller and SAN so that a cluster cannot access LUs that a host or another cluster can also access. This can be arranged by controller LUN mapping and masking.

All nodes in a cluster must see at least one node port for all nodes that are in the cluster, but nodes cannot see node ports for nodes that belong to another cluster. You can have nodes that are not members of any cluster zoned to see all of the clusters. This allows you to add a node to the cluster in the event that you must replace a node.

With Metro Mirror and Global Mirror configurations, additional zones are required that contain only the local nodes and the remote nodes. It is valid for the local hosts to see the remote nodes or for the remote hosts to see the local nodes. Any zone that contains the local and the remote back-end storage and local nodes or remote nodes, or both, is not valid.

If a node can see another node through multiple paths, use zoning where possible to ensure that the node to node communication does not travel over an ISL. If a node can see a storage controller through multiple paths, use zoning to restrict communication to those paths that do not travel over ISLs.

Host zones

The configuration rules for host zones are different depending upon the number of hosts that will access the cluster. For smaller configurations of less than 64 hosts per cluster, the SAN Volume Controller supports a simple set of zoning rules

which enable a small set of host zones to be created for different environments. For larger configurations of more than 64 hosts, the SAN Volume Controller supports a more restrictive set of host zoning rules.

Zoning that contains host HBAs must not contain either host HBAs in dissimilar hosts or dissimilar HBAs in the same host that are in separate zones. Dissimilar hosts means that the hosts are running different operating systems or are different hardware platforms; thus different levels of the same operating system are regarded as similar.

To obtain the best overall performance of the system and to prevent overloading, the workload to each SAN Volume Controller port must be equal. This can typically involve zoning approximately the same number of host fibre-channel ports to each SAN Volume Controller fibre-channel port.

Clusters with less than 64 hosts

For clusters with less than 64 hosts attached, zones that contain host HBAs must contain no more than 40 initiators including the SAN Volume Controller ports that act as initiators. A configuration that exceeds 40 initiators is not supported. A valid zone can be 32 host ports plus 8 SAN Volume Controller ports. When it is possible, place each HBA port in a host that connects to a node into a separate zone. Include exactly one port from each node in the I/O groups that are associated with this host. This type of host zoning is not mandatory, but is preferred for smaller configurations.

Note: If the switch vendor recommends fewer ports per zone for a particular SAN, the rules that are imposed by the vendor takes precedence over the SAN Volume Controller rules.

To obtain the best performance from a host with multiple fibre-channel ports, the zoning must ensure that each fibre-channel port of a host is zoned with a different group of SAN Volume Controller ports.

Clusters with more than 64 hosts

Each HBA port must be in a separate zone and each zone must contain exactly one port from each SAN Volume Controller node in each I/O group that the host accesses.

Note: A host can be associated with more than one I/O group and therefore access VDisks from different I/O groups in a SAN. However, this reduces the maximum number of hosts that can be used in the SAN. For example, if the same host uses VDisks in two different I/O groups, this consumes one of the 256 hosts in each I/O group. If each host accesses VDisks in every I/O group, there can be only 256 hosts in the configuration.

Zoning examples

These examples describe ways for zoning a switch.

Example 1

Consider the SAN environment in the following example:

- Two nodes (nodes A and B)
- Nodes A and B each have four ports

- Node A has ports A0, A1, A2, and A3
- Node B has ports B0, B1, B2, and B3
- Four hosts called P, Q, R, and S
- Each of the four hosts has four ports, as described in Table 11.

Table 11. Four hosts and their ports

P	Q	R	S
P0	Q0	R0	S0
P1	Q1	R1	S1
P2	Q2	R2	S2
P3	Q3	R3	S3

- Two switches called X and Y
- One storage controller
- The storage controller has four ports on it called I0, I1, I2, and I3

The following is an example configuration:

1. Attach ports 1 (A0, B0, P0, Q0, R0, and S0) and 2 (A1, B1, P1, Q1, R1, and S1) of each node and host to switch X.
2. Attach ports 3 (A2, B2, P2, Q2, R2, and S2) and 4 (A3, B3, P3, Q3, R3, and S3) of each node and host to switch Y.
3. Attach ports 1 and 2 (I0 and I1) of the storage controller to switch X.
4. Attach ports 3 and 4 (I2 and I3) of the storage controller to switch Y.

Create the following host zones on switch X:

5. Create a host zone containing ports 1 (A0, B0, P0, Q0, R0, and S0) of each node and host.
6. Create a host zone containing ports 2 (A1, B1, P1, Q1, R1, and S1) of each node and host.

Create the following host zones on switch Y:

7. Create a host zone on switch Y containing ports 3 (A2, B2, P2, Q2, R2, and S2) of each node and host.
8. Create a host zone on switch Y containing ports 4 (A3, B3, P3, Q3, R3, and S3) of each node and host.

Create the following storage zone:

9. Create a storage zone that is configured on each switch. Each storage zone contains all the SAN Volume Controller and storage ports on that switch.

Example 2

The following example describes a SAN environment that is similar to the previous example except for the addition of two hosts that have two ports each.

- Two nodes called A and B
- Nodes A and B have four ports each
 - Node A has ports A0, A1, A2, and A3
 - Node B has ports B0, B1, B2, and B3
- Six hosts called P, Q, R, S, T and U
- Four hosts have four ports each and the other two hosts have two ports each as described in Table 12 on page 90.

Table 12. Six hosts and their ports

P	Q	R	S	T	U
P0	Q0	R0	S0	T0	U0
P1	Q1	R1	S1	T1	U1
P2	Q2	R2	S2	—	—
P3	Q3	R3	S3	—	—

- Two switches called X and Y
- One storage controller
- The storage controller has four ports on it called I0, I1, I2, and I3

The following is an example configuration:

1. Attach ports 1 (A0, B0, P0, Q0, R0, S0 and T0) and 2 (A1, B1, P1, Q1, R1, S1 and T1) of each node and host to switch X.
2. Attach ports 3 (A2, B2, P2, Q2, R2, S2 and T1) and 4 (A3, B3, P3, Q3, R3, S3 and T1) of each node and host to switch Y.
3. Attach ports 1 and 2 (I0 and I1) of the storage controller to switch X.
4. Attach ports 3 and 4 (I2 and I3) of the storage controller to switch Y.

Attention: Hosts T and U (T0 and U0) and (T1 and U1) are zoned to different SAN Volume Controller ports so that each SAN Volume Controller port is zoned to the same number of host ports.

Create the following host zones on switch X:

5. Create a host zone containing ports 1 (A0, B0, P0, Q0, R0, S0 and T0) of each node and host.
6. Create a host zone containing ports 2 (A1, B1, P1, Q1, R1, S1 and U0) of each node and host.

Create the following host zones on switch Y:

7. Create a host zone on switch Y containing ports 3 (A2, B2, P2, Q2, R2, S2 and T1) of each node and host.
8. Create a host zone on switch Y containing ports 4 (A3, B3, P3, Q3, R3, S3 and U1) of each node and host.

Create the following storage zone:

9. Create a storage zone configured on each switch. Each storage zone contains all the SAN Volume Controller and storage ports on that switch.

Zoning considerations for Metro Mirror and Global Mirror

Ensure that you are familiar with the constraints for zoning a switch to support the Metro Mirror and Global Mirror features.

SAN configurations that use intracluster Metro Mirror and Global Mirror relationships do not require additional switch zones.

SAN configurations that use intercluster Metro Mirror and Global Mirror relationships require the following additional switch zoning considerations:

- The clusters must be zoned so that the nodes in each cluster can see the ports of the nodes in the other cluster.
- Use of interswitch link (ISL) trunking in a switched fabric.
- Use of redundant fabrics.

For intercluster Metro Mirror and Global Mirror relationships, you must perform the following steps to create the additional zones that are required:

1. Configure your SAN so that fibre-channel traffic can be passed between the two clusters. To configure the SAN this way, you can connect the clusters to the same SAN, merge the SANs, or use routing technologies.
2. Configure zoning to allow all nodes in the local fabric to communicate with all nodes in the remote fabric.

Notes:

- a. If you are using McData Eclipse routers, model 2640, to route between two SANs, you can connect a maximum of 64 port pairs over a single iFCP link. For larger clusters, you must create several zones that contain at least one port from each node in both the local cluster and the remote cluster. For example, if you have two 8 node clusters and select one port from each node, there are 64 port pairs in each zone. For maximum connectivity, you must have four zones and 4 iFCP links. For smaller clusters, you can use less zones and iFCP links.
 - b. If you are using McData Eclipse routers, model 1620, only 64 port pairs are supported, regardless of the number of iFCP links that are used.
3. Optionally, modify the zoning so that the hosts that are visible to the local cluster can recognize the remote cluster. This allows a host to examine data in both the local and remote cluster.
 4. Verify that cluster A cannot recognize any of the back-end storage that is owned by cluster B. Two clusters cannot share the same back-end storage devices.

Switch operations over long distances

Some SAN switch products provide features that allow the users to tune the performance of I/O traffic in the fabric in a way that can affect Metro Mirror performance. The two most significant features are ISL trunking and extended fabric.

The following table provides a description of the ISL trunking and the extended fabric features:

Feature	Description
ISL trunking	<p>Trunking enables the switch to use two links in parallel and still maintain frame ordering. It does this by routing all traffic for a given destination over the same route even when there might be more than one route available. Often trunking is limited to certain ports or port groups within a switch. For example, in the IBM 2109-F16 switch, trunking can only be enabled between ports in the same quad (for example, same group of four ports). For more information on trunking with the MDS, refer to "Configuring Trunking" on the Cisco Systems Web site.</p> <p>Some switch types can impose limitations on concurrent use of trunking and extended fabric operation. For example, with the IBM 2109-F16 switch, it is not possible to enable extended fabric for two ports in the same quad. Thus, extended fabric and trunking cannot be used together. Although it is possible to enable extended fabric operation to one link of a trunked pair, this does not offer any performance advantages and adds complexity to the configuration setup. Therefore, do not use mixed mode operations.</p>
Extended fabric	<p>Extended fabric operation allocates extra buffer credits to a port. This is important over long links that are usually found in intercluster Metro Mirror operation. Because of the time that it takes for a frame to traverse the link, it is possible to have more frames in transmission at any instant in time than is possible over a short link. The additional buffering is required to allow for the extra frames.</p> <p>For example, the default license for the IBM 2109-F16 switch has two extended fabric options: Normal and Extended Normal.</p> <ul style="list-style-type: none"> • The Normal option is suitable for short links. • The Extended Normal option provides significantly better performance for the links up to 10 km long. <p>Note: The extended fabric license provides two extra options: Medium, 10 - 50 km and Long, 50 - 100 km. Do not use Medium and Long settings in the intercluster Metro Mirror links that are currently supported.</p>

Limiting queue depth in large SANs

If you are designing a configuration for a large SAN, you must estimate the queue depth for each node in order to avoid application failures.

The queue depth is the number of I/O operations that can be run in parallel on a device.

If a SAN Volume Controller node reaches the maximum number of queued commands, many operating systems cannot recover if the situation persists for more than 15 seconds. This can result in one or more servers presenting errors to applications and application failures on the servers.

A large SAN is one in which the total number of VDisk-to-host mappings is at least 1 000. For example, 50 servers with each server addressing 20 VDIs.

Queue depth

The queue depth is the number of I/O operations that can be run in parallel on a device. It is usually possible to set a limit on the queue depth on the subsystem device driver (SDD) paths (or equivalent) or the host bus adapter (HBA).

Ensure that you configure the servers to limit the queue depth on all of the paths to the SAN Volume Controller disks in configurations that contain a large number of servers or virtual disks (VDisks).

Note: You might have a number of servers in the configuration that are idle or do not initiate the calculated quantity of I/O operations. If so, you might not need to limit the queue depth.

Calculating a queue depth limit

Several factors are considered in the formula for calculating the queue depth limit.

The formula for queue depth calculation considers the following factors:

- The maximum number of queued commands is per node and there are two nodes in an input/output (I/O) group. The system must continue to function when one of the nodes in an I/O group is not available. Thus, an I/O group is considered to have the same number of queued commands as a node. If a node fails, the number of paths to each disk is cut in half.
- If a virtual disk (VDisk) is mapped so that it can be seen by more than one server, then each of the servers can send commands to it.
- If a device driver times out of a command, it immediately reissues the command. The SAN Volume Controller will have both commands in its command queue.

Homogeneous queue depth calculation

Ensure you are familiar with the homogeneous queue depth calculation.

The homogeneous queues must meet one of the following statements:

- The queued commands are shared among all paths rather than providing servers with additional resources.
- The virtual disks (VDisks) are distributed evenly among the input/output (I/O) groups in the cluster.

You can set the queue depth for each VDisk on the servers using the following calculation:

$$q = ((n \times 7000) / (v \times p \times c))$$

where:

- q is the queue depth per device path
- n is the number of nodes in the cluster
- v is the number of VDIsks configured in the cluster
- p is the number of paths per VDisk per host. A path is a route from a server fibre-channel port to a SAN Volume Controller fibre-channel port that provides the server access to the VDisk.
- c is the number of hosts that can concurrently access each VDisk. Very few applications support concurrent access from multiple hosts to a single VDisk. This number typically is 1.

Example

Consider the following example:

- An eight-node SAN Volume Controller cluster ($n = 8$)
- 4096 VDIs ($v = 4096$)
- One server with access to each VDI ($c = 1$)
- Each host has four paths to each VDI ($p = 4$)

The calculation is $((8 \times 7\,000) / (4096 \times 4 \times 1)) = 4$.

The queue depth in the operating systems must be set to four concurrent commands per path.

Nonhomogeneous queue depth calculation

For nonhomogeneous queues, use the following calculation.

Nonhomogeneous queues meet one of the following criteria:

- One or more servers are allocated additional resources so that they can queue additional commands.
- VDIs are not distributed evenly among the I/O groups in the cluster.

Set the queue depth for each VDI on the servers using the following calculation.

For each VDI, consider each server to which that VDI has a mapping. This gives a set of server/VDI pairs. If the sum of the server and VDI queue depth for all of the pairs is less than 7 000, the server will not experience problems due to a full queue.

Limiting the queue depth

After you have calculated the queue depth limit, you must apply it.

Each operating system has a way to limit the queue depth on a per virtual disk (VDI) basis.

An alternative to setting a limit per VDI is to set a limit on the host bus adapter (HBA). Thus, if the queue depth per path limit is 5, the server has access to 40 VDIs through two adapters (four paths). It might be appropriate to place a queue depth limit of $(40 \times (4 \times 5)) / 2 = 400$ on each adapter. The queue depth limit of $(40 \times (4 \times 5)) / 2 = 400$ on each adapter enables sharing the queue depth allocation between VDIs.

Configuration requirements

Ensure that you are familiar with the configuration requirements for the SAN Volume Controller software and hardware.

You *must* perform the following steps before you configure the SAN Volume Controller cluster.

1. Your IBM service representative must have installed the SAN Volume Controller nodes and uninterruptible power supply units.
2. Install and configure your disk controller systems and create the RAID resources that you intend to virtualize. To prevent loss of data, virtualize only those RAIDs that provide some kind of redundancy, that is, RAID 1, RAID 10,

RAID 0+1, or RAID 5. Do *not* use RAID 0 because a single physical disk failure might cause the failure of many virtual disks (VDisks). RAID 0, like other types of RAID offers cost-effective performance by using available capacity through data striping. However, RAID 0 does not provide a parity disk drive for redundancy (RAID 5) or mirroring (RAID 10).

When creating RAID with parity protection (for example, RAID 5), consider how many component disks to use in each array. The more disks that you use, the fewer disks that you need to provide availability for the same total capacity (one per array). However, if you use more disks, it takes longer to rebuild a replacement disk after a disk failure. If a second disk failure occurs during the rebuild period, all data on the array is lost. More data is affected by a disk failure for a larger number of member disks resulting in reduced performance while rebuilding onto a hot spare and more data being exposed if a second disk fails before the rebuild has completed. The smaller the number of disks, the more likely it is that write operations span an entire stripe (stripe size x number of members minus 1). In this case, write performance is improved because the disk write operations do not have to be preceded by disk reads. The number of disk drives that are required to provide availability might be unacceptable if the arrays are too small.

When in doubt, create arrays with between six and eight member disks.

If reasonably small RAID devices are used, it is easier to extend a managed disk (MDisk) group by adding a new RAID of the same type. Construct multiple RAID devices of the same type, when it is possible.

When you create RAID with mirroring, the number of component disks in each array does not affect redundancy or performance.

Most back-end disk controller systems enable RAID to be divided into more than one SCSI logical unit (LU). When you configure new storage for use with the SAN Volume Controller cluster, you do not have to divide up the array. New storage is presented as one SCSI LU. This gives a one-to-one relationship between MDisks and RAID.

Attention: Losing an array in an MDisk group can result in the loss of access to *all* MDisks in that group.

3. Install and configure your switches to create the zones that the SAN Volume Controller cluster requires. One zone must contain all the disk controller systems and the SAN Volume Controller nodes. For hosts with more than one port, use switch zoning to ensure that each host fibre-channel port is zoned to exactly one fibre-channel port of each SAN Volume Controller node in the cluster. Set up a zone on each fibre-channel switch that includes all of the SAN Volume Controller ports that are connected to that switch.
4. If you want the SAN Volume Controller cluster to export redundant paths to disks, you must install a multipathing device on all of the hosts that are connected to the SAN Volume Controller cluster. Otherwise, you cannot use the redundancy inherent in the configuration. You can install the subsystem device driver (SDD) from the following Web site:
www.ibm.com/systems/support/storage/software/sdd/
5. Install and configure the IBM System Storage Productivity Center or a server that meets the software and hardware requirements for use the SAN Volume Controller cluster. The IBM System Storage Productivity Center includes three components that enable you to configure the SAN Volume Controller cluster. The first component is the SAN Volume Controller Console, which is a Web-based application. The second component is the SAN Volume Controller CIM agent. The third component is PuTTY, which is an SSH client software that enables you to use the command-line interface (CLI). See the *Read This First:*

Installing the IBM System Storage Productivity Center and IBM System Storage Productivity Center User's Guide for more information.

When you and the IBM service representative have completed the initial preparation steps, you must perform the following steps:

1. Add nodes to the cluster and set up the cluster properties.
2. Create MDisk groups from the MDisks to make pools of storage from which you can create VDIs.
3. Create host objects from the host bus adapter (HBA) fibre-channel ports to which you can map VDIs.
4. Create VDIs from the capacity that is available in your MDisk groups.
5. Map the VDIs to the host objects to make the disks available to the hosts, as required.
6. Optionally, create Copy Services (FlashCopy, Metro Mirror, and Global Mirror) objects, as required.

Supported fibre-channel extenders

Fibre-channel extenders extend a fibre-channel link by transmitting fibre-channel packets across long links without changing the contents of those packets.

IBM has tested a number of such fibre-channel extender technologies with SAN Volume Controller and supports fibre-channel extenders of all types for intercluster links, provided they meet the latency requirements for Metro Mirror and Global Mirror.

When you are planning to use fibre-channel extenders, be aware that the performance of the link to the remote location decreases as the distance to the remote location increases. For fibre-channel IP extenders, throughput is limited by latency and bit error rates. Typical I/O latency can be expected to be 10 microseconds per kilometer. Bit error rates vary depending on the quality of the circuit that is provided. You must review the total throughput rates that might be expected for your planned configuration with the vendor of your fibre-channel extender and your network provider.

See the following Web site for the latest supported hardware:

www.ibm.com/storage/support/2145

Performance of fibre-channel extenders

When you are planning to use fibre-channel extenders, be aware that the performance of the link to the remote location decreases as the distance to the remote location increases.

For fibre-channel IP extenders, throughput is limited by latency and bit error rates. Typical I/O latency can be expected to be 10 microseconds per kilometer. Bit error rates vary depending on the quality of the circuit that is provided.

You must review the total throughput rates that might be expected for your planned configuration with the vendor of your fibre-channel extender and your network provider.

Chapter 4. Creating a SAN Volume Controller cluster

After the IBM System Storage Productivity Center is configured, you must complete the two phases that are required to create a SAN Volume Controller cluster before you can configure the cluster.

The first phase to create a cluster is performed from the front panel of the SAN Volume Controller. The second phase is performed from the SAN Volume Controller Console, which is accessible from a Web server that runs on the IBM System Storage Productivity Center, or in previous releases, the master console.

Before you can access the SAN Volume Controller Console and command-line interface (CLI), you must configure the IBM System Storage Productivity Center. This includes using the PuTTY client to generate secure shell (SSH) key pairs that secure data flow between the SAN Volume Controller cluster configuration node and a client. For more information, see the *IBM System Storage Productivity Center User's Guide*.

Generating an SSH key pair using PuTTY

You must generate a Secure Shell (SSH) key pair to use the SAN Volume Controller Console and the command-line interface (CLI).

Perform the following steps to generate SSH keys on the IBM System Storage Productivity Center (SSPC) or master console using the PuTTY key generator (PuTTYgen):

1. Start PuTTYgen by clicking **Start** → **Programs** → **PuTTY** → **PuTTYgen**. The PuTTY Key Generator panel is displayed.
2. Click **SSH-2 RSA** as the type of key to generate.

Note: Leave the number of bits in a generated key value at 1024.

3. Click **Generate** and then move the cursor around the blank area of the Key section to generate the random characters that create a unique key. When the key has been completely generated, the information about the new key is displayed in the Key section.

Attention: Do not modify the Key fingerprint or the Key comment fields; this can cause your key to no longer be valid.

4. (Optional) If you are generating SSH keys for a computer other than the SSPC or master console, enter a passphrase in the **Key passphrase** and **Confirm passphrase** fields. The passphrase encrypts the key on the disk; therefore, it is not possible to use the key without first entering the passphrase.

Attention: If you are generating the key pair for the SSPC or master console, do not enter anything in the Key passphrase or the Confirm passphrase fields.

5. Save the public key by performing the following steps:
 - a. Click **Save public key**. You are prompted for the name and location of the public key.
 - b. Type `icat.pub` as the name of the public key and specify the location where you want to save the public key. For example, you can create a directory on your computer called *keys* to store both the public and private keys.
 - c. Click **Save**.

6. Save the private key by performing the following steps:
 - a. Click **Save private key**. The PuTTYgen Warning panel is displayed.
 - b. Click **Yes** to save the private key without a passphrase.
 - c. Type `icat` as the name of the private key, and specify the location where you want to save the private key. For example, you can create a directory on your computer called `keys` to store both the public and private keys. It is recommended that you save your public and private keys in the same location.
 - d. Click **Save**.
7. Close the PuTTY Key Generator window.

Storing the private SSH key in the SAN Volume Controller Console software

For both the hardware and software versions of the IBM System Storage Productivity Center or master console, when the SSH keys that are used to communicate with the SAN Volume Controller node are generated or changed, you must store a copy of the new private key in the SAN Volume Controller Console software.

Perform the following steps to store a copy of the new private key in the SAN Volume Controller Console software:

1. Open a command prompt window.
2. Type the following command:

```
copy path\icat.ppk C:"Program Files"\IBM\svccconsole\cimom
```

where *path* is the path where you stored the SSH private key when it was generated and `C:"Program Files"\IBM\svccconsole\cimom` is the location where you installed the SAN Volume Controller Console.

Important: Directory names with embedded spaces must be surrounded by double quotation marks.

3. Close the command prompt window.

Role-based security commands

Role-based security commands restrict administrative abilities by assigning one of three roles: **Administrator** (admin), **CopyOperator**, or **Monitor** (the default).

Use the following three commands to manage role assignments:

mkauth

Assigns the role of **CopyOperator** or **Administrator**

rmauth

Reverts the assigned role to the default role of **Monitor**

lsauth Displays entries in the Role-based Security authorization table

The **Administrator** and **CopyOperator** roles apply only to SSH sessions that are established within the SAN Volume Controller cluster by an **Administrator**. The commands that a user can initiate are determined by the role that is associated with the SSH key that established the session.

As an **Administrator**, a user can initiate all commands, and perform configurations and backups using the **svconfig** backup and restore tool.

By default, **Administrator** users also have the role of **Monitor**. As a **Monitor**, a user can initiate the following SAN Volume Controller CLI commands and functions:

svcinfo commands

All **svcinfo** commands

svctask commands

Only the following commands: **finderr**, **dumperrlog**, and **dumpinternallog**

svcservicetask commands

Only the following commands: **finderr** and **dumperrlog**

svconfig backup and restore tool

A configuration backup can be performed; a configuration restore can only be performed by an **Administrator**.

An **Administrator** can also have the role of **CopyOperator**. As a **CopyOperator**, a user can initiate the following SAN Volume Controller CLI commands and functions:

svcinfo commands

All **svcinfo** commands can be initiated.

svctask commands

Only the following commands can be initiated: **finderr**, **dumperrlog**, **dumpinternallog**, **prestartfcconsistgrp**, **startfcconsistgrp**, **stopfcconsistgrp**, **chfconsistgrp**, **prestartfcmap**, **startfcmap**, **stopfcmap**, **chfmap**, **startrcconsistgrp**, **stoprcconsistgrp**, **switchchrconsistgrp**, **chrconsistgrp**, **startrcrelationship**, **stoprcrelationship**, **switchchrrelationship**, **chrrelationship**, **chpartnership**

svcservicetask commands

Only the following commands can be initiated: **finderr** and **dumperrlog**

svconfig backup and restore tool

A configuration backup can be performed; a configuration restore can only be performed by an **Administrator**.

Creating a cluster from the front panel

After you have installed a pair of nodes, you can use the front panel of a SAN Volume Controller node to create a cluster.

Note: Before you create a cluster, ensure that you have followed the steps in the “Verifying the SAN Volume Controller installation” topic in the *IBM System Storage SAN Volume Controller Hardware Installation Guide*.

A SAN Volume Controller cluster can be created with either an IPv4 or and IPv6 address structures. Once the cluster is created it is possible to change the configuration to the other protocol and specify an address. If you choose to have the IBM service representative or IBM Business Partner initially create the cluster, you must provide the following information prior to configuring the cluster:

- For a cluster with an IPv4 address:
 - Cluster IPv4 address
 - Subnet mask

- Gateway IPv4 address
- For a cluster with an IPv6 address
 - Cluster IPv6 address
 - IPv6 prefix
 - Gateway IPv6 address

Attention: The Cluster IPv4 address and the IPv6 address must be unique to avoid possible communication problems.

The IBM service representative or IBM Business Partner uses the front panel of the node to enter the information that you have provided. The node generates a random password on the display panel. The IBM service representative or IBM Business Partner gives you this password. You must record the password and the IPv4 address or the IPv6 address. The password and the IP address are used to connect to the node and to create the cluster.

Perform the following steps to create and configure the cluster:

1. Choose a node that you want to make a member of the cluster that you are creating.

Note: You can add additional nodes after you have successfully created and initialized the cluster.

2. Press and release the up or down button until Node: is displayed on the node service panel.
3. Press and release the left or right button until Create Cluster? is displayed.

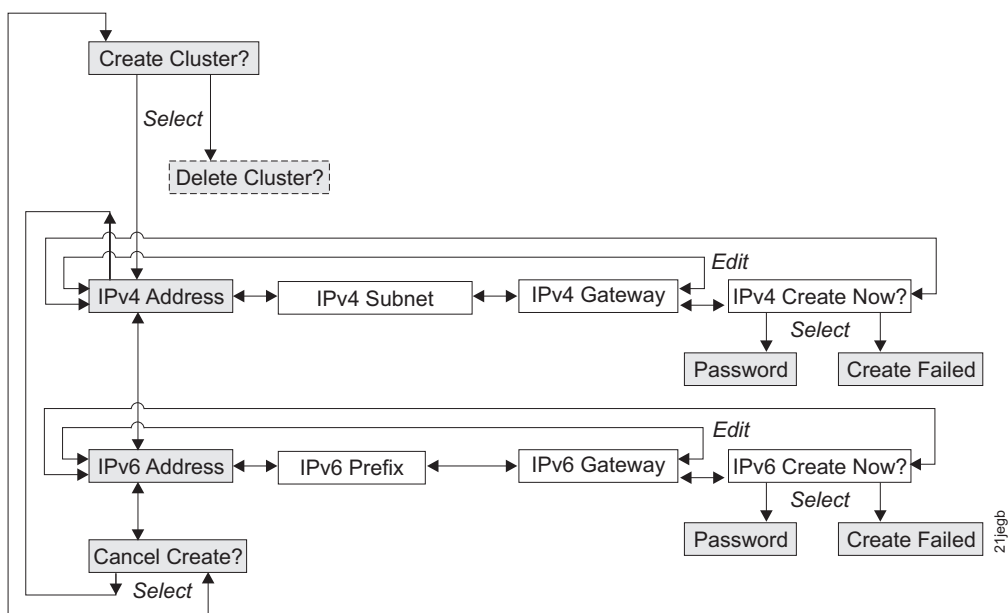


Figure 26. Create Cluster? navigation

4. Press and release the select button.
 - If Delete Cluster? is displayed on the first line of the service display panel, this node is already a member of a cluster. Press and release the Up button until Cluster: is displayed on the service display panel. The name of the cluster the node belongs to is displayed on line 2 of the service display panel. If you want to delete the node from this cluster, refer to the

instructions in “Deleting a node from a cluster” on page 131. If you do not want to delete this node from the cluster, review the situation and determine the correct nodes to include in the new cluster. Then go to step 1 on page 100 and begin again.

- If you are creating a cluster with an IPv4 address and IPv4 Address: is displayed on line 1 of the panel, go to “Creating a cluster with an IPv4 address.”
 - If you are creating a cluster with an IPv6 address, press and release the down button to see IPv6 Address: on line 1 of the panel. Go to “Creating a cluster with an IPv6 address” on page 102.
5. Press and release the select button.

Creating a cluster with an IPv4 address

Your cluster IP address can be an IPv4 or IPv6 address.

To create a cluster with an IPv4 address, complete the following steps:

1. Put the panel into edit mode by pressing and releasing the select button. The first IPv4 address number is highlighted.
2. Press the up button if you want to increase the value that is displayed; press the down button if you want to decrease that value. If you want to quickly increase the highlighted value, hold the up button. If you want to quickly decrease the highlighted value, hold the down button.

Note: To change the address scrolling speed, see the note at the end of this section.

3. Press the right or left buttons to move to the number field that you want to update.
4. Use the right button to move to the next field and use the up or down button to change the value of this field.
5. Repeat step 4 for each of the remaining fields of the IPv4 Address.
6. After you have changed the last field of the IPv4 Address, press and release the select button to put the data in view rather than edit mode.
7. Press the right button. IPv4 Subnet: is displayed.
8. Press and release the select button.
9. Use the up or down button to quickly increase or decrease the value of the first field of the IPv4 Subnet to the value that you have chosen.

Note: To change the address scrolling speed, see the note at the end of this section.

10. Use the right button to move to the next field and use the up or down buttons to change the value of this field.
11. Repeat step 10 for each of the remaining fields of the IPv4 Subnet.
12. After you have changed the last field of IPv4 Subnet, press the select button to put the data in view mode.
13. Press the right button. IPv4 Gateway: is displayed.
14. Press and release the select button.
15. Press the up button if you want to increase the value that is displayed; press the down button if you want to decrease that value. If you want to quickly increase the highlighted value, hold the up button. If you want to quickly decrease the highlighted value, hold the down button.

Note: To change the address scrolling speed, see the note at the end of this section.

16. Use the right button to move to the next field and use the up or down button to change the value of this field.
17. Repeat step 16 for each of the remaining fields of the IPv4 Gateway.
18. After you have changed the last field of IPv4 Gateway, press the select button to put the data in view mode.
19. Press and release the right button until IPv4 Create Now? is displayed.
20. Ensure that you have a pen and paper to record the cluster password before you create the cluster.

Attention: The password is displayed for 60 seconds, or until the up, down, left or right button is pressed, which deletes it. You must be ready to record the password before you select one of the following actions:

- If you want to review your settings before you create the cluster, use the right and left buttons to review those settings. Make any necessary changes, return to IPv4 Create Now?, and then press the select button.
- If you are satisfied with your settings, press the select button. If the cluster is created successfully, Password: is displayed on line 1 of the service display screen. Line 2 contains a password that you can use to access the cluster. Record this password now.

Important: If you do not record the password, you must restart the cluster configuration procedure. After you have recorded the password, press the up, down, left, or right button to clear the password from the screen.

After you complete this task, the following information is displayed on the service display screen:

- Cluster: is displayed on line 1.
- A temporary, system-assigned cluster name that is based on the IP address is displayed on line 2.

Note: To disable the fast increase and decrease address scrolling speed function using your keyboard, press and hold the down arrow button, press and release the select button, and then release the down arrow button. The disabling of the fast increase and decrease function lasts until cluster creation is completed or until the feature is enabled again. If you press and hold the up or down arrow button while the function is disabled, the value increases or decreases once every two seconds. To enable the fast increase and decrease function again, press and hold the up arrow button, press and release the select button, and then release the up arrow button.

Creating a cluster with an IPv6 address

Your cluster IP address can be an IPv4 or IPv6 address.

To create the cluster with an IPv6 address, complete the following steps:

1. From the IPv4 Address panel, press the down button. The IPv6 Address option is displayed.
2. Press the select button again to put the panel into edit mode. The IPv6 address and the IPv6 gateway address consist of eight 4-digit hexadecimal values. The full address is shown across four panels.

3. Press the right button or left button to move to the number field that you want to set.
4. Use the right button to move to the next field and use the up or down button to change the value of this field.
5. Repeat step 4 for each of the remaining fields of the IPv6 Address.
6. After you have changed the last field of the IPv6 Address, press and release the select button to put the data in view mode.
7. Press and release the right button until IPv6 Prefix: is displayed.
8. Press and release the select button.
9. Use the up or down button to quickly increase or decrease the value of the first field of the IPv6 Prefix to the value that you have chosen.

Note: To change the address scrolling speed, see the note at the end of this section.

10. Use the right button to move to the next field and use the up or down buttons to change the value of this field.
11. Repeat step 10 for each of the remaining fields of the IPv6 Prefix.
12. After you have changed the last field of the IPv6 Prefix, press the select button to put the data in view mode.
13. Press the right button. IPv6 Gateway: is displayed.
14. Press and release the select button.
15. Use the right button to move to the next field and use the up or down button to change the value of this field.
16. Repeat step 15 for each of the remaining fields of the IPv6 Gateway.
17. After you have changed the last field of IPv6 Gateway, press the select button to put the data in view mode.
18. Press and release the right button until IPv6 Create Now? is displayed.
19. Ensure that you have a pen and paper to record the cluster password before you create the cluster.

Attention: The password is displayed for 60 seconds, or until the up, down, left or right button is pressed, which deletes it. You must be ready to record the password before you select one of the following actions:

- If you want to review your settings before you create the cluster, use the right and left buttons to review those settings. Make any necessary changes, return to IPv6 Create Now?, and then press the select button.
- If you are satisfied with your settings, press the select button. If the cluster is created successfully, Password: is displayed on line 1 of the service display panel. Line 2 contains a password that you must use when you first access the cluster. Record this password now.

Important: If you do not record the password, you must restart the cluster configuration procedure. After you have recorded the password, press the up, down, left, or right button to clear the password from the screen.

After you complete this task, the following information is displayed on the service display screen:

- Cluster: is displayed on line 1.
- A temporary, system-assigned cluster name that is based on the IP address is displayed on line 2.

Note: To disable the fast increase and decrease address scrolling speed function using your keyboard, press and hold the down arrow button, press and release the select button, and then release the down arrow button. The disabling of the fast increase and decrease function lasts until cluster creation is completed or until the feature is enabled again. If you press and hold the up or down arrow button while the function is disabled, the value increases or decreases once every two seconds. To enable the fast increase and decrease function again, press and hold the up arrow button, press and release the select button, and then release the up arrow button.

Checking your Web browser and settings before accessing the SAN Volume Controller Console

To access the SAN Volume Controller Console, you must ensure that your Web browser is supported and set to allow pop-up windows.

See the SAN Volume Controller Console support information on the following Web site for the supported operating systems and Web browsers:

www.ibm.com/storage/support/2145

Perform the following steps to configure your Web browser:

1. Ensure that the Web browser is not set to block or suppress pop-up windows.

Note: If you are using Internet Explorer 7.0 and receive a message that a pop-up window has been blocked, click the Information Bar at the top of the browser and select **Always allow popups** from this site. If you receive a message that content was blocked because it was not signed by a valid security certificate, click the Information Bar at the top of the screen and select **Show blocked** content.

2. Ensure that you have not installed any applications on the Web browser that block or suppress pop-up windows. If such an application is installed with the Web browser, uninstall it or turn it off.
3. Disable the proxy setting by performing the following steps:

For Netscape:

- a. Open your Netscape browser and click **Edit** → **Preferences**. The Preferences window displays.
- b. From the left side category, click **Advanced** to expand the secondary options. The suboption Proxies displays.
- c. Click **Proxies**. The Proxies window displays.
- d. Select **Direct connection to Internet**.

For Internet Explorer:

- a. Click **Tools** → **Internet Options** → **Connections** → **LAN Settings**.
 - b. Click to clear the **Use a proxy server** box.
4. (Optional) Perform the following steps to add password protection so that your password does not display when you type it in:

For Netscape:

- a. Start a Netscape session.
- b. Click **Edit** → **Preferences** from the menu bar.
- c. Click **Privacy and Security**.

- d. Click **Web Passwords**.
- e. Ensure that the **Remember passwords for sites that require me to log in** box is unchecked.
- f. Click **OK**.

For Internet Explorer:

- a. Start an Internet Explorer session.
- b. Click **Tools** → **Internet Options** from the menu bar. The Internet Options panel is displayed.
- c. Click the **Content** tab.
- d. Click **AutoComplete**. The AutoComplete Settings panel is displayed.
- e. Ensure that the **User names and passwords on forms** box is unchecked.
- f. Click **OK**.

Accessing the SAN Volume Controller Console

The SAN Volume Controller Console is a Web-based application that you can use to manage multiple clusters.

Because the application is Web-based, do not set the browser to disable pop-up windows because this can prevent the windows in the SAN Volume Controller Console from opening. If you are using Internet Explorer 7.0 and receive a message that a pop-up window has been blocked, click the Information Bar at the top of the browser and select **Always allow popups from this site**. If you receive a message that content was blocked because it was not signed by a valid security certificate, click the Information Bar at the top of the screen and select **Show blocked content**.

You have two options for accessing your the SAN Volume Controller Console.

If you are accessing the SAN Volume Controller Console from the server running the IBM System Storage Productivity Center (SSPC) or the master console, you can click on the SAN Volume Controller Console icon on the desktop. If the icon does not appear on your desktop, you can access the SAN Volume Controller Console from the workstation where SSPC or the master console is installed by pointing your browser to the following URL:

```
http://localhost:9080/ica
```

where *localhost* is the URL of the machine where your SAN Volume Controller Console is installed.

As an alternative, you can use the SAN Volume Controller Console on any workstation that can access the SSPC or the master console. Start a supported Web browser and point to the following URL:

```
http://svconsoleip:9080/ica
```

where *svconsoleip* is the IP address of the server on which the SAN Volume Controller Console is running.

Log on to the SAN Volume Controller Console using the superuser user name, which is superuser, and the superuser password, which is passw0rd. The first time

that you access the SAN Volume Controller Console, you are required to change the superuser password. A valid password is 6 to 8 ASCII characters. The following characters are allowed: a - z, A - Z, 0 - 9, -, ., /, or _.

Creating a cluster using the SAN Volume Controller Console

After you have created the cluster using the SAN Volume Controller front panel, you can use the Add SAN Volume Controller Cluster function from the SAN Volume Controller Console to identify the cluster to the IBM System Storage Productivity Center (SSPC) or the master console.

Ensure that you have followed the steps for generating an SSH key pair before you can use the SAN Volume Controller Console to create a cluster. If you are adding an SSH public key to enable your system to use the command-line interface (CLI), you must also generate an SSH key pair for the CLI.

Perform the following steps to create a cluster:

1. Start the SAN Volume Controller Console by clicking on the desktop icon or by pointing your Web browser to `http://svccconsoleip:9080/ica`, where *svccconsoleip* is the IP address of the SSPC or the master console. The IBM System Storage SAN Volume Controller Signon window is displayed.

Note: If you are using Internet Explorer 7.0 and receive a message that a pop-up window has been blocked, click the Information Bar at the top of the browser and select **Always allow popups from this site**. If you receive a message that content was blocked because it was not signed by a valid security certificate, click the Information Bar at the top of the screen and select **Show blocked content**.

2. Type superuser for the user ID and password for the password. The first time you sign on as the superuser, you must change the password for the superuser. A valid password is 6 to 8 ASCII characters. The following characters are allowed: a - z, A - Z, 0 - 9, -, ., /, or _ . After you change the password, the Welcome panel is displayed.
3. If this is the first time that you have accessed the SAN Volume Controller Console, go to step 4. Otherwise, go to step 5.
4. Click **Add SAN Volume Controller Cluster** from the Welcome panel. The Adding a Cluster panel displays. Go to step 7 and proceed.
5. Select **Clusters** from the portfolio. The Viewing Clusters panel is displayed.
6. From the task list, select **Add a Cluster** and click **Go**.
7. The Adding a Cluster panel is displayed. Type the IP address of the cluster. This address should be the same IP address that you entered on the front panel. The SAN Volume Controller Console supports both IPv4 and IPv6 address structures. For IPv4, SAN Volume Controller Console supports the standard format for these addresses; 208.77.188.166 is an example of an IPv4 address. For IPv6 addresses, the following formats are supported:
 - Eight colon-separated groups of four hexadecimal digits; for example, 1234:1234:abcd:0123:0000:0000:7689:6576
 - Eight colon-separated groups of hexadecimal digits with the leading zeros omitted; for example, 1234:1234:abcd:123:0:0:7689:6576
 - Zero suppression format; for example, 1234:1234:abcd:123::7689:6576

Note: You can only suppress one set of zeros in an address.

8. Select the **Create (Initialize) Cluster** check box to create the new cluster.

Note: If the cluster is already in use and you are adding this cluster to the list of managed clusters for this installation of the SAN Volume Controller Console), *do not* select the Create (Initialize) Cluster check box. Click **OK**. The Security Alert panel is displayed.

9. Click **View Certificate**. The Certificate panel is displayed.
 - a. Click **Install Certificate**.
 - b. Click **Next**.
 - c. Click **Next**.
 - d. Click **Install**.
 - e. Click **OK** to complete the Install Certificate panel.
 - f. Click **OK** to close the Certificate panel.
 - g. Click **Yes** to close the Security Alert panel.
10. The Connecting to *ipaddress* panel is displayed, where *ipaddress* is the IP address of the system that you are connecting to. Type the cluster user name `admin` and the password that was generated when you created the cluster from the front panel.
11. Click **OK**.
12. Click **Continue** when the Create a Cluster wizard begins. The Create New Cluster panel is displayed.
13. Complete the Create New Cluster panel.
 - a. Type a new administrator password.

Important: Record this password because you will need it to upload new SSH Keys using the SAN Volume Controller Console.

- b. Type the service password.

Important: Record this password because you will need it if you cannot access the cluster using the administrator ID and password.

- c. Type a name for your cluster. A valid cluster name is 1 to 15 ASCII characters. The following characters are allowed: a - z, A - Z, 0 - 9, -, ., /, or `_`. The cluster name cannot begin with a number or the dash (-) character.
- d. Type the service IP address for the cluster. The service IP address is the IP address that a node uses when it is started in service mode. You cannot mix IPv4 and IPv6 address structures. For example, if your cluster IP address is an IPv6 address, the service IP address must also be an IPv6 address. You can use either a fixed IP address or a Dynamic Host Configuration Protocol (DHCP) IP address. A DHCP IP address is dynamically allocated at the time the node enters service mode and therefore is not defined or stored in cluster information. A fixed IP address is defined in advance of service mode and therefore is defined and stored in cluster information. With DHCP, multiple nodes can be in service mode simultaneously. After being generated, DHCP addresses are displayed on the front panel.
- e. Select the fabric speed. This value is only valid if the nodes in the cluster do not automatically negotiate the fabric speed. Node models, SAN Volume Controller 2145-4F2 and SAN Volume Controller 2145-8F2, do not automatically negotiate their fabric speed and only operate at 1 or 2 Gbps; therefore, the fabric speed for these node models can be set at 1 or 2 Gbps. If your cluster contains nodes that automatically negotiate the fabric speed, set this value to 2 Gbps, even if the fibre channel operates at 4 Gbps.

- f. If you want the ability to reset the administrator password from the front panel, select the **Administrator Password Policy** check box. This option allows you to reset administrator passwords from the front panel in the event the passwords are lost.
 - g. Click **Create New Cluster** when you have completed this panel. After a few seconds, the cluster is created.
 - h. Click **Continue** after the panel indicates that the cluster is being created.
14. Click **Continue** after you are notified that the password has been changed. The **Error Notification Settings** panel is displayed for the SNMP method.
- a. To have errors and events forwarded as SNMP traps, select **Error Only** or **All**. Selecting **Error Only** sends all SNMP traps at or above the threshold limit, excluding information events, and selecting **All** sends all SNMP traps at or above the threshold limit, including information events
 - b. Enter a **Name** and **SNMP Community** name.
 - c. Enter a **Port** number.
 - d. Enter the IPv4 or IPv6 address of the system that is running your SNMP management software.
 - e. Click **Add Destination**. (To not add any destinations at this point, click **Bypass**.)
15. Click the **Continue** button. The License Settings panel is displayed.
- a. Select your license: Capacity Licensing or Physical Disk Licensing.
 - b. For Capacity Licensing, enter the capacities that are specified in your license for the following features. If you are installing only one cluster, enter the capacity value that is indicated in your license for each feature, in terabytes (TB). If you are installing multiple clusters, divide the value for each feature in the license among each of the clusters, and allocate whole numbers of terabytes for each cluster.

Virtualization Limit (Terabytes)

Enter the capacity, in terabytes, that you are licensed to use for virtualization. A value of zero is not allowed for this field.

Note: Only whole number values are valid for the Virtualization Limit.

FlashCopy Limit (Terabytes)

Enter the capacity, in terabytes, that you are licensed to use for FlashCopy.

Note: Only whole number values are valid for the FlashCopy Limit.

Metro and Global Mirror Limit (Terabytes)

Enter the capacity, in terabytes, that you are licensed to use for Metro Mirror and Global Mirror.

Note: Only whole number values are valid for the Metro and Global Mirror Limit.

- c. For Physical Disk Licensing, enter the following **Physical Disk Limit**, **FlashCopy**, and **Global and Metro Mirror** values.

Physical Disk Limit

Enter the number of physical disks that your cluster is licensed to manage. Any value from 0 - 60 is supported.

Note: If **Physical Disk Limit** is set to 0, **FlashCopy** and **Global and Metro Mirror** are automatically disabled.

FlashCopy

Select **Enabled** if you have a Physical Disk **FlashCopy** license; otherwise, select **Disabled**.

Global and Metro Mirror

Select **Enabled** if you have a Physical Disk **Global and Metro Mirror** license; otherwise, select **Disabled**.

- d. Click **Set License Settings**.
16. Click **Continue**. The Maintaining SSH Keys panel is displayed.
- If prompted, type `admin` as the user name and type the new password that you gave during step 13 on page 107.
 - You have two options for adding the SSH key to the SAN Volume Controller Console. You can either upload the SSH key directly to the SAN Volume Controller Console or you can enter the key as direct input on this panel. To upload the file, in the Public Key (file upload) field, select **Browse** to locate the public key that is stored in a directory when you generated an SSH key pair. For example, if the directory was called `keys` select that directory to add to the field. It is recommended that you save your public and private keys in the same location. To enter the SSH key as direct input, copy the contents of the key from the software utility and paste it in the Public Key (direct input) field.
 - In the ID (label) field, enter an identifier for the key. You can create your own ID to identify this key. Typically this ID identifies the key owner or location. The ID must meet the following requirements:
 - The ID can be a maximum of 30 alphanumeric characters.
 - Valid characters are uppercase letters (A - Z), lowercase letters (a - z), digits (0 - 9), the dash (-), and the underscore (_).
 - The first character cannot be a dash [-].
 - Select the appropriate access level for the key by specifying the user type and the corresponding role. The following user types and roles are available:

SVC Console

Select this user type when you are creating a private and public key pair that is used between the SAN Volume Controller Console and the cluster. This option creates an Administrator user with an Administrator role. This is the recommended user type if you are creating a cluster.

Administrator

Select this user type when you are creating a private and public key pair that allows administrators to access the SAN Volume Controller cluster from an SSH command line. The public key will be placed on the SAN Volume Controller cluster and the private key must be held on the host running the command line client. You can select the following roles for this user type:

Monitor

Select this role if you want the administrator to view the cluster configuration.

Administrator

Select this role if you want the administrator to update the cluster configuration.

Service

Select this option when you are creating a private and public key pair that allows service personnel to access the SAN Volume Controller cluster from an SSH command line. The public key will be placed on the SAN Volume Controller cluster and the private key must be held on the host running the command line client.

e. Click **Add Key**.

17. Click on the **X** that is located in the right corner of the window to close the wizard.

You have successfully connected and configured the cluster. The cluster should be listed on the Viewing Clusters panel.

Note: You might have to click **Refresh** on the Viewing Clusters panel to see the new cluster.

You can now set up cluster properties, add additional nodes to the cluster, create managed disk groups, add managed disks to managed disk groups, identify virtual disks, create and map host objects.

Chapter 5. Using the SAN Volume Controller Console

The SAN Volume Controller Console is a Web-browser based GUI and an SMI-S compliant CIM Agent that is based on the Open Pegasus CIM Server. The SAN Volume Controller Console can be used to create and maintain the configuration of storage that is associated with SAN Volume Controller clusters. It also provides user management and access to multiple clusters.

See the SAN Volume Controller Console support information on the following Web site for the supported operating systems and Web browsers:

www.ibm.com/storage/support/2145

Key functions

You can use the SAN Volume Controller Console to perform the following functions:

- Initial set up of the cluster, its nodes, and the I/O groups (or node pairs).
- Set up and maintain managed disks and managed disk groups.
- Set up and maintain Secure Shell keys.
- Set up and maintain virtual disks.
- Set up logical host objects.
- Map virtual disks to hosts.
- Navigate from managed hosts to virtual disk and to managed disk groups, and the reverse direction up the chain.
- Set up and start Copy Services:
 - FlashCopy mappings and FlashCopy consistency groups.
 - Metro Mirror and Global Mirror relationships and consistency groups.
- Perform service and maintenance tasks.

SAN Volume Controller Console layout

Ensure that you are familiar with the basic frame layout of the SAN Volume Controller Console.

Figure 27 on page 112 provides, the basic frame layout, which consists of a banner, task bar, portfolio and a work area. An optional frame can be added for embedded task assistance or help.

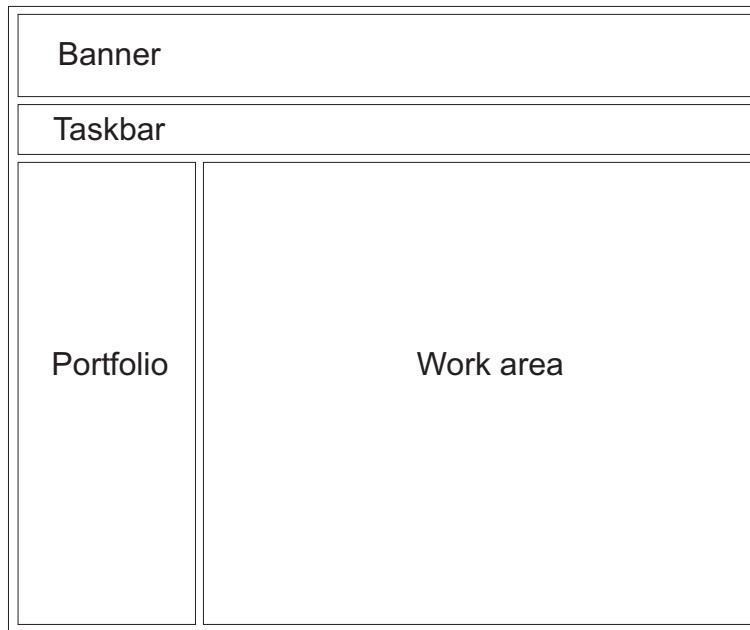


Figure 27. Basic frame layout

SAN Volume Controller Console banner

The banner of the SAN Volume Controller Console provides product or customer identification.

SAN Volume Controller Console task bar

The task bar of the SAN Volume Controller Console keeps track of all opened primary tasks and allows you to quickly go back to the previous task or move forward to the next task.

Figure 28 shows the task bar. You can click the **question mark (?)** icon on the right side to display the information center in a separate browser window. You can click the **(I)** icon to display a help topic for the panel that is currently displayed in the work area.



Figure 28. Task bar

SAN Volume Controller Console portfolio

The portfolio area of the SAN Volume Controller Console contains task-based links that open panels in the work area. Common tasks are grouped under task headings and are expandable and collapsible.

The following task-based links are available from the Welcome panel of the SAN Volume Controller Console:

- Welcome
- Clusters
- Users

- Change Password

The following task-based links are available after you have launched the SAN Volume Controller Console:

- Welcome
- Manage Cluster
 - View Cluster Properties
 - Maintain Cluster Passwords
 - Modify IP Addresses
 - Set Cluster Time
 - Start Statistics Collection
 - Stop Statistics Collection
 - Shut Down Cluster
- Work with Nodes
 - I/O Groups
 - Nodes
- Manage Progress
 - View Progress
- Work with Managed Disks
 - Disk Controller Systems
 - Discovery Status
 - Managed Disks
 - Managed Disk Groups
- Work with Hosts
 - Hosts
 - Fabrics
- Work with Virtual Disks
 - Virtual Disks
 - Virtual Disk-to-Host Mappings
- Manage Copy Services
 - FlashCopy Mappings
 - FlashCopy Consistency Groups
 - Metro and Global Mirror Relationships
 - Metro and Global Mirror Consistency Groups
 - Metro and Global Mirror Cluster Partnership
- Service and Maintenance
 - Upgrade Software
 - Run Maintenance Procedures
 - Set SNMP Error Notification
 - Set Email Features
 - Analyze Error Log
 - License Settings
 - View License Settings Log
 - Dump Configuration
 - List Dumps

- Backup Configuration
- Delete Backup

SAN Volume Controller Console work area

The work area of the SAN Volume Controller Console is where you work with a cluster and the objects it contains.

The work area is the main area of the application. For each panel that displays a table, you can optionally set filters to sort the information and arrange the data that is displayed. Table filter views are persistent for the duration of the login session.

Launching the SAN Volume Controller Console to manage a cluster

You can launch the SAN Volume Controller Console from the Viewing Clusters panel.

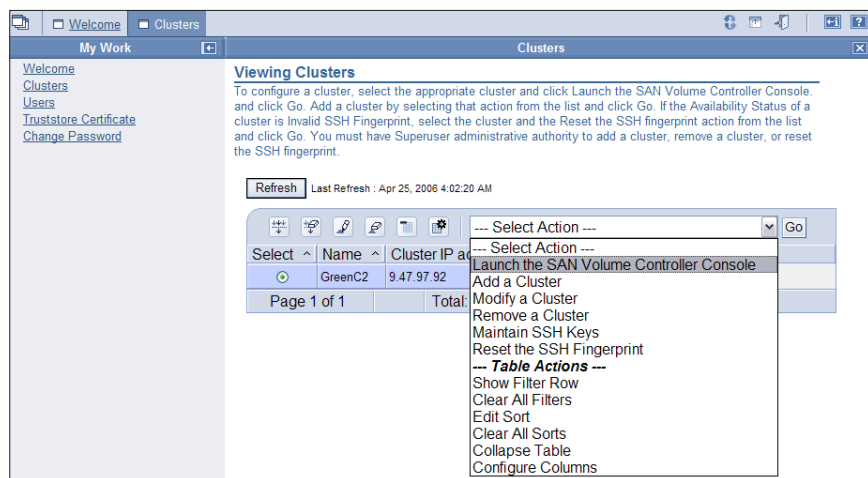
The SAN Volume Controller Console is the centralized Web application that is used to manage your clusters.

Perform the following steps to launch the SAN Volume Controller Console for a specific cluster:

1. Start the SAN Volume Controller Console by clicking on the desktop icon or by pointing your Web browser to `http://<svccconsoleip>:9080/ica`, where `<svccconsoleip>` is the IP address of the IBM System Storage Productivity Center or the master console. Either an IPv4 or IPv6 connection is allowed. For example, the appropriate Web browser address could be of the form `http://9.134.5.6:9080/aica` or `http://[2020:1234::1234]:9080/ica`.

Note: If you are using Internet Explorer 7.0 and receive a message that a popup has been blocked, click the Information Bar at the top of the browser and select Always allow popups from this site. If you receive a message that content was blocked because it was not signed by a valid security certificate, click the Information Bar at the top of the screen and select Show blocked content.

2. Click **Clusters** in the portfolio. The Viewing Clusters panel is displayed.
3. Select the cluster to manage with the application.
4. Select **Launch the SAN Volume Controller Console** from the task list.



5. Click **Go**. A secondary browser window opens.

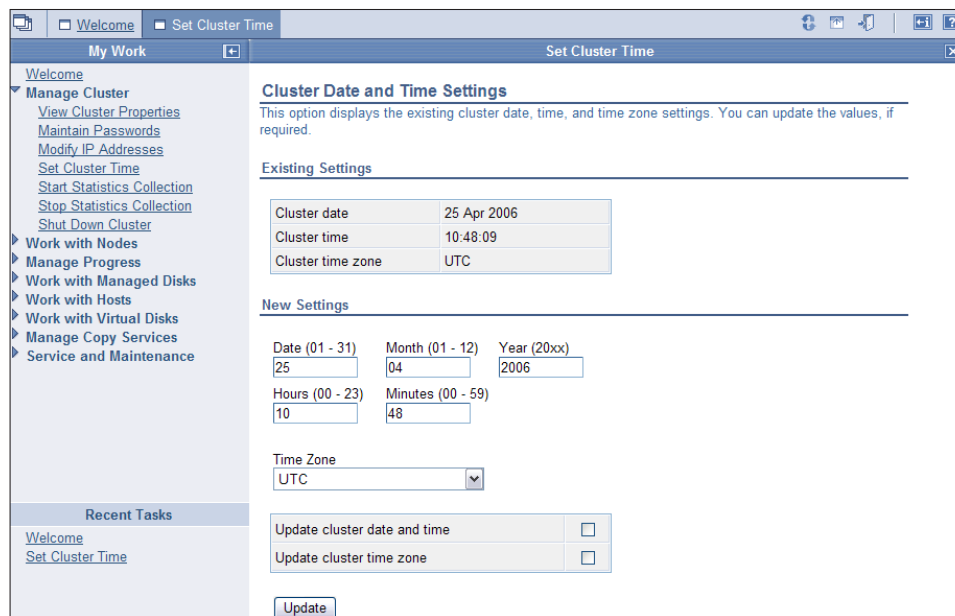
Setting cluster date and time

You can set the date and time for a SAN Volume Controller cluster from the Cluster Date and Time Settings panel.

This task assumes that you have already launched the SAN Volume Controller Console.

You can set the cluster date and time manually, or by specifying an NTP server:

1. Click **Manage Clusters** → **Set Cluster Time** in the portfolio. The Cluster Date and Time Settings panel is displayed.



2. To use NTP to manage the cluster date and time, enter an IPv4 or IPv6 address and click **Update**. To set the cluster date and time manually, continue with the following steps.

3. Type your changes into the **Date**, **Month**, **Year**, **Hours** and **Minutes** fields and select a new time zone from the **Time Zone** list.
4. Select **Update cluster time and date**, **Update cluster time zone**, or both.
5. Click **Update** to submit the update request to the cluster.

Modifying the cluster IP addresses

You can display and change the IP addresses that are associated with a cluster from the Modify IP Addresses panel.

This task assumes that you have already launched the SAN Volume Controller Console.

If you change the cluster IP address, the cluster stops serving Web pages that use the old IP address. You must use the new IP address to reconnect your Web browser to the cluster. When you reconnect to the cluster, accept the new site certificate.

Perform the following steps to change the IP addresses:

1. Click **Manage Cluster** → **Modify IP Address** in the portfolio. The Modify IP Addresses panel is displayed. Both IPv4 and IPv6 addresses can be defined on this panel. The Modify IP Addresses panel displays the existing value for the following IP addresses and enables you to change the settings:

IPv4 Enter the following values for the cluster using IPv4 address types:

Cluster IP Address

Enter the new IP address for the cluster. The current value is displayed. If you do not want to change this value, leave the **New Value** field blank.

Service IP Address

Select the service IP address which connects to a node if the node has been removed from the cluster and is being serviced. You can select one of the following options:

Assign automatically (DHCP)

Select this if you want the service IP address to be assigned automatically through a DHCP server.

Static IP

Enter a IP address for the service IP address. The current value is displayed. If you do not want to change this value, leave the **New Value** field blank.

Subnet Mask

Enter the subnet mask for the cluster. The current value is displayed. If you do not want to change this value, leave the **New Value** field blank.

Gateway

Enter the gateway IP address used for the cluster. The current value is displayed. If you do not want to change this value, leave the **New Value** field blank.

IPv6 Enter the following values for IPv6 address types:

IPv6 Network Prefix

Enter the IPv6 network prefix of the cluster and service IPv6 addresses. The prefix has a value between 0 and 127. The

current value is displayed. If you do not want to change this value, leave the **New Value** field blank.

Cluster IP Address

Enter the new IP address for the cluster. The current value is displayed. If you do not want to change this value, leave the **New Value** field blank. The SAN Volume Controller Console supports following IPv6 formats:

- Eight colon-separated groups of four hexadecimal digits; for example, 1234:1234:abcd:0123:0000:0000:7689:6576
- Eight colon-separated groups of hexadecimal digits with the leading zeros omitted; for example, 1234:1234:abcd:123:0:0:7689:6576
- Zero suppression format; for example, 1234:1234:abcd:123::7689:6576

Note: You can only suppress one set of zeros in an address.

Service IP Address

Select the service IP address that connects to a node while the node is removed from the cluster and serviced. You can select one of the following options:

Assign automatically (DHCP)

Select this if you want the service IP address to be assigned automatically through a DHCP server.

Static IP

Enter the service IP address. The current value is displayed. If you do not want to change this value, leave the **New Value** field blank.

Gateway

Enter the gateway IP address for the cluster. The current value is displayed. If you do not want to change this value, leave the **New Value** field blank.

SAN Volume Controller Console

Enter the following values for the SAN Volume Controller Console. This IP address is initialized when the cluster is created, and it is used as a means of reporting the IP address of the controlling console across the fabric.

Note: Changing the IP address on this field does not update the SAN Volume Controller device configuration.

IP Address

Select the IP address structure type to use for the SAN Volume Controller Console IP address. The current value is displayed. If you do not want to change this value, leave the **New Value** field blank.

Port Enter the port for the SAN Volume Controller Console.

2. Click **Modify Settings** to update the IP address. When you specify a new cluster IP address, the existing communication with the cluster is broken. You must use the new cluster IP address to reestablish your Web browser connection.

A new SSL certificate is generated by the cluster to display the new IP address. This new certificate displays when the Web browser first connects to the cluster.

Changing from an IPv4 to an IPv6 address

Your cluster IP address can be an IPv4 or IPv6 address.

Perform the following steps to change the cluster IP address from IPv4 to IPv6:

1. To change the cluster to accept both IPv4 and IPv6 addresses, complete the following steps:
 - a. Click **Manage Cluster** → **Modify IP Addresses** in the portfolio. The Modify IP Addresses panel is displayed. On this panel there are two sections for each of the supported address structures. If you are converting from IPv4 addresses to IPv6 addresses, the IPv4 addresses should be currently defined. You can enter values for the IPv6 addresses under the IPv6 section on this panel.
 - b. In the **IPv6 Network Prefix** field, enter the IPv6 network prefix of the cluster. The prefix has a value between 0 and 127.
 - c. In the **Cluster IP Address** field, enter the new IP address for the cluster. The following IPv6 formats can be used:
 - Eight colon-separated groups of four hexadecimal digits; for example, 1234:1234:abcd:0123:0000:0000:7689:6576
 - Eight colon-separated groups of hexadecimal digits with the leading zeros omitted; for example, 1234:1234:abcd:123:0:0:7689:6576
 - Zero suppression format; for example, 1234:1234:abcd:123::7689:6576

Note: You can only suppress one set of zeros in an address.
 - d. For the **Service IP Address** field, select the service IP address that connects to a node while the node is removed from the cluster and serviced. You can select one of the following options:
 - Assign automatically (DHCP)
 - Static IP
 - e. In the **Gateway** field, enter the gateway IP address for the cluster.
 - f. For the **SAN Volume Controller Console IP Address** field, enter the IP address for the cluster. This IP address is initialized when the cluster is created, and it is used as a means of reporting the IP address of the controlling console across the fabric.

Note: Changing the IP address on this field does not change the SAN Volume Controller Console configuration.
 - g. In the **SAN Volume Controller Console Port** field, type the port number.
 - h. Click **Modify Settings**. The cluster switches to dual stack mode and is available on both the IPv4 address and the IPv6 address.
 - i. Keep this panel open to complete this process.
2. Remove the managed cluster with the IPv4 address, by completing the following tasks:
 - a. Click **View Cluster Properties** in the portfolio. The View Cluster Properties panel is displayed.
 - b. Select the cluster you want to remove and select **Remove a Cluster** from the list. Click **Go**. The Confirming the Removal of Cluster panel is displayed.
 - c. Click **Yes** to remove the cluster.

- d. Return to the View Cluster Properties panel.
3. Verify the cluster is available on the new address by issuing the ping command for the new IP address. A successful ping indicates that the cluster is available at the new IP address.
4. Add the cluster with the new IPv6 address, by completing these steps:
 - a. On the Viewing Clusters panel, select **Add a Cluster** from the list and click **Go**. The Adding a Cluster panel is displayed.
 - b. Type the IPv6 address for the cluster.
 - c. Ensure that the **Create (Initialize) Cluster** check box is not selected.
 - d. Click **OK**.
 - e. Click **Yes** to confirm adding the cluster.
5. Return to the Modify IP Address panel and click **Delete All IPv4 Settings** to remove the settings.

The cluster is now only available from the IPv6 address.

Changing from an IPv6 to an IPv4 address

Your cluster IP address can be an IPv4 or IPv6 address.

Perform the following steps to change the cluster from IPv6 to IPv4:

1. Change the cluster to accept both IPv4 and IPv6 addresses, by completing these steps:
 - a. Click **Manage Cluster** → **Modify IP Address** in the portfolio. The Modify IP Addresses panel is displayed.
 - b. In the **Cluster IP Address** field, enter the new IP address for the cluster.
 - c. For the **Service IP Address** field, select the service IP address that connects to a node while the node is removed from the cluster and serviced. You can select one of the following options:
 - Assign automatically (DHCP)
 - Static IP
 - d. In the **Gateway** field, enter the gateway IP address for the cluster.
 - e. In the **SAN Volume Controller Console IP Address** field, enter the IP address for the cluster.
 - f. In the **SAN Volume Controller Console Port** field, type the port number.
 - g. Keep this panel open to complete this process.
2. Remove the managed cluster with the IPv6 address, by completing the following tasks:
 - a. Click **View Cluster Properties** in the portfolio. The View Cluster Properties panel is displayed.
 - b. Select the cluster with the IPv6 address that you want to remove and select **Remove a Cluster** from the list. Click **Go**. The Confirming the Removal of Cluster panel is displayed.
 - c. Click **Yes** to remove the cluster.
 - d. Return to the View Cluster Properties panel.
3. Verify the cluster is available on the new settings by issuing the ping command with the new IP address. A successful ping indicates that the cluster is available at the new IP address.
4. Add the cluster with the new IPv4 address, by completing these steps:

- a. On the Viewing Clusters panel, select **Add a Cluster** from the list and click **Go**. The Adding a Cluster panel is displayed.
 - b. Type the IPv4 address for the cluster.
 - c. Ensure that the **Create (Initialize) Cluster** check box is not selected.
 - d. Click **OK**.
 - e. Click **Yes** to confirm adding the cluster.
5. Return to the Modify IP Address panel and click **Delete All IPv6 Settings** to remove the settings.

The cluster is now only available from the IPv4 address.

Maintaining cluster passwords

You can use the SAN Volume Controller Console is used to control access to the cluster. The password that you are updating is used for the cluster. This is not the same password that is used to log into the SAN Volume Controller Console.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to maintain cluster passwords:

1. Click **Manage Cluster** → **Maintain Passwords** in the portfolio. The Maintain Passwords panel is displayed.
2. Type the new administrator or service password in the appropriate fields and click **Maintain Passwords** to change the password.

Note: Passwords must be typed twice to allow verification. Passwords can consist of A - Z, a - z, 0 - 9, and underscore.

3. If you are changing an administrator password, you must reauthenticate the administrator password by entering the new administrator password in the password prompt.
4. Record the administrator password because you cannot access the cluster through the SAN Volume Controller Console without this password.

Viewing cluster properties

You can use the SAN Volume Controller Console to view the properties for a cluster.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the properties of a cluster:

1. Click **Manage Cluster** → **View Cluster Properties** in the portfolio. The Viewing General Properties panel is displayed.
2. Click the following tabs:
 - a. **General** to display the general properties.
 - b. **IP Addresses** to view the IP addresses that are used by the cluster.
 - c. **Space** to view the space and capacity for managed disks (MDisks), MDisk groups and virtual disks (VDisks).
 - d. **SNMP** to view the SNMP details.
 - e. **Statistics** to view the cluster statistics details.

- f. **Metro Mirror and Global Mirror** to view the Metro Mirror or Global Mirror properties of the cluster.
3. Click **Close** to close the panel.

Adding nodes to a cluster

For availability purposes, you must connect the nodes in an I/O group to different uninterruptible power supply units.

Before you add a node to a cluster, you must make sure that the switch zoning is configured such that the node being added is in the same zone as all other nodes in the cluster. If you are replacing a node and the switch is zoned by worldwide port name (WWPN) rather than by switch port, make sure that the switch is configured such that the node being added is in the same VSAN/zone.

Special procedures when adding a node to a cluster

Before you add a node to the cluster, you must check to see if any of the following conditions are true:

- The cluster has more than one I/O group.
- The node that is being added to the cluster uses physical node hardware or a slot which has previously been used for a node in the cluster.
- The node that is being added to the cluster uses physical node hardware or a slot which has previously been used for a node in another cluster and both clusters have visibility to the same hosts and back-end storage.

If any of the previous conditions are true, the following special procedures apply:

- The node must be added to the same I/O group that it was previously in. You can use the command-line interface (CLI) command **svcinfo lsnode** or the SAN Volume Controller Console to determine the WWNN of the cluster nodes.
- Before you add the node back into the cluster, you must shut down all of the hosts that are using the cluster. The node must then be added before the hosts are rebooted. If the I/O group information is unavailable or it is inconvenient to shut down and reboot all of the hosts that are using the cluster, perform the following actions:
 - On all hosts that are connected to the cluster, unconfigure the fibre-channel adapter device driver, the disk device driver, and multipathing device driver before you add the node to the cluster.
 - Add the node to the cluster and then reconfigure the fibre-channel adapter device driver, the disk device driver, and multipathing device driver.

Note: Consider the following information when using multipathing device drivers:

- Applications on the host systems direct I/O operations to file systems or logical volumes that are mapped by the operating system to virtual paths (vpaths), which are pseudo disk objects that are supported by the multipathing device drivers. Multipathing device drivers maintain an association between a vpath and a SAN Volume Controller virtual disk (VDisk). This association uses an identifier (UID) which is unique to the VDisk and is never reused. The UID allows multipathing device drivers to directly associate vpaths with VDIs.
- Multipathing device drivers operate within a protocol stack that contains disk and fibre channel device drivers that allow it to communicate with the SAN Volume Controller using the SCSI protocol over fibre channel as

defined by the ANSI FCS standard. The addressing scheme that is provided by these SCSI and fibre-channel device drivers uses a combination of a SCSI logical unit number (LUN) and the worldwide node name (WWNN) for the fibre-channel node and ports.

- If an error occurs, the error recovery procedures (ERPs) operate at various tiers in the protocol stack. Some of these ERPs cause I/O to be redriven using the same WWNN and LUN numbers that were previously used.
- Multipathing device drivers do not check the association of the VDisk with the vpath on every I/O operation that it performs.

Scenarios where the special procedures can apply

The following two scenarios describe situations where the special procedures can apply:

- Four nodes of an eight-node cluster have been lost because of the failure of a pair of 2145 UPS or four 2145 UPS-1U. In this case, the four nodes must be added back into the cluster using the CLI command `svctask addnode` or the SAN Volume Controller Console.
- You decided to delete four nodes from the cluster and add them back into the cluster using the CLI command `svctask addnode` or the SAN Volume Controller Console.

Adding nodes to a cluster using the SAN Volume Controller Console

Attention:

1. If you are re-adding a node to the SAN, ensure that you are adding the node to the same I/O group from which it was removed. Failure to do this can result in data corruption. You must use the information that was recorded when the node was originally added to the cluster. If you do not have access to this information, call the IBM Support Center to add the node back into the cluster without corrupting the data.
2. The LUNs that are presented to the ports on the new node must be the same as the LUNs that are presented to the nodes that currently exist in the cluster. You must ensure that the LUNs are the same before you add the new node to the cluster.
3. LUN masking for each LUN must be identical on all nodes in a cluster. You must ensure that the LUN masking for each LUN is identical before you add the new node to the cluster.
4. You must ensure that the model type of the new node is supported by the SAN Volume Controller software level that is currently installed on the cluster. If the model type is not supported by the SAN Volume Controller software level, upgrade the cluster to a software level that supports the model type of the new node. See the following Web site for the latest supported software levels:
www.ibm.com/storage/support/2145

Each node in an I/O group must be connected to a different uninterruptible power supply. If you do not provide a name, the cluster assigns a default name to the object. Whenever possible you must provide a meaningful name for objects to make identifying that object easier in the future.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to add a node to a cluster:

1. Click **Work with Nodes** → **Nodes** in the portfolio. The Viewing Nodes panel is displayed.
2. Select **Add a node** from the task list and click **Go**. The Adding a Node to a Cluster panel is displayed.
3. If you are adding a node into the cluster for the first time, record the following information:
 - Node serial number
 - All WWPNs
 - The I/O group that the node belongs to

Important: You need this information to avoid possible data corruption if you have to remove and re-add the node to the cluster.

4. Select the node that you want to add to the cluster from the **Available Candidate Nodes** list.
5. Select the I/O group from the **I/O Groups** list.
6. In the **Node Name** field, type the name that you want to assign to the node.
7. Click **OK**.

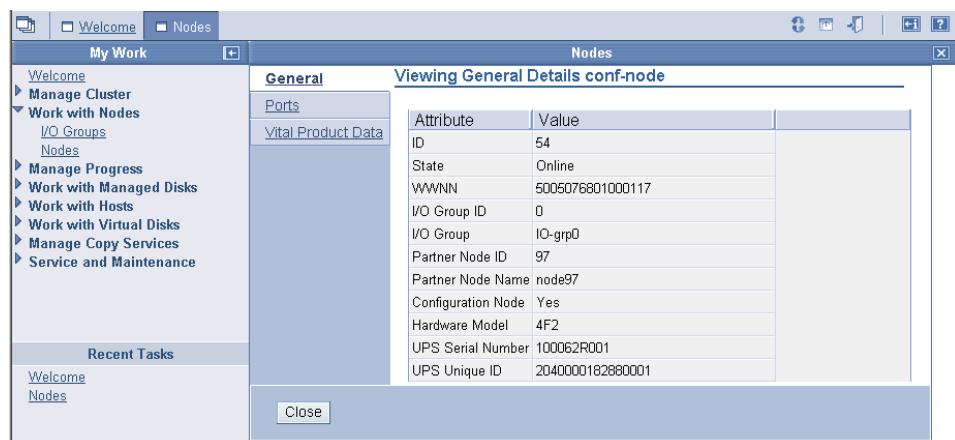
Viewing the node status

You can view the properties for a node from the Viewing General Details panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the node properties:

1. Click **Work with Nodes** → **Nodes** in the portfolio. The Viewing Nodes panel is displayed.
2. Click the name of the node for which you want to view detailed information. The Viewing General Details panel is displayed.



3. Click **Ports** to view the worldwide port name (WWPN) details. The Viewing Port Details panel is displayed.
4. Click **Vital Product Data** to view the node hardware details. The Viewing Vital Product Data panel is displayed.
5. Click **Close** to close the panel.

Viewing the vital product data

You can view the vital product data for a node from the Viewing Vital Product Data panel.

Perform the following steps to view the vital product data for a node:

1. Click **Work With Nodes** in the portfolio.
2. Click **Nodes** in the portfolio. The Nodes panel is displayed.
3. Click on the node whose details you want to view.
4. Click **Vital Product Data** to view the data.
5. Click **Close** to return to the Viewing Vital Product Data panel.

Increasing the size of a cluster

You can use the SAN Volume Controller Console to increase the size of a cluster.

You can increase throughput by adding more nodes to the cluster. The nodes must be added in pairs and assigned to a new I/O group.

Perform the following steps to increase the size of your cluster:

1. Add a node to your cluster and repeat this step for the second node.
2. If you want to balance the load between the existing I/O groups and the new I/O groups, you can migrate your virtual disks (VDisks) to new I/O groups; see “Migrating VDisks” on page 140 for details.. Repeat this step for all VDisks that you want to assign to the new I/O group.

Adding a node to increase the size of a cluster

You can use the SAN Volume Controller Console to add a node to a cluster.

Attention: If you are adding a node that was previously removed from a cluster, ensure that you are adding the node to the same I/O group from which it was removed. Failure to do this can result in data corruption. If you do not know the I/O group name or ID that it was removed from, contact the IBM Support Center to add the node to the cluster without corrupting data.

If you want to add a node that was previously removed from a cluster, you must have the following information about the node:

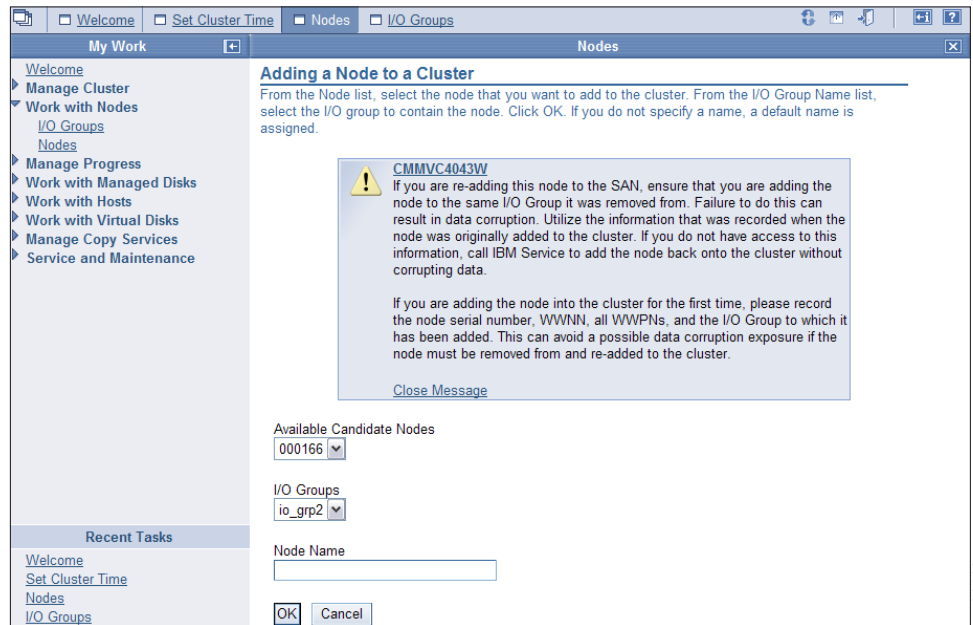
- Node serial number
- Worldwide node name (WWNN)
- All of the worldwide port names (WWPN)
- The name or ID of the I/O group from which the node was previously removed

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to add a node to the cluster:

1. Click **Work with Nodes** → **I/O groups** to determine the I/O group where the node will be added. The Viewing Input/Output Groups panel is displayed.
2. Record the name or ID of the first I/O group that has a node count of zero (0).
3. Click **Work with Nodes** → **Nodes**. The Viewing Nodes panel is displayed.

4. Select the node that you want to add from the list of available candidate nodes.
5. Select **Add a Node** from the task list and click **Go**. The Adding a Node to a Cluster panel is displayed.



6. Select the node that you want to add to the cluster from the **Available Candidate Nodes** list.
7. Select the I/O group from the **I/O Groups** list.

Important: If you are adding a node that was previously removed from the cluster, you must select the name of the I/O group from which the node was previously removed. If you are adding a node that has never been in a cluster, select the name of the I/O group that you recorded in step 2 on page 124.

8. Click **OK**.
9. Verify that the node is online by refreshing the Viewing Nodes panel. You might have to close the panel and reopen it to refresh the panel.
10. Click the name of the node that you have added to the cluster. The Viewing General Details panel is displayed.
11. Click the **General**, **Ports** and **Vital Product Data** tabs and record the following information:
 - Node serial number
 - WWNN
 - WWPNN
 - The name or ID of the I/O group that the node belongs to
12. Click **Close** to close the panel.

If the disk controller uses mapping to present RAID arrays or partitions to the cluster and the WWNNs or the WWPNNs have changed, you must modify the port groups that belong to the cluster.

Moving a VDisk to a new I/O group

You can move a virtual disk (VDisk) to a new I/O group to manually balance the workload across the nodes in the cluster.

This task assumes that you have already launched the SAN Volume Controller Console.

Attention: This is a disruptive procedure. Access to the VDisk is lost while you follow this procedure. Under no circumstances should VDisks be moved to an offline I/O group. You must ensure that the I/O group is online before moving the VDisks to avoid data loss.

Perform the following steps to move a single VDisk:

1. Quiesce all I/O operations for the VDisk. You might have to determine the hosts that are using this VDisk.
2. Update the multipathing device driver configuration to remove all device identifiers that are presented by the VDisk you intend to move. If you are using the system device driver (SDD), the device identifiers are referred to as virtual paths (vpaths).
Attention: Failure to perform this step can result in data corruption.
3. Stop and delete all FlashCopy mappings, Metro Mirror, or Global Mirror relationships that use this VDisk. To check if the VDisk is part of a mapping or relationship, perform the following steps:
 - a. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
 - b. Click on the name of the VDisk that you want to migrate. The View VDisk General Details panel is displayed.
 - c. Look for the **FlashCopy Map Count** and **Relationship ID** fields. If these fields are not blank, the VDisk is part of a mapping or relationship.
 - d. Click **Close** to close the panel.
4. Move the VDisk by selecting the VDisk from the Viewing Virtual Disks panel and select **Modify a VDisk** from the task list and click **Go**. The Modifying Virtual Disk panel is displayed.
5. Select the new I/O group from the **I/O Group** list and click **OK**.
6. Follow your multipathing device drivers instructions for discovering new device identifiers. For example, if you are using SDD, see the *IBM System Storage Multipath Subsystem Device Driver User's Guide* and follow the instructions for discovering vpaths.

Replacing a faulty node with a spare node

You can use the SAN Volume Controller Console and the SAN Volume Controller front panel to replace a faulty node in a cluster.

Before you attempt to replace a faulty node with a spare node you must ensure that you meet the following requirements:

- SAN Volume Controller version 3.1.0 or higher is installed on the cluster and on the spare node.
- You know the name of the cluster that contains the faulty node.
- A spare node is installed in the same rack as the cluster that contains the faulty node.

- You make a record of the last five characters of the original worldwide node name (WWNN) of the spare node. You will need this information, if and when, you want to stop using this node as a spare node.

If a node fails, the cluster continues to operate with degraded performance, until the faulty node is repaired. If the repair operation takes an unacceptable amount of time, it is useful to replace the faulty node with a spare node. However, the appropriate procedures must be followed and precautions must be taken so you do *not* interrupt I/O operations and compromise the integrity of your data.

The following table describes the changes that are made to your configuration when you replace a faulty node in the cluster:

Node attributes	Description												
Front panel ID	This is the number that is printed on the front of the node and is used to select the node that is added to a cluster.												
Node ID	This is the ID that is assigned to the node. A new node ID is assigned each time a node is added to a cluster; the node name remains the same following service activity on the cluster. You can use the node ID or the node name to perform management tasks on the cluster. However, if you are using scripts to perform those tasks, use the node name rather than the node ID. This ID will change during this procedure.												
Node name	This is the name that is assigned to the node. If you do not specify a name, the SAN Volume Controller assigns a default name. The SAN Volume Controller creates a new default name each time a node is added to a cluster. If you choose to assign your own names, you must type the node name on the Adding a node to a cluster panel. You cannot manually assign a name that matches the naming convention used for names assigned automatically by SAN Volume Controller. If you are using scripts to perform management tasks on the cluster and those scripts use the node name, you can avoid the need to make changes to the scripts by assigning the original name of the node to a spare node. This name might change during this procedure.												
Worldwide node name	This is the WWNN that is assigned to the node. The WWNN is used to uniquely identify the node and the fibre-channel ports. During this procedure, the WWNN of the spare node is changed to that of the faulty node. The node replacement procedures must be followed exactly to avoid any duplication of WWNNs. This name does not change during this procedure.												
Worldwide port names	<p>These are the WWPNS that are assigned to the node. WWPNS are derived from the WWNN that is written to the spare node as part of this procedure. For example, if the WWNN for a node is 50050768010000F6, the four WWPNS for this node are derived as follows:</p> <table> <tbody> <tr> <td>WWNN</td> <td>50050768010000F6</td> </tr> <tr> <td>WWNN displayed on front panel</td> <td>000F6</td> </tr> <tr> <td>WWPN Port 1</td> <td>50050768014000F6</td> </tr> <tr> <td>WWPN Port 2</td> <td>50050768013000F6</td> </tr> <tr> <td>WWPN Port 3</td> <td>50050768011000F6</td> </tr> <tr> <td>WWPN Port 4</td> <td>50050768012000F6</td> </tr> </tbody> </table> <p>These names do not change during this procedure.</p>	WWNN	50050768010000F6	WWNN displayed on front panel	000F6	WWPN Port 1	50050768014000F6	WWPN Port 2	50050768013000F6	WWPN Port 3	50050768011000F6	WWPN Port 4	50050768012000F6
WWNN	50050768010000F6												
WWNN displayed on front panel	000F6												
WWPN Port 1	50050768014000F6												
WWPN Port 2	50050768013000F6												
WWPN Port 3	50050768011000F6												
WWPN Port 4	50050768012000F6												

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to replace a faulty node in the cluster:

1. Verify the name and ID of the node that you want to replace.
Perform the following steps to verify the name and ID:
 - a. Make sure that the SAN Volume Controller Console application is running on the cluster that contains the faulty node.
 - b. Click **Work with Nodes** → **Nodes** in the portfolio. The Viewing Nodes panel is displayed. If the node is faulty, it is shown as offline.
 - c. Ensure the partner node in the I/O group is online.
 - If the other node in the I/O group is offline, start the Directed Maintenance Procedures (DMPs) to determine the fault.
 - If you have been directed here by the DMPs, and subsequently the partner node in the I/O group has failed, recover the offline VDisks.
 - If you are replacing the node for other reasons, determine the node that you want to replace and ensure that the partner node in the I/O group is online.
 - If the partner node is offline, you will lose access to the VDisks that belong to this I/O group. Start the DMPs and fix the other node before proceeding to the next step.
2. Click the name of the faulty (offline) node. The Viewing General Details panel is displayed.
3. Click the **General**, **Ports** and **Vital Product Data** tabs and record the following information:
 - Node serial number
 - Worldwide node name
 - All of the worldwide port names
 - Name or ID of the I/O group that contains the node
 - Front panel ID
 - Uninterruptible power supply serial number
4. Ensure that the faulty node has been powered off.
5. Use the SAN Volume Controller Console to delete the faulty node from the cluster.

Remember: You must record the following information to avoid data corruption when this node is re-added to the cluster:

- Node serial number
 - WWNN
 - All WWPNS
 - I/O group that contains the node
6. Disconnect all four fibre-channel cables from the node.

Important: Do not plug the fibre-channel cables into the spare node until the spare node is configured with the WWNN of the faulty node.
 7. Connect the power and signal cables from the spare node to the uninterruptible power supply that has the serial number you recorded in step 3.

Note: For 2145 UPS units, you can plug the signal cable into any vacant position on the top row of serial connectors on the 2145 UPS. If no spare serial connectors are available on the 2145 UPS, disconnect the

cables from the faulty node. For 2145 UPS-1U units, you must disconnect the cables from the faulty node.

8. Power on the spare node.
9. You must change the WWNN of the spare node to that of the faulty node. The procedure for doing this depends on the SAN Volume Controller version that is installed on the spare node. Press and release the down button until the Node: panel displays. Then press and release the right button until the WWNN: panel displays. If repeated pressing of the right button returns you to the Node: panel, without displaying a WWNN: panel, go to step 11; otherwise, continue with step 10.
10. Change the WWNN of the spare node (with SAN Volume Controller V4.3 and above installed) to match the WWNN of the faulty node by performing the following steps:
 - a. With the Node WWNN: panel displayed, press and hold the down button, press and release the select button, and then release the down button. The display switches into edit mode. Edit WWNN is displayed on line 1. Line 2 of the display contains the last five numbers of the WWNN.
 - b. Change the WWNN that is displayed to match the last five numbers of the WWNN that you recorded in step 3 on page 128. To edit the highlighted number, use the up and down buttons to increase or decrease the numbers. The numbers wrap F to 0 or 0 to F. Use the left and right buttons to move between the numbers.
 - c. When the five numbers match the last five numbers of the WWNN that you recorded in step 3 on page 128, press the select button to accept the numbers.
11. Change the WWNN of the spare node (with SAN Volume Controller versions prior to V4.3 installed) to match the WWNN of the faulty node by performing the following steps:
 - a. Press and release the right button until the Status: panel is displayed.
 - b. With the node status displayed on the front panel, press and hold the down button; press and release the select button; release the down button. WWNN is displayed on line 1 of the display. Line 2 of the display contains the last five numbers of the WWNN.
 - c. With the WWNN displayed on the front panel; press and hold the down button; press and release the select button; release the down button. The display switches into edit mode.
 - d. Change the WWNN that is displayed to match the last five numbers of the WWNN that you recorded in step 3 on page 128. To edit the highlighted number, use the up and down buttons to increase or decrease the numbers. The numbers wrap F to 0 or 0 to F. Use the left and right buttons to move between the numbers.
 - e. When the five numbers match the last five numbers of the WWNN that you recorded in step 3 on page 128, press the select button to accept the numbers.
 - f. Press the select button to retain the numbers that you have updated and return to the WWNN panel.
12. Connect the four fibre-channel cables that you disconnected from the faulty node and connect them to the spare node.

If an Ethernet cable has not been connected to the spare node, disconnect the Ethernet cable from the faulty node and connect it to the spare node.
13. Use the SAN Volume Controller Console to add the spare node to the cluster. If possible, use the same node name that was used for the faulty node. If

necessary, the spare node is updated to the same SAN Volume Controller version as the cluster. This update can take up to 20 minutes.

14. Use the tools that are provided with your multipathing device driver on the host systems to verify that all paths are now online. See the documentation that is provided with your multipathing device driver for more information. For example, if you are using the subsystem device driver (SDD), see the *IBM System Storage Multipath Subsystem Device Driver User's Guide* for instructions on how to use the SDD management tool on host systems. It might take up to 30 minutes for the paths to come online.
15. Repair the faulty node.

Attention: When the faulty node is repaired, do not connect the fibre-channel cables to it. Connecting the cables might cause data corruption because the spare node is using the same WWNN as the faulty node.

If you want to use the repaired node as a spare node, perform the following steps.

For SAN Volume Controller V4.3 and above:

- a. With the Node WWNN: panel displayed, press and hold the down button, press and release the select button, and then release the down button. The display switches into edit mode. Edit WWNN is displayed on line 1. Line 2 of the display contains the last five numbers of the WWNN.
- b. Change the displayed number to 00000. To edit the highlighted number, use the up and down buttons to increase or decrease the numbers. The numbers wrap F to 0 or 0 to F. Use the left and right buttons to move between the numbers.
- c. Press the select button to accept the numbers.

This node can now be used as a spare node.

For SAN Volume Controller versions prior to V4.3:

- a. Press and release the right button until the Status: panel is displayed.
- b. With the node status displayed on the front panel, press and hold the down button; press and release the select button; release the down button. WWNN is displayed on line 1 of the display. Line 2 of the display contains the last five numbers of the WWNN.
- c. With the WWNN displayed on the front panel; press and hold the down button; press and release the select button; release the down button. The display switches into edit mode.
- d. Change the displayed number to 00000. To edit the highlighted number, use the up and down buttons to increase or decrease the numbers. The numbers wrap F to 0 or 0 to F. Use the left and right buttons to move between the numbers.
- e. Press the select button to accept the numbers.
- f. Press the select button to retain the numbers that you have updated and return to the WWNN panel.

This node can now be used as a spare node.

Attention: Never connect a node with a WWNN of 00000 to the cluster. If this node is no longer required as a spare and is to be used for normal attachment to a cluster, you must change the WWNN to the number you recorded when a spare was created. Using any other number might cause data corruption.

Renaming a node

You can rename a node from the Renaming Node panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to rename a node:

1. Click **Work with Nodes** → **Nodes** in the portfolio. The Viewing Nodes panel is displayed.
2. Select the node you want to rename and select **Rename a Node** from the list. Click **Go**. The Renaming Node panel is displayed.
3. Type the new name of the node and click **OK**.

Deleting a node from a cluster

You might have to remove a node from a cluster if the node has failed and is being replaced with a new node or if the repair that has been performed has caused that node to be unrecognizable by the cluster.

The cache on the selected node is flushed before the node is taken offline. In some circumstances, such as when the system is already degraded (for example, when both nodes in the I/O group are online and the virtual disks within the I/O group are degraded), the system ensures that data loss does not occur as a result of deleting the only node with the cache data. The cache is flushed before the node is deleted to prevent data loss if a failure occurs on the other node in the I/O group.

To take the specified node offline immediately without flushing the cache or ensuring that data loss does not occur, run the **rmnode** command with the **-force** parameter using the SAN Volume Controller CLI. For more information, see the *IBM System Storage SAN Volume Controller Command-Line Interface User's Guide*.

This task assumes that you have already launched the SAN Volume Controller Console.

Attention:

- If you are removing a single node and the remaining node in the I/O group is online, the data on the partner node goes into write-through mode. This data can be exposed to a single point of failure if the remaining node fails.
- If both nodes in the I/O group are online and the VDIs are already degraded before you delete the node, redundancy to the VDIs is already degraded. A loss of access to data and loss of data might occur.
- Removing the last node in the cluster destroys the cluster. Before you delete the last node in the cluster, ensure that you want to destroy the cluster.
- When you delete a node, you remove all redundancy from the I/O group. As a result, new or existing failures can cause I/O errors on the hosts. The following failures can occur:
 - Host configuration errors
 - Zoning errors
 - Multipathing software configuration errors
- If you are deleting the last node in an I/O group and there are virtual disks (VDIs) assigned to the I/O group, you cannot delete the node from the cluster if the node is online. You must back up or migrate all data that you want to save before you delete the node. If the node is offline, you can delete the node.

Perform the following steps to delete a node from a cluster:

1. Determine the VDIs that are still assigned to this I/O group:
 - a. Request a filtered view of VDIs where the filter attribute is the name of the I/O group.
 - b. Determine which hosts the VDI is mapped to.
 - If you do not want to maintain access to these VDIs, proceed to step 2.
 - If you are deleting the last node in the I/O group and some or all of these VDIs contain data that you want to continue to access, you must migrate the VDI to a different (online) I/O group.
2. Unless this is the last node in the cluster, turn the power off to the node that you are removing using the Shut Down a Node option on the SAN Volume Controller Console. This step ensures that the multipathing device driver does not rediscover the paths that are manually removed before you issue the delete node request.

Attention:

- When you remove the configuration node, it moves to a different node within the cluster. This process may take a short time, typically less than a minute. The cluster IP address remains unchanged, but any SSH client attached to the configuration node might need to reestablish a connection. The SAN Volume Controller Console reattaches to the new configuration node transparently.
 - If you turn the power on to the node that has been removed and it is still connected to the same fabric or zone, it attempts to rejoin the cluster. At this point, the cluster tells the node to remove itself from the cluster and the node becomes a candidate for addition to this cluster or another cluster.
 - If you are adding this node into the cluster, ensure that you add it to the same I/O group that it was previously a member of. Failure to do so can result in data corruption.
3. Before you delete the node, it is essential to update the multipathing device driver configuration on the host to remove all device identifiers that are

presented by the VDisk that you intend to remove. If you are using the subsystem device driver (SDD), the device identifiers are referred to as virtual paths (vpaths). Subsystem device driver (SDD)

Attention: Failure to perform this step can result in data corruption.

See the *IBM System Storage Multipath Subsystem Device Driver User's Guide* for details about how to dynamically reconfigure SDD for the given host operating system.

4. Click **Work with Nodes** → **Nodes** in the portfolio. The Viewing Nodes panel is displayed.

Viewing Nodes
Click on a node to view its details, or select a node and an action from the list and click Go. Add a node to the cluster by selecting that action from the list and clicking Go.

Refresh Last Refresh : Apr 25, 2006 7:28:34 AM

--- Select Action --- Go

Select	ID	Name	Status	World Wide Node Name (WWNN)	I/O Group Name	Config Node
<input type="radio"/>	1	node1	Online	500507680100018C	io_grp0	Yes
<input type="radio"/>	2	node2	Online	5005076801000173	io_grp0	No

Page 1 of 1 Total: 2 Filtered: 2 Displayed: 2 Selected: 0

5. Select the node to delete and select **Delete a Node** from the task list. Click **Go**. The Deleting Node from Cluster panel is displayed.
6. Click **Yes** to delete the node.

Renaming an I/O group

You can rename an I/O group from the Viewing I/O Groups panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to rename an I/O group:

1. Click **Work with Nodes** → **I/O Groups** in the portfolio. The Viewing Input/Output Groups panel is displayed.
2. Select the I/O group that you want to rename and select **Rename an I/O Group** from the list. Click **Go**. The Renaming I/O Group panel is displayed.
3. Type the new name of the I/O Group in the **New Name** field.
4. Click **OK**.

Modifying a cluster

You can rename a cluster and change the fabric speed from the Modifying Cluster panel.

This task assumes that you are at the Welcome panel for the SAN Volume Controller Console.

Perform the following steps to modify a cluster:

1. Click **Clusters** in the portfolio. The Viewing Clusters panel is displayed.
2. Select the cluster to modify and select **Modify a Cluster** from the task list. Click **Go**. The Modifying Cluster panel is displayed. You can perform the following from this panel:

- Type a new name for the cluster.
 - Select a fabric speed from the **Fabric Speed** list.
3. Click **OK** to modify the cluster.

Shutting down a cluster

You can shut down a SAN Volume Controller cluster from the Shutting Down cluster panel.

If you want to remove all input power to a cluster (for example, the machine room power must be shutdown for maintenance), you must shut down the cluster before the power is removed. If you do not shut down the cluster before turning off input power to the uninterruptible power supply units, the SAN Volume Controller nodes detect the loss of power and continue to run on battery power until all data that is held in memory is saved to the internal disk drive. This increases the time that is required to make the cluster operational when input power is restored and severely increases the time that is required to recover from an unexpected loss of power that might occur before the uninterruptible power supply batteries have fully recharged.

When input power is restored to the uninterruptible power supply units, they start to recharge. However, the SAN Volume Controller nodes do not permit any I/O activity to be performed to the virtual disks (VDisks) until the uninterruptible power supply is charged enough to enable all the data on the SAN Volume Controller nodes to be saved in the event of an unexpected power loss. This might take as long as two hours. Shutting down the cluster prior to removing input power to the uninterruptible power supply units prevents the battery power from being drained and makes it possible for I/O activity to resume as soon as input power is restored.

Before shutting down a cluster, quiesce all I/O operations that are destined for this cluster. Failure to do so can result in failed I/O operations being reported to your host operating systems.

Attention: If you are shutting down the entire cluster, you lose access to all VDIs that are provided by this cluster. Shutting down the cluster also shuts down all SAN Volume Controller nodes. This shutdown causes the hardened data to be dumped to the internal hard drive.

Begin the following process of quiescing all I/O to the cluster by stopping the applications on your hosts that are using the VDIs that are provided by the cluster.

1. Determine which hosts are using the VDIs that are provided by the cluster.
2. Repeat the previous step for all VDIs.

When input power is restored, you must press the power button on the uninterruptible power supply units before you press the power buttons on the SAN Volume Controller nodes.

Perform the following steps to shut down a cluster:

1. Click **Manage Clusters** → **Shut down Cluster** in the portfolio. The Shutting Down cluster panel is displayed.
2. Click **Yes**.

Shutting down a node

You can shut down a SAN Volume Controller node from the Shutting Down Node panel.

If you are shutting down the last SAN Volume Controller node in an I/O group, quiesce all I/O operations that are destined for this SAN Volume Controller node. Failure to do so can result in failed I/O operations being reported to your host operating systems.

This task assumes that you have already launched the SAN Volume Controller Console.

When input power is restored, you must press the power button on the uninterruptible power supply units before you press the power button on the SAN Volume Controller node.

Perform the following steps to use the shutdown command to shut down a SAN Volume Controller node:

1. Click **Work with Nodes** → **Nodes** in the portfolio. The Viewing Nodes panel is displayed.
2. Select the node to shut down.
3. Select **Shut Down a Node** from the task list and click **Go**. The Shutting Down Node panel is displayed.
4. Click **Yes**.

Discovering MDisks

You can have the cluster rescan the fibre-channel network. The rescan discovers any new managed disks (MDisks) that might have been added to the cluster and rebalances MDisk access across the available controller device ports.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to discover MDisks:

1. Click **Work with Managed Disks** → **Managed Disks** in the portfolio. The Viewing Managed Disks panel is displayed.
2. Select **Discover MDisks** from the task list and click **Go**. The Discovering Managed Disks panel is displayed. The newly discovered MDisks are displayed in a table on the Discovering Managed Disks panel.
3. Click **Close** to return to the Viewing Managed Disks panel.

Viewing discovery status

You can view the status of a managed disk (MDisk) discovery from the Viewing Discovery Status panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view status of an MDisk discovery:

1. Click **Work with Managed Disks** → **Discovery Status**. The Viewing Discovery Status panel is displayed.

2. Click **Close** to close this panel.

Renaming MDisks

You can rename a managed disk (MDisk) from the Renaming Managed Disk panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to rename an MDisk:

1. Click **Work with Managed Disks** → **Managed Disks** in the portfolio. The Viewing MDisks panel is displayed.
2. Select the MDisk you want to rename and select **Rename an MDisk** from the list. Click **Go**. The Renaming Managed Disk panel is displayed.
3. Type a new name for the MDisk.
4. Click **OK**.

Adding excluded MDisks to a cluster

You can add managed disks (MDisks) that have been excluded from the cluster back into the cluster from the Including Managed Disk panel.

You must fix the fabric-related problem that caused the MDisk to become excluded from the cluster before you can add the MDisk to the cluster.

This task assumes that you have already launched the SAN Volume Controller Console.

The MDisk might have been excluded from the cluster because of multiple I/O failures that are caused by noisy links.

Perform the following steps to add an excluded MDisk to a cluster:

1. Click **Work with Managed Disks** → **Managed Disks** in the portfolio. The Viewing MDisks panel is displayed.
2. Select the excluded MDisk to add to the cluster and select **Include an MDisk** from the list. Click **Go**. The Including Managed Disk panel is displayed.
3. Follow the instructions that are displayed on the Including Managed Disk panel.

Setting quorum disks

You can set a managed disk (MDisk) as a quorum disk from the Setting a Quorum Disk panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Attention: You must set quorum disks on multiple controllers to avoid the possibility of losing all of the quorum disks with a single failure.

Perform the following steps to set an MDisk as a quorum disk:

1. Click **Work with Managed Disks** → **Managed Disks** in the portfolio. The Viewing Managed Disks panel is displayed.
2. Select the MDisk to set as a quorum disk and select **Set a Quorum Disk** from the list. Click **Go**. The Setting a Quorum Disk panel is displayed.

3. Select a quorum index number from the **Quorum Index** list and click **OK**.

Determining the relationship between MDisks and VDIsks

You can use the SAN Volume Controller Console to determine the relationship between managed disks (MDisks) and virtual disks (VDIsks).

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to determine the relationship between MDisks and VDIsks:

1. Click **Work with Managed Disks** → **Managed Disks** in the portfolio. The Viewing Managed Disks panel is displayed.
2. Select the MDisk that you want to view.
3. Select **Show VDIsks** from the task list and click **Go**. The Viewing Virtual Disks panel is displayed. This panel lists the VDIsks that use this MDisk.

Determining the relationship between MDisks and RAID arrays or LUNs

Each managed disk (MDisk) corresponds with a single RAID array, or a single partition on a given RAID array. Each RAID controller defines a LUN number for this disk. The LUN number and controller name or ID are needed to determine the relationship between MDisks and RAID arrays or partitions.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to determine the relationship between MDisks and RAID arrays:

1. Click **Work with Managed Disks** → **Managed Disks** in the portfolio. The Viewing Managed Disks panel is displayed.
2. Click the name of the MDisk that you want to view. The Viewing Managed Disk (MDisk) Details panel is displayed.
3. Record the controller name and controller LUN number.
4. Click **Work with Managed Disks** → **Disk Controller Systems** in the portfolio.
5. Click the name of the controller that you recorded in step 3 to show the detailed view of the controller. The Viewing General Details panel is displayed.
6. Record the vendor ID, the product ID and worldwide node name (WWNN).
7. Use the vendor ID, the product ID and WWNN to determine which controller presents this MDisk.
8. From the native user interface for the controller that presents this MDisk, list the LUNs that the controller presents and match the LUN number with that noted in step 2. This is the exact RAID array and partition that corresponds with the MDisk.

Displaying MDisk groups

You can display the managed disk (MDisk) group that an MDisk is a part of from the Viewing Managed Disk Groups panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to display the MDisk group:

1. Click **Work with Managed Disks** → **Managed Disks** in the portfolio. The Viewing Managed Disks panel is displayed.
2. Select the MDisk and select **Show MDisk Group** from the list. Click **Go**. The Viewing Managed Disk Groups panel is displayed. The MDisk group is displayed in a table on the Viewing Managed Disk Groups panel.

Creating MDisk groups

You can create a new managed disk (MDisk) group using the Create a Managed Disk Group wizard.

If you intend to keep the virtual disk (VDisk) allocation within one disk controller system, ensure that the MDisk group that corresponds with a single disk controller system is presented by that disk controller system. This also enables nondisruptive migration of data from one disk controller system to another disk controller system and simplifies the decommissioning process if you want to decommission a disk controller system at a later time.

Ensure all MDisks that are allocated to a single MDisk group are of the same RAID-type. Using the same RAID-type ensures that a single failure of a physical disk in the disk controller system does not take the entire group offline. For example, if you have three RAID-5 arrays in one group and add a non-RAID disk to this group, you lose access to all the data that is striped across the group if the non-RAID disk fails. Similarly, for performance reasons, you should not mix RAID types.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to create a new MDisk group:

1. Click **Work with Managed Disks** → **Managed Disk Groups** in the portfolio. The Viewing Managed Disk Groups panel is displayed.
2. Select **Create an MDisk Group** from the task list and click **Go**. The Create a Managed Disk Group wizard begins.
3. Complete the Create a Managed Disk Group wizard.

Adding MDisks to MDisk groups

You can add managed disks (MDisks) to an MDisk group from the Adding Managed Disks to Managed Disk Group panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to add MDisks to an MDisk group:

1. Click **Work with Managed Disks** → **Managed Disk Groups** in the portfolio. The Viewing Managed Disk Groups panel is displayed.
2. Select the MDisk group to add MDisks to and select **Add MDisks** from the list. Click **Go**. The Adding Managed Disks to Managed Disk Group panel is displayed.
3. Select the MDisks to add and click **OK**.

Removing MDisks from an MDisk group

You can remove managed disks (MDisks) from an MDisk group.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to remove an MDisk from an MDisk group:

1. Click **Work with Managed Disks** → **Managed Disk Groups** in the portfolio. The Viewing Managed Disk Groups panel is displayed.
2. Select the MDisk Group that you want to delete MDisks from and select **Remove MDisks** from the list. Click **Go**. The Deleting Managed Disks from Managed Disk Group panel is displayed.
3. Select the MDisk that you want to remove.
4. Click **OK**.

Viewing the progress of an MDisk removal

You can view the progress of a managed disk (MDisk) removal from the Viewing MDisk Removal Progress panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the progress of an MDisk removal:

1. Click **Manage Progress** → **View Progress**. The View Progress panel is displayed.
2. Click the **MDisk Removal** link. The Viewing MDisk Removal Progress panel is displayed.

Renaming MDisk groups

You can rename a managed disk (MDisk) group from the Modify Managed Disk Group panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to rename an MDisk group:

1. Click **Work with Managed Disks** → **Managed Disk Groups** in the portfolio. The Viewing Managed Disk Groups panel is displayed.
2. Select the MDisk group that you want to rename and select **Modify an MDisk Group** from the list. Click **Go**. The Modify Managed Disk Group panel is displayed.

Displaying VDIs

You can display the virtual disks (VDIs) that use a managed disk (MDisk) group from the Viewing Virtual Disks panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to display the VDIs that use an MDisk group:

1. Click **Work with Managed Disks** → **Managed Disk Groups** in the portfolio. The Viewing Managed Disk Groups panel is displayed.

2. Select the MDisk group to display VDIs for and select **Show VDIs Using This Group** from the list. Click **Go**. The Viewing Virtual Disks panel is displayed.

Deleting MDisk groups

You can delete a managed disk (MDisk) group using the Deleting a Managed Disk Group panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to delete an MDisk group:

1. Click **Work with Managed Disks** → **Managed Disk Groups** in the portfolio. The Viewing Managed Disk Groups panel is displayed.
2. Select the MDisk group to delete and select **Delete an MDisk Group** from the list. Click **Go**. The Deleting a Managed Disk Group panel is displayed.

Creating VDIs

You can create virtual disks (VDIs) using the Create Virtual Disks wizard.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to create VDIs:

1. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
2. Select **Create VDIs** from the task list and click **Go**. The Create Virtual Disks wizard begins. This wizard allows you to create mirrored VDIs and space-efficient VDIs.
3. Complete the Create Virtual Disks wizard.

Viewing the progress of VDisk formatting

You can view the progress of virtual disk (VDisk) formatting from the Viewing VDisk Formatting Progress panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the progress of VDisk formatting:

1. Click **Manage Progress** → **View Progress**. The View Progress panel is displayed.
2. Click the **VDisk Formatting** link. The Viewing VDisk Formatting Progress panel is displayed.

Migrating VDIs

You can migrate a virtual disk (VDisk) from one managed disk (MDisk) group to another from the Migrating VDIs panel.

This task assumes that you have already launched the SAN Volume Controller Console.

The SAN Volume Controller provides various data migration features. You can use these features to move the placement of data both within MDisk groups and

between MDisk groups. These features can be used concurrently with I/O operations. There are two ways that you can migrate data:

1. Migrate data (extents) from one MDisk to another MDisk within the same MDisk group. This can be used to remove active or overutilized MDisks. This can only be performed using the command-line interface (CLI).
2. Migrate VDIs from one MDisk group to another. This can be used to remove active MDisk groups; for example, you can reduce the utilization of a group of MDisks.

You can determine the usage of MDisks by gathering I/O statistics about MDisks and VDIs. After you have gathered this data, you can analyze it to determine which VDIs or MDisks are active.

When a migration command is issued, a check ensures that the migration target has sufficient free extents available. If there are sufficient free extents, the command proceeds.

Notelist:

- You cannot use the SAN Volume Controller data migration function to move a VDisk between MDisk groups that have different extent sizes. However, you can start with a non-mirrored VDisk in one MDisk group and then add a mirrored copy to that VDisk in another MDisk group. You can also create a FlashCopy mapping to create an instant copy of a VDisk that is in another MDisk group.
- Migration commands fail if the target or source VDisk is offline, or if there is insufficient quorum disk space to store the metadata. Correct the offline or quorum disk condition and retry the command.

While the migration proceeds, it is possible for the free destination extents to be consumed by another process; for example, by creating a new VDisk in the destination MDisk group or by starting more migrate commands. In this situation, when all the destination extents have been allocated, the migration commands suspend and an error is logged (error ID 020005). There are two methods for recovering from this situation:

1. Add additional MDisks to the target MDisk group. This provides additional extents in the group and allows the migrations to be restarted (by marking the error as fixed).
2. Migrate one or more VDIs that are already created from the MDisk group to another group. This frees up extents in the group and allows the original migrations to be restarted.

Perform the following steps to migrate VDIs between MDisk groups:

1. Perform the following steps to determine if VDIs are overused:
 - a. Click **Manage Cluster** → **Start statistics collection** in the portfolio. The Starting the Collection of Statistics panel is displayed.
 - b. Enter 15 minutes for the interval and click **OK**. This generates a new I/O statistics dump file approximately every 15 minutes.
 - c. Wait at least 15 minutes before you proceed to the next step.
2. View the I/O statistics log.
 - a. Click **Service and Maintenance** → **List dumps** in the portfolio. The List Dumps panel is displayed.

- b. Click **I/O Statistics Logs**. This lists the I/O statistics files that have been generated. These are prefixed with m and Nm for MDisk statistics and v for VDisk statistics.
 - c. Click a filename to view the contents of the log.
 - d. Analyze the dumps to determine which VDIsks are active. It might be helpful to also determine which MDIsks are heavily utilized so you can spread the data that they contain more evenly across all the MDIsks in the group. Either create a new MDisk group or determine an existing group that is not yet over used. You can do this by checking the I/O statistics files that were previously generated and ensuring that the MDIsks or VDIsks in the target MDisk group are less utilized than the source group.
3. Stop the statistics collection by clicking **Manage Cluster** → **Stop statistics collection** in the portfolio.
 4. Migrate the VDisk.
 - a. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
 - b. Select the VDisk to migrate and select **Migrate a VDisk** from the task list. Click **Go**. The Migrating Virtual Disks panel is displayed.
 - c. Select a target MDisk group from the **Target MDisk Group** list.
 - d. Click **OK**.

Viewing the progress of VDisk migration

You can view the progress of virtual disk (VDisk) migration from the Viewing VDisk Migration Progress panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the progress of VDisk migration:

1. Click **Manage Progress** → **View Progress**. The View Progress panel is displayed.
2. Click the **VDisk Migration** link. The Viewing VDisk Migration Progress panel is displayed.

Shrinking VDIsks

You can use the SAN Volume Controller Console to make a target or auxiliary virtual disk (VDisk) the same size as the source or master VDisk when you create FlashCopy[®] mappings, Metro Mirror relationships, or Global Mirror relationships.

You can shrink a VDisk from the Shrinking Virtual Disks panel in the SAN Volume Controller Console. Shrinking a VDisk reduces its total capacity. Use this function when you want a FlashCopy target disk to have the same capacity as its source. However, if the VDisk contains data, do not shrink the size of the disk.

Attention:

1. The SAN Volume Controller arbitrarily reduces the capacity of the VDisk by removing one or more extents from those that are allocated to the VDisk. You cannot control which extents are removed so you cannot guarantee that it is unused space that is removed.
2. If the VDisk contains data that is being used, but you still want to reduce its size, ensure that you back up your data before you attempt this operation.
3. If the VDisk is being used by hosts, ensure that the target VDisk is not mapped to any hosts before you shrink the VDisk.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to shrink a VDisk:

1. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
2. Select the VDisk to shrink and select **Shrink a VDisk** from the task list. Click **Go**. The Shrinking Virtual Disks panel is displayed.
3. Enter the capacity to reduce the size of the VDisk by in the **Reduce By Capacity** field and click **OK**.

Shrinking or expanding space-efficient VDisks

You can use the SAN Volume Controller Console to increase or decrease the real capacity of a space-efficient virtual disk (VDisk).

You can use the Shrink/Expand Space-Efficient Disks panel in the SAN Volume Controller Console to change the real capacity of a space-efficient VDisk, unless the VDisk is in image mode.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to shrink or expand a space-efficient VDisk:

1. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
2. Select the VDisk and select **Expand/Shrink Space-efficient VDisk** from the task list. Click **Go**. The Shrink/Expand Space-Efficient Disks panel is displayed.
3. Choose which copies of the VDisk that you want to shrink or expand.
4. Enter the amount to either decrease or increase the real capacity of the selected space-efficient VDisk in the **Amount to shrink/expand** field.

Note: You cannot shrink the real capacity of a space-efficient VDisk below its used capacity. Further shrinking is restricted to prevent data loss.

5. Select the **Shrink** or **Expand** option and then click **OK**.
6. If you are expanding a striped space-efficient VDisk, you can select an MDisk candidate to be used to allocate new extents to the space-efficient VDisk.

If you are working with VDisk copies, perform the following steps:

- a. Select the MDisk to use to allocate new extents to the space-efficient VDisk.
- b. Select **MDisk for each copy**.
- c. Click **Add** to add the selected MDisk to the **Managed Disks Striped in This Order** list.

- d. After you have added all the MDisks to use to expand the capacity of the VDisk, you can use the arrows to determine the order in which they are used.

Configuring bitmap space for Copy Services or VDisk mirroring

You can use the Modify Copy Service Space panel in the SAN Volume Controller Console to modify the amount of memory that is available for the FlashCopy, Metro Mirror, or Global Mirror Copy Services features or virtual disk (VDisk) mirroring.

The total bitmap space that is available for Copy Services features and VDisk mirroring in an I/O group is 512 MB. The following table provides an example of the amount of memory that is required for VDisk Mirroring and each Copy Service feature:

Feature	Grain size	1 MB of memory provides the following VDisk capacity for the specified I/O group
Metro Mirror or Global Mirror	256 KB	2 TB of total Metro Mirror and Global Mirror VDisk capacity
FlashCopy	256 KB	2 TB of total FlashCopy source VDisk capacity
FlashCopy	64 KB	512 GB of total FlashCopy source VDisk capacity
Incremental FlashCopy	256 KB	1 TB of total incremental FlashCopy source VDisk capacity
Incremental FlashCopy	64 KB	256 GB of total incremental FlashCopy source VDisk capacity
VDisk Mirroring	256 KB	2TB of mirrored VDisk capacity
Notes:		
<ol style="list-style-type: none"> 1. For multiple FlashCopy targets, you must consider the number of mappings. For example, for a mapping with a grain size of 256 KB, 8 KB of memory allows one mapping between a 16 GB source VDisk and a 16 GB target VDisk. Alternatively, for a mapping with a 256 KB grain size, 8 KB of memory allows two mappings between one 8 GB source VDisk and two 8 GB target VDIs. 2. When creating a FlashCopy mapping, if you specify an I/O group other than the I/O group of the source VDisk, the memory accounting goes towards the specified I/O group, not towards the I/O group of the source VDisk. 3. For VDisk mirroring, the full 512 MB of memory space enables 1 PB of total VDisk Mirroring capacity. 		

Before you specify the memory settings on the Modify Copy Service Space panel, consider the following factors.

- For FlashCopy relationships, only the source VDisk allocates space in the bitmap table.
- For Metro Mirror or Global Mirror relationships, two bitmaps exist. One is used for the master cluster and one is used for the auxiliary cluster, because the direction of the relationship can be reversed.
- The smallest possible bitmap is 4 KB; therefore, a 512 byte VDisk requires 4 KB of bitmap space.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to change the amount of memory that is available for Copy Services features or virtual disk (VDisk) mirroring:

1. Click **Work with Nodes** → **I/O Groups** in the portfolio. The Viewing Input/Output Groups panel is displayed.
2. Select the I/O Group and select **Modify Copy Services Space** from the task list. Click **Go**. The Modify Copy Service Space panel is displayed.

The current setting of total memory that is allocated for Global / Metro Mirror, FlashCopy, and VDisk Mirroring is displayed. The total free memory that can be allocated for Global / Metro Mirror, FlashCopy, and VDisk Mirroring is also displayed.

3. Enter a value between 0 MB and 512 MB for the new total amount of memory to allocate for Global / Metro Mirror, FlashCopy, or virtual disk (VDisk) mirroring.
4. Click **OK** to change the total bitmap space allocated for the selected Copy Services feature or VDisk mirroring in an I/O group.

Adding a mirrored copy to a VDisk

Use the Add Copy to VDisk panel in the SAN Volume Controller Console to add a mirrored copy to the selected virtual disk (VDisk). Each VDisk can have a maximum of two copies.

Creating mirrored copies of a VDisk allows the VDisk to remain accessible even when a managed disk (MDisk) that the VDisk depends on becomes unavailable. You can create copies of a VDisk either from different MDisk groups or by creating an image mode copy of the VDisk. Copies allow for availability of data; however, they are not separate objects. You can only create or change mirrored copies from the VDisk.

In addition, you can use VDisk mirroring as an alternative method of migrating VDIs between MDisk groups. For example, if you have a non-mirrored VDisk in one MDisk group and want to migrate that VDisk to a second MDisk group, you can add a new copy of the VDisk by specifying the second MDisk group for that VDisk copy. After the copies have synchronized, you can delete the copy in the first MDisk group. The VDisk is migrated to the second MDisk group while remaining online during the migration.

This alternative method of migrating VDIs has the following advantages:

- Access to the VDisk data is not lost if the second MDisk group goes offline during the migration.
- The speed of the migration can be adjusted, using the VDisk synchronization rate, and the migration can be paused.
- The migration can be ended by deleting the VDisk copy in the second MDisk group before migration completes.
- The MDisk groups can have different extent sizes.

This alternative method of migrating VDIs has the following limitations:

- You cannot use this method for VDIs that are already mirrored.
- There are more manual steps that are associated with this method.

- Write I/O performance is slightly affected during the migration, because the mirrored copies must be kept synchronized.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to add a mirrored copy to a VDisk:

1. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
2. Select the VDisk to copy and select **Add Mirrored VDisk Copy** from the task list. Click **Go**. The Add Copy to VDisk panel is displayed.
3. Select the type of VDisk copy and then select the managed disk (MDisk) group to create the VDisk copy from. View the panel Help for more information about the options that are available on this panel.
4. Click **OK** to add a mirrored copy to the selected VDisk.

Splitting a VDisk copy

You can create a separate virtual disk (VDisk) by splitting a synchronized VDisk copy. You can select a copy to split off from the VDisk and set its attributes.

1. Click **Work with Virtual Disks** → **Virtual Disks**. The Viewing Virtual Disk panel is displayed.
2. Select a VDisk that contains copies and select **Split a VDisk Copy** from the task list and click **Go**. The Split a Copy from VDisk panel displays.
3. Select the VDisk copy that is displayed in the table to create a new VDisk.
4. Enter a name for the new VDisk.
5. Select the **Force Split** option to force the split to proceed even though the copy you are trying to split is not synchronized.

Note: If you select this option, the split copy might not be point-in-time consistent.

6. Select the I/O group for the new VDisk that you are creating from the VDisk copy. By default, the VDisk is created in the same I/O group as the VDisk that the copy is split from.
7. Select the preferred node for the new VDisk that you are creating from the VDisk copy. When you let the system choose the preferred node, the system performs workload balancing by managing the I/O traffic for the VDIs across multiple nodes.
8. Select the cache mode for the new VDisk that you are creating from the VDisk copy.
9. Optional: Enter a unit device identifier for the new VDIs in the **Unit Device Identifier** field. This field is used only by hosts that are using the OpenVMS operating system. For other operating systems, setting a unit device identifier is not required.
10. Click **OK**.

Deleting a copy from a VDisk

Use the Deleting a Copy from VDisk panel in the SAN Volume Controller Console to delete a mirrored copy from the selected virtual disk (VDisk).

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to delete a mirrored copy from a VDisk:

1. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
2. Select the VDisk with a copy to delete and select **Delete a Mirrored VDisk Copy** from the task list. Click **Go**. The Deleting a Copy from VDisk panel is displayed.
3. If necessary, click **Force delete** to force the deletion of the VDisk copy in the following situations:
 - Migration to an image mode VDisk is in progress for the selected VDisk copy.
 - If the selected VDisk copy is an image mode with virtual medium errors.
 - The cache is not empty for an image mode VDisk copy.
 - The image mode VDisk copy is not synchronized.

If the copy being deleted is the last synchronized VDisk copy, the VDisk and all its copies are deleted.

4. Select the VDisk copy to delete and click **OK**.

Viewing virtual disk-to-host mappings

You can view the virtual disk-to-host mappings from the Virtual Disk-to-Host Mappings panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view your virtual disk-to-host mappings:

1. Click **Work with Virtual Disks** → **Virtual Disk-to-Host Mappings** in the portfolio. The Virtual Disk-to-Host Mappings panel is displayed.
2. Click **Close** to close the panel.

Creating a VDisk-to-host mapping

You can create a new mapping between a virtual disk (VDisk) and a host from the Creating Virtual Disk-to-Host Mappings panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to create a new mapping:

1. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disk panel is displayed.
2. Select the VDisk to map to your host and select **Map VDIsks to a Host** from the list. Click **Go**. The Creating Virtual Disk-to-Host Mappings panel is displayed.
3. Select the host that you want to map the VDisk to, and click **OK**.

Deleting a virtual disk-to-host mapping

You can delete a mapping between a virtual disk (VDisk) and a host object from the Deleting a Virtual Disk-to-Host Mapping panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to delete a mapping between a VDisk and a host object:

1. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
2. Select the VDisk that you no longer want mapped to your host and select **Delete a VDisk-to-Host-Mapping** from the list and click **Go**. The Deleting a VDisk-to-Host Mapping panel is displayed.
3. Select the host from which you want to remove the VDisk mapping and click **OK**.

Determining the relationship between VDisks and MDisks

You can use the SAN Volume Controller Console to determine the relationship between virtual disks (VDisks) and managed disks (MDisks).

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to determine the relationship between VDisks and MDisks:

1. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
2. Select the VDisk that you want to view.
3. Select **Show MDisks This VDisk is Using** from the task list and click **Go**. The Viewing Managed Disks panel is displayed. This panel lists the MDisks that the selected VDisk uses.

Verifying and repairing mirrored VDisk copies

The virtual disk (VDisk) copy verification process checks if data on mirrored VDisk copies match. You can choose repair options if differences are found during the verification process.

Attention: Proceed with this task only if all VDisk copies are synchronized.

Use the Verifying VDisk Copies panel to start the VDisk copy verification process for a selected VDisk. If differences are found during verification, you can choose one of the following actions.

- Stop the process when the first difference is found. Select this option if you only want to verify that the mirrored VDisk copies are identical. You can run this option, starting at a different logical block address (LBA) each time to count the number of differences on a VDisk.
- Automatically repair the copy by overwriting sectors with data from the primary VDisk copy. Select the resync option if you are sure that either the primary VDisk copy data is correct or that your host applications can handle incorrect data.
- Create a virtual medium error at the VDisk level. Select this option if you are unsure what the correct data is and you do not want an incorrect version of the data to be used.

When differences are not found, the verification process automatically repairs the VDisk copy if a medium error is encountered on one of the copies.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to verify mirrored VDisk copies:

1. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
2. Select the VDisk to verify and then select **Verify VDisk Copies** from the task list. Click **Go**. The Verifying VDisk Copies panel is displayed.
3. Select the repair action if errors are found and click **OK**. You can also specify an LBA from which to start the verification. Start at different LBAs to count the number of differences on a VDisk.

Viewing the progress of mirror copy verification

You can view the progress of verification of one or more mirror copies for a virtual disk (VDisk) from the Viewing Mirror Copy Verification Progress panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the progress of mirror copy verification:

1. Click **Manage Progress** → **View Progress**. The View Progress panel is displayed.
2. Click the **VDisk Copy Verification** link. The Viewing Mirror Copy Verification Progress panel is displayed.
3. Click **Close** to close the panel.

Repairing offline space-efficient VDIs

When a space-efficient virtual disk (VDisk) is taken offline because its metadata is corrupted, you can use the Repairing Space-Efficient VDisk panel to repair the metadata. The repair operation automatically detects corrupted metadata and performs any necessary repair actions.

This task assumes that you have already launched the SAN Volume Controller Console.

Use the Repairing Space-Efficient VDisk panel when directed through maintenance procedures. When the repair operation completes successfully, the error is automatically marked as fixed and the volume is brought back online. If the repair operation fails, an error is logged (error ID 060003) and the volume remains offline.

Once started, the VDisk remains offline for the duration of the repair, but you can move the VDisk to another I/O group.

Attention: You can only use this panel to repair a space-efficient VDisk that has reported corrupt metadata.

Perform the following steps to repair the offline space-efficient VDisk:

1. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
2. Select the VDisk to repair and then select **Repair Space-efficient VDisk** from the task list. Click **Go**. The Repairing Space-Efficient VDIs panel is displayed.
3. Select the VDisk copy to repair and click **OK**.

Viewing the progress of space-efficient VDisk copy repair

You can view the progress of space-efficient virtual disk (VDisk) copy repair from the Viewing Space-Efficient Copy Repair Progress panel.

The time that is needed to complete a space-efficient VDisk copy repair depends on the amount of data that is currently on the copy. The repair process might complete very quickly.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the progress of space-efficient VDisk copy repair:

1. Click **Manage Progress** → **View Progress**. The View Progress panel is displayed.
2. Click the **Space-Efficient Copy Repair** link. The Viewing Space-Efficient Copy Repair Progress panel is displayed.
3. Click **Close** to close the panel.

Recovering from offline VDIs

You can use the SAN Volume Controller Console to recover from an offline virtual disk (VDisk) after a node or an I/O group has failed.

If you have lost both nodes in an I/O group and have, therefore, lost access to all the VDIs that are associated with the I/O group, you must perform one of the following procedures to regain access to your VDIs. Depending on the failure type, you might have lost data that was cached for these VDIs and the VDIs are now offline.

Data loss scenario 1

One node in an I/O group has failed and failover has started on the second node. During the failover process, the second node in the I/O group fails before the data in the write cache is written to hard disk. The first node is successfully repaired but its hardened data is not the most recent version that is committed to the data store; therefore, it cannot be used. The second node is repaired or replaced and has lost its hardened data, therefore, the node has no way of recognizing that it is part of the cluster.

Perform the following steps to recover from an offline VDisk when one node has earlier-level hardened data and the other node has lost hardened data:

1. Recover the node and add it back into the cluster.
2. Delete all FlashCopy, Metro Mirror, and Global Mirror mappings and relationships that use the offline VDIs.
3. Run the **recovervdisk**, **recovervdiskbyiogrp** or **recovervdiskbycluster** command.
4. Recreate all FlashCopy, Metro Mirror, and Global Mirror mappings and relationships that use the VDIs.

Data loss scenario 2

Both nodes in the I/O group have failed and have been repaired. The nodes have lost their hardened data, therefore, the nodes have no way of recognizing that they are part of the cluster.

Perform the following steps to recover from an offline VDisk when both nodes have lost their hardened data and cannot be recognized by the cluster:

1. Delete all FlashCopy, Metro Mirror, and Global Mirror mappings and relationships that use the offline VDIs.
2. Run the **recovervdisk**, **recovervdiskbyiogrp** or **recovervdiskbycluster** command.
3. Recreate all FlashCopy, Metro Mirror, and Global Mirror mappings and relationships that use the VDIs.

Recovering VDIs

Virtual disks (VDIs) or VDisk copies are corrupted if they have lost cached data or space-efficient metadata, usually as a result of hardware failure. A Fast Write State of Corrupt indicates this data loss.

You can recover one or more corrupted VDIs and VDisk copies. This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to recover VDIs and VDisk copies:

1. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
2. Select the offline VDIs and select **Recover VDisk** from the task list and click **Go**. The Recovering VDIs panel is displayed.
3. Verify that the VDIs and VDisk copies have completed recovery by monitoring the VDisk Recovery Results panel.

Recovering VDIs by I/O group

Virtual disks (VDIs) or VDisk copies are corrupted if they have lost cached data or space-efficient metadata, usually as a result of hardware failure. A Fast Write State of Corrupt indicates this data loss.

You can recover all corrupted VDIs and VDisk copies in an I/O group. This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to recover VDIs and VDisk copies by I/O group:

1. Click **Work with Nodes** → **I/O Groups** in the portfolio. The Viewing I/O Groups panel is displayed.
2. Select the I/O Group and select **Recover VDIs by I/O Group** from the task list and click **Go**. The Recovering VDIs by I/O Group panel is displayed. Click **OK**.
3. Verify that the VDIs and VDisk copies have completed recovery by monitoring the VDisk Recovery Results panel.

Recovering VDIs by cluster

Virtual disks (VDIs) or VDisk copies are corrupted if they have lost cached data or space-efficient metadata, usually as a result of hardware failure. A Fast Write State of Corrupt indicates this data loss.

You can recover all corrupted VDIs and VDisk copies in a cluster. This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to recover VDIs and VDisk copies by cluster:

1. Click **Work with Virtual Disks** → **Virtual Disks** → **Viewing VDIs** in the portfolio. The Viewing Virtual Disks panel is displayed.
2. Select **Recover All VDIs** from the task list and click **Go**. The Recovering All VDIs panel is displayed. Click **OK**.

3. Verify that the VDIsks and VDisk copies have completed recovery by monitoring the VDisk Recovery Results panel.

Moving offline VDIsks to their original I/O group

After a node or an I/O group fails, you can move offline virtual disks (VDIsks) to their original I/O group.

This task assumes that you have already launched the SAN Volume Controller Console.

Attention: Under no circumstances should VDIsks be moved to an offline I/O group. Ensure that the I/O group is online before moving back the VDIsks to avoid any further data loss.

Perform the following steps to move offline VDIsks to their original I/O group:

1. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
2. Select the offline VDisk and select **Modify a VDisk** from the task list and click **Go**. The Modifying Virtual Disk panel is displayed.
3. From the **I/O Group** list, select the name of the VDisk's original I/O group. You might be asked to confirm and force the move; select to force the move. Click **OK**. The Viewing Virtual Disks panel is displayed.
4. Verify that the VDisk is online.
5. Repeat these steps for each offline VDisk.

Deleting VDIsks

You can delete a virtual disk (VDisk) from the Deleting Virtual Disk panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to delete a VDisk:

1. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
2. Select the VDisk you want to delete and select **Delete a VDisk** from the list. Click **Go**. The Deleting Virtual Disk panel is displayed.
3. Click **OK**.

Using image mode VDIsks

Ensure that you are familiar with using image mode virtual disks (VDIsks).

An image mode VDisk provides a direct block-for-block translation from the managed disk (MDisk) to the VDisk with no virtualization. This mode is intended to allow virtualization of MDIsks that already contain data that was written directly, not through a SAN Volume Controller node. Image mode VDIsks have a minimum size of 1 block (512 bytes) and always occupy at least one extent.

Image mode MDIsks are members of an MDisk group but, they do not contribute to free extents. Image mode VDIsks are not affected by the state of the MDisk group because the MDisk group controls image mode VDIsks through the VDIsks association to an MDisk. Therefore, if an MDisk that is associated with an image mode VDisk is online and the MDisk group of which they are members goes

offline, the image mode VDisk remains online. Conversely, the state of an MDisk group is not affected by the state of the image mode VDIsks in the group.

An image mode VDisk behaves just as a managed mode VDisk in terms of the Metro Mirror, Global Mirror, and FlashCopy Copy Services. Image mode VDIsks are different from managed mode in two ways:

- Migration. An image mode disk can be migrated to another image mode disk. It becomes managed while the migration is ongoing, but returns to image mode when the migration is complete.
- Quorum disks. Image mode disks cannot be quorum disks. This means that a cluster with only image mode disks does not have a quorum disk.

Creating an image mode VDisk

You can import storage that contains existing data and continue to use this storage but make use of the cache and advanced functions, such as Copy Services and data migration. These disks are known as image mode virtual disks (VDIsks).

Make sure that you are aware of the following before you create image mode VDIsks:

- Unmanaged-mode managed disks (MDisks) that contain existing data cannot be differentiated from unmanaged-mode MDIsks that are blank. Therefore, it is vital that you control the introduction of these disks to the cluster. It is recommended that you introduce these disks one at a time. For example, map a single logical unit from your RAID controller to the cluster and refresh the view of MDIsks. The newly detected disk is displayed.
- Do *not* manually add an unmanaged-mode MDisk that contains existing data to an MDisk group. If you do, the data is lost. When you use the command to convert an image mode VDisk from an unmanaged-mode disk, select the MDisk group where you want to add the VDisk.

See the following Web site for more information:

www.ibm.com/storage/support/2145

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to create an image mode VDisk:

1. Stop all I/O operations from the hosts.
2. Unmap the logical disks that contain the data from the hosts.
3. Perform the following steps to create one or more MDisk groups:
 - a. Click **Work with Managed Disks** → **Managed Disk Groups** in the portfolio. The Viewing Managed Disk Groups panel is displayed.
 - b. Select **Create an MDisk Group** from the task list and click **Go**. The Create Managed Disk Group wizard begins.
 - c. Use the wizard to create the MDisk group.
4. Perform the following steps to convert the unmanaged-mode MDisk to an image mode VDisk:
 - a. Click **Work with Managed Disks** → **Managed Disks** in the portfolio. The Viewing Managed Disks panel is displayed.
If the new unmanaged-mode MDisk is not listed, you can perform a fabric-level discovery. Select **Discover MDisks** from the task list and click

- Go.** When this process is complete, refresh the list of MDisks, and the unmanaged-mode MDisk should appear in the list.
- b. Select the unmanaged-mode MDisk and select **Create VDisk in Image Mode** from the task list. Click **Go**. The Create Image mode Virtual Disk wizard begins.
 - c. Use the wizard to select the MDisk group where the image mode VDisk should be added and the I/O group that will provide the data path for the VDisk.
5. Perform the following steps to map the new VDisk to the hosts that were previously using the data that the MDisk now contains:
- a. Click **Work with Virtual Disks** → **Virtual Disks** in the portfolio. The Viewing Virtual Disks panel is displayed.
 - b. Select the VDisks and select **Map VDisks to a host** from the task list. Click **Go**. The Creating Virtual Disk-to-Host Mappings panel is displayed.
 - c. Select the host that you want to map the VDisk to and click **OK**.

After the image mode VDisk is mapped to a host object, it is detected as a disk drive with which the host can perform I/O operations.

If you want to virtualize the storage on an image mode VDisk, you can transform it into a striped VDisk. Migrate the data on the image mode VDisk to managed-mode disks in another MDisk group.

Migration methods

Several methods can be used to migrate image mode virtual disks (VDisks) into managed mode VDisks.

In order to perform any type of migration activity on an image mode VDisk, the image mode VDisk must first be converted into a managed mode disk. The VDisk is automatically converted into a managed mode disk whenever any kind of migration activity is attempted. After the image mode to managed mode migration operation has occurred, the VDisk becomes a managed mode VDisk and is treated the same way as any other managed mode VDisk.

If the image mode disk has a partial last extent, this last extent in the image mode VDisk must be the first to be migrated. This migration is processed as a special case. After this special migration operation has occurred, the VDisk becomes a managed mode VDisk and is treated in the same way as any other managed mode VDisk. If the image mode disk does not have a partial last extent, no special processing is performed. The image mode VDisk is changed into a managed mode VDisk and is treated the same way as any other managed mode VDisk.

An image mode disk can also be migrated to another image mode disk. The image mode disk becomes managed while the migration is ongoing, but returns to image mode when the migration is complete.

You can perform the following types of migrations:

- Migrate extents
- Migrate a VDisk
- Migrate to image mode

Note: Migration commands fail if the target or source VDisk is offline, or if there is insufficient quorum disk space to store the metadata. Correct the offline or quorum disk condition and reissue the command.

Perform the following steps to migrate VDisks:

1. Dedicate one MDisk group to image mode VDisks.
2. Dedicate one MDisk group to managed mode VDisks.
3. Use the migrate VDisk function to move the VDisks.

Viewing the progress of image mode migration

You can view the progress of image mode migration from the Viewing Image Mode Migration Progress panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the progress of image mode migration:

1. Click **Manage Progress** → **View Progress**. The View Progress panel is displayed.
2. Click the **Image Mode Migration** link. The Viewing Image Mode Migration Progress panel is displayed.

Viewing the progress of extent migration

You can view the progress of image mode migration from the Viewing Extent Migration Progress panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the progress of extent migration:

1. Click **Manage Progress** → **View Progress**. The View Progress panel is displayed.
2. Click the **Extent Migration** link. The Viewing Extent Migration Progress panel is displayed.

Creating hosts

You can create a new host object from the Creating Hosts panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to create a new host object:

1. Click **Work with Hosts** → **Hosts** in the portfolio. The Viewing Hosts panel is displayed.
2. Select **Create a Host** from the task list and click **Go**. The Creating Hosts panel is displayed.
3. Type the name for the host in the **Host Name** field. If you do not specify a name, a default name is assigned.
4. Select the type of host from the **Type** list.
5. Select the I/O groups to map to this host from the **I/O Groups** list.
6. Assign a worldwide port name (WWPN). A WWPN consists of 16 hexadecimal digits (for example, 210100e08b251dd4). You can select a WWPN from the list

of candidates, or you can enter a WWPN that is not in the list. You can assign one or more WWPNs to a single logical host object.

7. Click **OK**.
8. Repeat steps 2 on page 155 through 7 for each host object to create.

Viewing host details

You can view details about a host object from the Viewing General Details panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view details for a host object:

1. Click **Work with Hosts** → **Hosts** in the portfolio. The Viewing Hosts panel is displayed.
2. Click the name of the host for which you want to view details. The Viewing General Details panel is displayed.
3. Click **Close** to return to the Viewing Hosts panel.

Viewing port details

You can view the ports that are attached to a host object from the Viewing Port Details panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the ports for a host object:

1. Click **Work with Hosts** → **Hosts** in the portfolio. The Viewing Hosts panel is displayed.
2. Click the name of the host for which you want to view port details. The Viewing General Details panel is displayed.
3. Click **Ports** to view the ports that are attached to the host object. The Viewing Port Details panel is displayed.
4. Click **Close** to return to the Viewing Hosts panel.

Viewing mapped I/O groups

You can view the I/O groups that are mapped to a host object from the Viewing Mapped I/O Groups panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the I/O groups that are mapped to a host object:

1. Click **Work with Hosts** → **Hosts** in the portfolio. The Viewing Hosts panel is displayed.
2. Click the name of the host for which you want to view the mapped I/O groups. The Viewing General Details panel is displayed.
3. Click **Mapped I/O Groups** to view the I/O groups that are mapped to the host object. The Viewing Mapped I/O Groups panel is displayed.
4. Click **Close** to return to the Viewing Hosts panel.

Displaying VDisks that are mapped to a host

You can display the virtual disks (VDisks) that are mapped to a host by using the Viewing Virtual Disks panel.

This task assumes that you have already launched the SAN Volume Controller Console.

If a large number of new VDisks are mapped to a host and a large number of devices are already running I/O operations, a significant number of errors might be logged. When the new VDisk is mapped, multiple recoverable errors can be logged in the event log. The event log displays the errors that are caused by a check condition. The errors state that there has been a change to the device information since the last logical unit number (LUN) operation.

Perform the following steps to show the VDisks that are mapped to a host:

1. Click **Work with Hosts** → **Hosts** in the portfolio. The Viewing Hosts panel is displayed.
2. Select the host and select **Show the VDisks Mapped to this Host** from the task list. Click **Go**.

Modifying a host

You can modify a host from the Modifying Host panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to modify a host:

1. Click **Work with Hosts** → **Hosts** in the portfolio. The Viewing Hosts panel is displayed.
2. Select the host that you want to modify and select **Modify a Host** from the task list. Click **Go**. The Modifying Host panel is displayed.

You can modify the following attributes for a host:

- Name
 - Type
 - I/O group
 - Port mask
3. Click **OK** after you have selected the new attributes. If you are modifying a host-to-I/O group mapping that results in the loss of a VDisk-to-host mapping, the Forcing the Deletion of a Host to I/O Group Mappings panel is displayed. Perform one of the following steps:
 - Click **Force Remove** to remove the host-to-I/O group mapping.
 - Click **Cancel** to preserve the host-to-I/O group mapping.

Adding ports to a host

You can add ports to a host from the Adding Ports panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to add ports to a host:

1. Click **Work with Hosts** → **Hosts** in the portfolio. The Viewing Hosts panel is displayed.
2. Select the host that you want to add ports to and select **Add Ports** from the task list. Click **Go**. The Adding Ports panel is displayed.
3. Perform one of the following steps to add the ports:
 - Select the ports that you want to add from the **Available Ports** list and click **Add**.
 - Type the worldwide port names (WWPNs) that you want to add in the **Additional Ports** field.
4. Click **OK**.

Deleting ports from a host

You can delete ports from the Deleting Ports panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to delete ports from a host:

1. Click **Work with Hosts** → **Hosts** in the portfolio. The Viewing Hosts panel is displayed.
2. Select the host that you want to delete ports from and select **Delete Ports** from the task list. Click **Go**. The Deleting Ports panel is displayed.
3. Select the ports that you want to delete from the **Available Ports** list and click **Add**.
4. Click **OK**.

Replacing an HBA in a host

It is sometimes necessary to replace the host bus adapter (HBA) that connects the host to the SAN. You must notify the SAN Volume Controller cluster of the new worldwide port name (WWPN) that this HBA contains.

Before you begin this task, you must ensure that the switch is zoned correctly.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to notify the SAN Volume Controller cluster of a change to a defined host object:

1. Locate the host object that corresponds with the host in which you have replaced the HBA.
2. Click **Work with Hosts** → **Hosts** in the portfolio. The Viewing Hosts panel is displayed.
3. Select the host object and then select **Add Ports** from the task list. Click **Go**. The Adding ports panel is displayed.
4. Select the candidate WWPNs from the **Available Ports** list and click **Add**. Click **OK**. The Viewing Hosts panel is displayed.
5. Select the host object and select **Delete Ports** from the task list. Click **Go**. The Deleting Ports panel is displayed.
6. Select the WWPNs that you want to remove (the ones that correspond with the old HBA that was replaced) and click **Add**. Click **OK**.

Any mappings that exist between the host object and VDisks are automatically applied to the new WWPNs. Therefore, the host sees the VDisks as the same SCSI LUNs as before. See the *IBM System Storage Multipath Subsystem Device Driver User's Guide* or your multipathing device driver user's guide for adding device identifiers (virtual paths if you are using SDD) to existing device identifiers.

Deleting hosts

You can delete a host object from the Deleting Hosts panel.

A deletion fails if there are any virtual disk (VDisk)-to-host mappings for the host. If you attempt to delete the host and it fails due to the existence of VDisk mappings, you are presented with the opportunity to perform a forced deletion, which deletes the VDisk mappings before the host is deleted.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to delete a host object:

1. Click **Work with Hosts** → **Hosts** in the portfolio. The Viewing Hosts panel is displayed.
2. Select the host to delete and select **Delete a host** from the task list. Click **Go**. The Deleting Hosts panel is displayed.
3. Verify that you are deleting the correct host and click **OK**.

When you delete a host object, all active ports are added to the **Available Ports** list.

Viewing fabrics

You can view the fabrics that are associated with a cluster from the Viewing Fabrics panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the fabrics:

1. Click **Service and Maintenance** → **Fabrics**. The Viewing Fabrics panel is displayed.
2. Click **Close** to close the panel.

Creating FlashCopy mappings

You can create a FlashCopy mapping using the Create a FlashCopy Mapping wizard.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to create FlashCopy mappings:

1. Click **Manage Copy Services** → **FlashCopy mappings** in the portfolio. The Viewing FlashCopy Mappings panel is displayed.
2. Select **Create a Mapping** from the task list and click **Go**. The Create a FlashCopy Mapping wizard begins.
3. Complete the Create a FlashCopy Mapping wizard.

Starting FlashCopy mappings

You can use the SAN Volume Controller Console to start FlashCopy mappings.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to start a FlashCopy mapping:

1. Click **Manage Copy Services** → **FlashCopy Mappings** in the portfolio. The Viewing FlashCopy Mappings panel is displayed.
2. Select the appropriate mapping's row from the table.
3. Select **Start a Mapping** from the task list and click **Go**. The Starting FlashCopy Mapping panel is displayed.
4. If you select **Prepare FlashCopy Mapping**, any data to be written to the source virtual disk is flushed from cache before the FlashCopy operation starts.
5. Click **OK**. The Viewing FlashCopy Mappings panel is displayed.

Viewing the progress of a FlashCopy

You can view the progress of a FlashCopy from the Viewing FlashCopy Progress panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the progress of a FlashCopy:

1. Click **Manage Progress** → **View Progress**. The View Progress panel is displayed.
2. Click the **FlashCopy** link. The Viewing FlashCopy Progress panel is displayed.

Stopping FlashCopy mappings

You can use the SAN Volume Controller Console to stop FlashCopy mappings.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to stop a FlashCopy mapping:

1. Click **Manage Copy Services** → **FlashCopy Mappings** in the portfolio. The Viewing FlashCopy Mappings panel is displayed.
2. Select the appropriate mapping's row from the table.
3. Select **Stop a Mapping** from the task list and click **Go**. The Stopping FlashCopy Mapping panel is displayed.
4. Click **Stop**, **Forced Stop**, or **Cancel**. The Viewing FlashCopy Mappings panel is displayed.

Modifying FlashCopy mappings

You can use the SAN Volume Controller Console to change the attributes for a FlashCopy mapping.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to change the attributes for a FlashCopy mapping:

1. Click **Manage Copy Services** → **FlashCopy Mappings** in the portfolio. The Viewing FlashCopy Mapping panel is displayed.
2. Select **Modify a Mapping** from the task list and click **Go**. The Modifying FlashCopy Mapping panel is displayed.
3. Specify the modifications and click **OK** or **Cancel**. The Viewing FlashCopy Mappings panel is displayed.

Deleting FlashCopy mappings

You can delete a FlashCopy mapping from the Deleting FlashCopy Mappings panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to delete a FlashCopy mapping:

1. Click **Manage Copy Services** → **FlashCopy mappings** in the portfolio. The Viewing FlashCopy mappings panel is displayed.
2. Select the appropriate mapping's row from the table.
3. Select **Delete a Mapping** from the task list and click **Go**. The Deleting FlashCopy Mapping panel is displayed.

Note: If the FlashCopy mapping is in active state, the Forcing the Deletion of a FlashCopy Mapping panel is displayed. Follow the instructions that are displayed on the Forcing the Deletion of a FlashCopy Mapping panel.

Creating FlashCopy consistency groups

You can use the SAN Volume Controller Console to create FlashCopy consistency groups.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to create a FlashCopy consistency group:

1. Click **Manage Copy Services** → **FlashCopy Consistency Groups** in the portfolio. The Viewing FlashCopy Consistency Groups panel is displayed.
2. Select **Create a Consistency Group** from the task list and click **Go**. The Creating FlashCopy Consistency Groups panel is displayed.
3. Type the name of the FlashCopy consistency group in the **FlashCopy Consistency Group Name** field. If you do not specify a name, a default name is assigned to the FlashCopy consistency group.
4. Optionally, check the **Automatically delete consistency group when empty** box. Checking this box automatically deletes the consistency group when the last FlashCopy mapping in the group is deleted or removed from the consistency group.
5. Select the mappings in the consistency group from the **FlashCopy Mappings** list and click **OK**.

Note: You can create the FlashCopy consistency group before you create the mappings and then add the FlashCopy mappings to the consistency group. To add FlashCopy mappings this way, you must use the Modifying FlashCopy Mapping panel.

Starting FlashCopy consistency groups

You can start a FlashCopy consistency group from the Starting FlashCopy Consistency Group panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to start a FlashCopy consistency group:

1. Click **Manage Copy Services** → **FlashCopy Consistency Groups** in the portfolio. The Viewing FlashCopy Consistency Groups panel is displayed.
2. Select the appropriate group's row from the table.
3. Select **Start a Consistency Group** from the task list and click **Go**. The Starting FlashCopy Consistency Groups panel is displayed.

Note: If the group has not been prepared, **Prepare FlashCopy consistency group** is automatically selected. If you select this check box, any data to be written to the source virtual disks is flushed from the cache before the FlashCopy operation starts.

4. Click **OK** or **Cancel**. The Viewing FlashCopy Consistency Groups panel is displayed.

Stopping FlashCopy consistency groups

You can stop a FlashCopy consistency group from the Stopping FlashCopy Consistency Group panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to stop a FlashCopy consistency group:

1. Click **Manage Copy Services** → **FlashCopy Consistency Groups** in the portfolio. The Viewing FlashCopy Consistency Groups panel is displayed.
2. Select the appropriate consistency group's row from the table.
3. Select **Stop a Consistency Group** from the task list and click **Go**. The Stopping FlashCopy Consistency Group panel is displayed.
4. Click **Stop**, **Forced Stop**, or **Cancel**. The Viewing FlashCopy Consistency Groups panel is displayed.

Renaming FlashCopy consistency groups

You can rename a FlashCopy consistency group from the Modifying FlashCopy Consistency Group panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to rename a consistency group:

1. Click **Manage Copy Services** → **FlashCopy Consistency Groups** in the portfolio. The Viewing FlashCopy Consistency Groups panel is displayed.
2. Select the appropriate group row from the table.
3. Select **Rename a Consistency Group** from the task list and click **Go**. The Modifying FlashCopy Consistency Group panel is displayed.

4. Enter the new name and click **OK**. The Viewing FlashCopy Consistency Groups panel is displayed.

Deleting FlashCopy consistency groups

You can delete a FlashCopy consistency group from the Deleting FlashCopy consistency groups panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to delete a FlashCopy consistency groups:

1. Click **Manage Copy Services** → **FlashCopy Consistency Groups** in the portfolio. The Viewing FlashCopy Consistency Groups panel is displayed.
2. Select the appropriate consistency group's row from the table.
3. Select **Delete a Consistency Group** from the task list and click **Go**. The Deleting FlashCopy Consistency Group panel is displayed.
4. Click **OK** to delete. The Viewing FlashCopy Consistency Groups panel is displayed.

Creating Metro Mirror and Global Mirror relationships

You can use the SAN Volume Controller Console to create Metro Mirror and Global Mirror relationships.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to create a Metro Mirror or Global Mirror relationship:

1. Click **Manage Copy Services** → **Metro & Global Mirror Relationships** in the portfolio. The Viewing Metro & Global Mirror Relationships panel is displayed.
2. Select **Create a Relationship** from the list and click **Go**. The Create a Metro or Global Mirror Relationship wizard. begins.
3. Complete the Create a Metro or Global Mirror Relationship wizard.

Starting a Metro Mirror or Global Mirror copy process

You can use the SAN Volume Controller Console to start a Metro Mirror or Global Mirror copy process.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to start a Metro Mirror or Global Mirror copy process:

1. Click **Manage Copy Services** → **Metro & Global Mirror Relationships** in the portfolio. The Viewing Metro & Global Mirror Relationships panel is displayed.
2. Select the relationship for which you want to start the copy process.
3. Select **Start Copy Process** and click **Go**. The Starting Copy Process panel is displayed.

Viewing the progress of Metro Mirror and Global Mirror copy processes

You can use the SAN Volume Controller Console to view the progress of Metro Mirror and Global Mirror copy processes.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view the progress of Metro Mirror and Global Mirror copy processes:

1. Click **Manage Progress** → **View Progress**. The View Progress panel is displayed.
2. Click the **Mirror** link. The Viewing Mirror Progress panel is displayed.

Stopping a Metro Mirror or Global Mirror copy process

You can use the SAN Volume Controller Console to stop a Metro Mirror or Global Mirror copy process.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to stop a Metro Mirror or Global Mirror copy process:

1. Click **Manage Copy Services** → **Metro & Global Mirror Relationships** in the portfolio. The Viewing Metro & Global Mirror Relationships panel is displayed.
2. Select the relationship for which you want to stop the copy process.
3. Select **Stop Copy Process** and click **Go**. The Stopping Copy Process panel is displayed.
4. Click **OK** to stop the copy process.

Modifying Metro Mirror and Global Mirror relationships

You can use the SAN Volume Controller Console to modify the attributes for Metro Mirror and Global Mirror relationships.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to modify the attributes for Metro Mirror and Global Mirror relationships:

1. Click **Manage Copy Services** → **Metro & Global Mirror Relationships** in the portfolio. The Viewing Metro & Global Mirror Relationships panel is displayed.
2. Select the relationship to modify.
3. Select **Modify a Relationship** from the task list and click **Go**. The Modifying Metro & Global Mirror Relationship panel is displayed.

You can change the following attributes from this panel:

- The relationship name
- The consistency group that contains this relationship

Switching the copy direction of a Metro Mirror or Global Mirror relationship

You can use the SAN Volume Controller Console to reverse the roles of the primary and secondary virtual disks (VDisks) in a Metro Mirror or Global Mirror relationship.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to reverse the roles of the primary and secondary VDisks:

1. Click **Manage Copy Services** → **Metro & Global Mirror Relationships** in the portfolio. The Viewing Metro & Global Mirror Relationships panel is displayed.
2. Select **Switch Copy Direction** from the task list and click **Go**. The Switching the Direction of Mirror Relationship panel is displayed.

Deleting Metro Mirror or Global Mirror relationships

You can use SAN Volume Controller Console the to delete a Metro Mirror or Global Mirror relationship

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to delete a Metro Mirror or Global Mirror relationship:

1. Click **Manage Copy Services** → **Metro & Global Mirror Relationships** in the portfolio. The Viewing Metro & Global Mirror Relationships panel is displayed.
2. Select the relationship to delete by clicking on the appropriate line in the **Select** column.
3. Select **Delete a Relationship** from the task list and click **Go**. The Deleting Mirror Relationship panel is displayed.
4. Click **OK** to delete the relationship.

Creating Metro Mirror or Global Mirror consistency groups

You can create Metro Mirror or Global Mirror consistency groups using the wizard.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to create a Metro Mirror or Global Mirror consistency group:

1. Click **Manage Copy Services** → **Metro & Global Mirror Consistency Groups** in the portfolio.
2. Select **Create a Consistency Group** from the task list and click **Go**. The wizard begins.
3. Complete the wizard.

Renaming a Metro Mirror or Global Mirror consistency group

You can use the SAN Volume Controller Console to rename a Metro Mirror or Global Mirror consistency group.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to rename a Metro Mirror or Global Mirror consistency group:

1. Click **Manage Copy Services** → **Metro & Global Mirror Consistency Groups** in the portfolio.
2. Select the consistency group that you want to change.
3. Select **Rename a Consistency Group** from the task list and click **Go**. The Renaming Mirror Consistency Group panel is displayed.

4. Type a new name for the consistency group in the **New Name** field.
5. Click **OK**.

Starting a Metro Mirror or Global Mirror consistency group copy

You can use the SAN Volume Controller Console to start a Metro Mirror or Global Mirror copy process.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to start a Metro Mirror or Global Mirror copy process:

1. Click **Manage Copy Services** → **Metro & Global Mirror Consistency Groups** in the portfolio
2. Select the relationship for which you want to start the copy process.
3. Select **Start Copy Process** and click **Go**. The Starting Copy Process panel is displayed.

Stopping a Metro Mirror or Global Mirror consistency group copy process

You can use the SAN Volume Controller Console to stop a Metro Mirror or Global Mirror copy process.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to stop a Metro Mirror or Global Mirror copy process:

1. Click **Manage Copy Services** → **Metro & Global Mirror Consistency Groups** in the portfolio.
2. Select the group for which you want to stop the copy process.
3. Select **Stop Copy Process** and click **Go**. The Stopping Copy Process panel is displayed.
4. Follow the directions that are displayed on this panel.

Deleting Metro Mirror and Global Mirror consistency groups

You can use the SAN Volume Controller Console to delete Metro Mirror and Global Mirror consistency groups.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to delete a Metro Mirror or Global Mirror consistency group:

1. Click **Manage Copy Services** → **Metro & Global Mirror Consistency Groups** in the portfolio.
2. Select the group to delete.
3. Select **Delete a Consistency Group** from the task list and click **Go**.
4. Click **OK** to delete the consistency group.

Creating Metro Mirror and Global Mirror partnerships

You can use the SAN Volume Controller Console to create Metro Mirror and Global Mirror partnerships.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to create a Metro Mirror or Global Mirror partnership:

1. Click **Manage Copy Services** → **Metro & Global Mirror Cluster Partnership** in the portfolio.
2. Click **Create**. The Create Cluster Partnerships panel is displayed.
3. Follow the instructions that are displayed on this panel to create the cluster partnership.

Modifying Metro Mirror or Global Mirror partnerships

You can change the bandwidth that is available for background copies from the Modify Cluster Partnership panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to change a Metro Mirror or Global Mirror partnership:

1. Click **Manage Copy Services** → **Metro & Global Mirror Cluster Partnerships** in the portfolio.
2. Click **Modify**. The Modify Cluster Partnership panel is displayed.
3. Type the new rate for the background copy.

Note: You can set the bandwidth attribute for the path from cluster A to cluster B to a different setting from the setting used for the path from cluster B to cluster A.

4. Click **OK**.

Starting and stopping Metro Mirror or Global Mirror partnerships

You can start and stop Metro Mirror or Global Mirror partnerships using the Modify Cluster Partnership panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to start or stop a Metro Mirror or Global Mirror partnership:

1. Click **Manage Copy Services** → **Metro & Global Mirror Cluster Partnerships** in the portfolio.
2. Click **Modify**. The Modify Cluster Partnership panel is displayed.
3. To stop a partnership, click **Stop**.
4. To start a partnership, click **Start**.
5. Click **OK**.

Deleting Metro Mirror or Global Mirror partnerships

You can use the SAN Volume Controller Console to delete a Metro Mirror or Global Mirror partnership on the local cluster.

This task assumes that you have already launched the SAN Volume Controller Console.

The Metro Mirror or Global Mirror partnership must be deleted on both the local and remote cluster for the partnership to be completely removed.

Perform the following steps to delete a Metro Mirror or Global Mirror partnership on the local cluster.

Note: If a Metro Mirror or Global Mirror partnership has configured relationships or groups, you must delete the relationships and groups before you can delete the partnership.

1. Click **Manage Copy Services** → **Metro & Global Mirror Cluster Partnerships** in the portfolio.
2. Click **Delete**. The Delete Cluster Partnership panel is displayed.
3. Click **Delete** to delete the Partnership on the local cluster or click **Cancel** to return to the previous panel.

Viewing the license settings log

You can view the license settings log for the cluster from the License Settings panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following step to view the license settings log for the cluster:

Click **Service and Maintenance** → **View License Settings Log** in the portfolio. The License Settings panel is displayed.

Viewing and updating license settings

You can use the SAN Volume Controller Console to view and update your license settings.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to view and update the license settings:

1. In the portfolio, click **Service and Maintenance** → **License Settings**. The License Settings panel is displayed.
2. Choose Capacity Licensing or Physical Disk Licensing and click **Go**.
3. Enter your license settings and click **Update License Settings**.
4. The updated license information is displayed. To confirm that the settings match your license agreement, click **I Agree**.

Running the cluster maintenance procedure

You can use the SAN Volume Controller Console to run the cluster maintenance procedure.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to run the cluster maintenance procedure:

1. Click **Service and Maintenance** → **Run Maintenance Procedures** in the portfolio. The Maintenance Procedures panel is displayed.
2. Click **Start Analysis** to analyze the cluster error log. The Maintenance panel is displayed.

If you click the error code of a error log entry, you are guided through a series of actions that help you estimate the state of the cluster and determine if the error was an isolated event or a component failure. If a component has failed, it might be necessary to exchange that component. Where necessary, images of the failing component are displayed. If a repair is performed successfully, the state of an error record in the error log changes from an unfixed error to a fixed error.

Modifying SNMP error notification settings

You can use the SAN Volume Controller Console to change Simple Network Management Protocol (SNMP) error notification settings for the cluster.

This task assumes that you have already launched the SAN Volume Controller Console.

SNMP error notification settings apply to the entire cluster. You can specify the types of errors that cause the cluster to send a notification. The cluster sends an SNMP notification. The SNMP setting represents the kind of error.

Perform the following steps to configure the error notification settings:

1. Click **Service and Maintenance** → **Set SNMP Error Notification** in the portfolio. The **Modify SNMP Error Notification Settings** panel is displayed.

The following table describes the three types of notification:

Notification type	Description
All	Report all errors at or above the threshold limit, including information events.
Error Only	Report all errors at or above the threshold limit, excluding information events.
None	Do not report any errors or information events. This option disables error notification.

If you specify **All** or **Error Only**, errors are reported to the SNMP destinations of your choice. To specify an SNMP destination, you *must* provide a valid IP address and SNMP community string.

Note: A valid community string can contain up to 60 letters or digits, without any spaces. A maximum of six SNMP destinations can be specified. When you create the cluster or enable error notification for the first time,

you are asked to specify only one SNMP destination. You can add five additional destinations by using the Error Notification options.

2. Select **Add Destination**, and click **Go**.
3. The **Create SNMP Error Notification Destination** panel is displayed. To add a new destination, enter a Name, SNMP Community, SNMP IP Address, and Error Notification Level. Click **Add Destination**.
4. To delete a destination, select the destination description, select **Delete Destination** from the drop down menu, and click **Go**. Click **Confirm** in the confirmation dialog.
5. To delete all destinations, select **Delete All**, and click **Go**. Click **Confirm** in the confirmation dialog.
6. To modify a destination, select the destination description, select **Modify Destination**, and click **Go**.
7. To test destination notifications, select the destination description, select **Test Notifications**, and click **Go**.

Call Home and inventory e-mail information

The SAN Volume Controller can use Call Home e-mail and Inventory Information e-mail to provide necessary data and event notifications to you and to the IBM Support Center.

Call Home e-mail

Call Home support is initiated for the following reasons or types of data:

- Problem or event notification: Data is sent when there is a problem or an informational event.
- Communication tests: You can test for the successful installation and communication infrastructure.
- Inventory information: A notification is sent to provide the necessary status and hardware information to IBM service personnel.

To send data and notifications to IBM service personnel, use one of the following e-mail addresses:

- For SAN Volume Controller nodes located in North America, Latin America, South America or the Caribbean Islands, use `callhome1@de.ibm.com`
- For SAN Volume Controller nodes located anywhere else in the world, use `callhome0@de.ibm.com`

Call Home e-mail can contain any combination of the following types of information:

- Contact name
- Contact phone number
- Offshift phone number
- Contact e-mail
- Machine location
- Record type
- Machine type
- Machine serial number
- Error ID
- Error code

- Software version
- FRU part number
- Cluster name
- Node ID
- Error sequence number
- Time stamp
- Object type
- Object ID
- Problem data

Inventory information e-mail

Inventory information e-mail is a type of Call Home notification. Inventory information can be sent to IBM to assist IBM service personnel in evaluating your SAN Volume Controller system. Because inventory information is sent using the Call Home e-mail function, you must meet the Call Home function requirements and enable the Call Home e-mail function before you can attempt to send inventory information e-mail. You can adjust the contact information, adjust the frequency of inventory e-mail, or manually send an inventory e-mail using the SAN Volume Controller Console or the SAN Volume Controller command-line interface. Inventory information is automatically reported to IBM when you activate error reporting.

Inventory information that is sent to IBM can include the following information about the cluster on which the Call Home function is enabled:

- Time stamp
- Contact information, including name and phone number. This is initially set to the contact information that was set for the Call Home e-mail function. However, you can change the contact information specifically for inventory e-mail using the SAN Volume Controller Console or the **mkemailuser** or **chemailuser** CLI commands.
- Machine location. This is the machine location that is set for the Call Home e-mail function.
- Software level
- License information. This is the same information that it output from the **svcinfo lslicense** command.
- Cluster vital product data (VPD). The cluster VPD is the same information that is output from the **svcinfo lscluster** command, including the following items:
 - Cluster name and IDs
 - Cluster location
 - Bandwidth
 - IP addresses
 - Memory capacities
 - SNMP settings
 - Time zone setting
 - E-mail settings
 - Microcode level
 - Fibre-channel port speed

- Node VPD for each node in the cluster. The node VPD is the same information that is output from the `svcinfo lsnodevpd` command, including the following items:
 - System part number
 - Number of various hardware parts, such as fans, processors, memory slots, fibre-channel cards, and SCSI/IDE devices
 - Part numbers of the various hardware parts
 - BIOS information
 - System manufacturing information, such as system product and manufacturer
 - Firmware level for the service processor
- Software VPD, including the following items:
 - Code level
 - Node name
 - Ethernet status
 - Worldwide node name (WWNN)
 - MAC address
- Processor information, including the following items for each processor:
 - Location of processor
 - Type of cache
 - Size of cache
 - Manufacturer
 - Version
 - Speed
 - Status (enabled or disabled)
- Memory information, including the following items:
 - Part number
 - Device location
 - Bank location
 - Size
- Fibre-channel card information, including the following items:
 - Part number
 - Port number
 - Device serial number
 - Manufacturer
- SCSI/IDE device information, including the following items:
 - Part number
 - Bus ID
 - Device ID
 - Model
 - Revision level
 - Serial number
 - Approximate capacity
- Front panel assembly information, including the following items:
 - Part number
 - ID

- Location
- Uninterruptible power supply information, including the following items:
 - Electronics part number
 - Battery part number
 - Uninterruptible power supply assembly part number
 - Input power cable part number
 - Uninterruptible power supply serial number
 - Uninterruptible power supply type
 - Uninterruptible power supply internal part number
 - ID
 - Firmware levels

Setting up e-mail notifications for errors and inventory events using the SAN Volume Controller Console

You can use the Email Error Notification panel to enable the SAN Volume Controller Console e-mail service to send error notification and inventory reports to the IBM Support Center.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to set up error and inventory e-mail notifications:

1. Click **Service and Maintenance** → **Set Email Features**. The Email Error Notification panel is displayed.
2. Click **Manage Email Service**.
3. Follow the instructions on the panel and the instructions in the panel help to complete the setup for error and inventory e-mail notifications.

Note: Inventory information is automatically reported to IBM when you activate error reporting.

Displaying and saving log and dump files

You can save the log and dump files for nodes.

You can save dump data for any node in the cluster. When you use this procedure to display dump data only, the dump files for the configuration node are displayed. An option on the dumps menu allows you to display data from other nodes. If you choose to display or save data from another node, that data is first copied to the configuration node.

The software dump files contain dumps of the SAN Volume Controller memory. Your IBM service representative might ask for these dumps to debug problems. The software dumps are large files (approximately 300 MB). Consider copying these files to your host using secure copy methods.

The **List dumps** option supports the following file types:

- Error logs
- I/O statistic logs
- I/O trace logs

- Feature logs
- Software dumps
- Audit logs
- CIMOM logs

Perform the following steps to display log and dump files:

This task assumes that you have already launched the SAN Volume Controller Console.

1. Click **Service and Maintenance** → **List Dumps** in the portfolio. The List Dumps panel is displayed.

The List dumps (other nodes) continued panel displays the number of log files or dumps of a particular type that are available on the cluster. If there is more than one node in the cluster, the **Check other nodes** button is displayed. If you click this button, the log files and dumps for all nodes that are part of the cluster are displayed. Dumps and logs on all nodes in the cluster can be deleted on or copied to the configuration node.

If you click on one of the file types, all the files of that type are listed in a table.

Note: For error logs and software dumps, the file names include the node name and time and date as part of the file name.

2. Copy the files to your local workstation by right-clicking on the filename and using the **Save Link As...** (Netscape) or **Save Target As...** (Internet Explorer) option from the Web browser.

Analyzing the error log

You can analyze the error log from the Analyze Error Log panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Note: Log files that are copied to the configuration node are *not* automatically deleted by the SAN Volume Controller.

Perform the following steps to analyze the error log:

1. Click **Service and Maintenance** → **Analyze Error Log** in the portfolio. The Error log analysis panel is displayed.

The Error log analysis panel lets you analyze the cluster error log. You can display the whole log or filter the log so that only errors, events, or unfixed errors are displayed. In addition, you can request that the table is sorted by either error priority or time. For error priority, the most serious errors are the lowest-numbered errors. Therefore, they are displayed first in the table.

Either the oldest or the latest entry can be displayed first in the table. You can also select how many error log entries are displayed on each page of the table. The default is set to 10 and the maximum number of error logs that can be displayed on each page is 99.

2. After selecting the options, click **Process** to display the filtered error log in the table. The Analyze error log continued panel is displayed.

Forward and backward scroll buttons are displayed, depending on the existing page number and the total number of pages that are in the table. If the table contains more than two pages of entries, a **Go to** input area is displayed in the table footer. This input area enables you to skip to a particular page number.

If you click on the sequence number of a table record, more information about that error log entry is displayed. If the record is an error (instead of an event), you can change the fixed or unfixed status of the record; that is, you can mark an unfixed error as fixed or a fixed error as unfixed.

3. Click **Clear log** to erase the entire cluster error log.

Note: Clicking **Clear log** does *not* fix the existing errors.

Recovering a node and returning it to the cluster

After a node or an I/O group fails, you can use the SAN Volume Controller to recover a node and return it to the cluster.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to recover a node and return it to the cluster:

1. Click **Work with Nodes** → **Nodes** in the portfolio. The Viewing Nodes panel is displayed.
2. Verify that the node is offline.
3. Select the offline node.
4. Select **Delete a Node** from the task list and click **Go**. The Deleting Node from Cluster panel is displayed.
5. Click **Yes**.
6. Verify that the node can be seen on the fabric.
7. If the nodes are repaired by replacing the front panel module or a node is repaired by replacing it with another node, the worldwide node name (WWNN) for the node changes. In this case, you must follow these additional steps:
 - a. At the end of the recovery process, you must follow your multipathing device driver's procedure to discover the new paths and to check that each device identifier is now presenting the correct number of paths. If you are using the subsystem device driver (SDD), the device identifiers are referred to as virtual paths (vpaths). See the *IBM System Storage Multipath Subsystem Device Driver User's Guide* or the documentation that is provided with your multipathing device driver for more information.
 - b. You might also have to modify the configuration of your disk controller systems. If your disk controller system uses a mapping technique to present its RAID arrays or partitions to the cluster, you must modify the port groups that belong to the cluster because the WWNN or worldwide port names (WWPNs) of the node have changed.

Attention: If more than one I/O group is affected, ensure that you are adding the node to the same I/O group from which it was removed. Failure to do this can result in data corruption. Use the information that was recorded when the node was originally added to the cluster. This can avoid a possible data corruption exposure if the node must be removed from and re-added to the cluster. If you do not have access to this information, call the IBM Support Center to add the node back into the cluster without corrupting the data. If you are adding the node into the cluster for the first time, you must record the following information:

- Node serial number
 - WWNN
 - All WWPNS
 - I/O group that the node belongs to
8. Add the node back into the cluster.
 - a. From the Viewing Nodes panel, select **Add a Node** from the task list and click **Go**. The Adding a Node to a Cluster panel is displayed.
 - b. Select the node from the list of candidate nodes and select the I/O group from the list. Optionally enter a node name for this node.
 - c. Click **OK**.
 9. Verify that the node is online by refreshing the Viewing Nodes panel.

Note: If the panel does not refresh, close the panel and reopen it.

Managing SSH keys

You can manage SSH keys from the SAN Volume Controller Console.

The communication between the SAN Volume Controller Console software and the SAN Volume Controller cluster is through the Secure Shell (SSH) protocol. In this protocol, the SAN Volume Controller Console software acts as the SSH client and the SAN Volume Controller cluster acts as the SSH host server.

As an SSH client, the SAN Volume Controller Console must use an SSH2 RSA key pair composed of a public key and a private key which are coordinated when the keys are generated. The SSH client public key is stored on each SAN Volume Controller cluster with which the SAN Volume Controller Console communicates. The SSH client private key is known to the SAN Volume Controller Console software by being stored in a specific directory with a specific name. If the SSH protocol detects the key pair is mismatched, the SSH communication fails.

The SAN Volume Controller Console externalizes the status of a mismatched or invalid SAN Volume Controller Console client key pair in the **Availability Status** column of the Cluster panel.

You can use the SAN Volume Controller Console to perform the following SSH key management tasks:

- Add SSH keys to other hosts
- Add additional keys to the SAN Volume Controller Console
- Replace the client SSH key private key
- Replace the SSH key pair
- Reset the SSH fingerprint
- Reset a refused SSH key

Adding SSH keys for hosts other than the IBM System Storage Productivity Center or the master console

You can add Secure Shell (SSH) keys on other hosts.

Perform the following steps to add SSH keys on hosts:

1. Generate the public-private key pair on each host that you want to use the SAN Volume Controller command-line interface. See the information that came with your SSH client for specific details about using the key generation program that comes with your SSH client.
2. Copy the public keys from each of these hosts to the IBM System Storage Productivity Center or the master console.
3. Use the PuTTY secure copy function to copy these public keys from the IBM System Storage Productivity Center or the master console to the cluster.
4. Repeat 3 for each public key that you copied in step 2.

Adding subsequent SSH public keys to the SAN Volume Controller

You can add subsequent Secure Shell (SSH) public keys to the SAN Volume Controller from the SSH Public Key Maintenance panel.

This task assumes that you are at the Welcome panel for the SAN Volume Controller Console.

The SSH key allows the IBM System Storage Productivity Center or the master console (where the SAN Volume Controller Console is running) to access the cluster.

During the cluster creation wizard, you added a SSH key to the cluster. You can add additional SSH keys to grant SSH access to other servers.

Perform the following steps to add additional SSH keys:

1. Click **Clusters** in the portfolio.
2. Click the cluster whose SSH keys you want to maintain.
3. Select **Maintain SSH Keys** from the task list and click **Go**. The SSH Public Key Maintenance panel is displayed.
4. Follow the instructions that are on the SSH Public Key Maintenance panel.
5. Click **Add Key** when you have completed the SSH Public Key Maintenance panel.

After the initial configuration of the cluster has been performed using the SAN Volume Controller Console and at least one SSH client key has been added, the remainder of the configuration can either be performed using the SAN Volume Controller Console or the command-line interface.

Replacing the SSH key pair

You can use the SAN Volume Controller Console to replace the Secure Shell (SSH) key pair.

Scenarios where you must replace the SSH key pair

The following scenarios require you to replace the SSH key pair:

- If you change the SSH keys that are used by the IBM System Storage Productivity Center or the master console to communicate with the SAN Volume Controller Console, you must store the client SSH private key in the SAN Volume Controller Console software and then store the client SSH public key on the SAN Volume Controller cluster.
- If you change the IP address of your SAN Volume Controller cluster after you have added the cluster to SAN Volume Controller Console, the SAN Volume Controller Console is not aware of the existence of the cluster.

Replacing the client SSH private key known to the SAN Volume Controller software

You can replace the client SSH private key that is known to the SAN Volume Controller software.

Attention: If you have successfully contacted other SAN Volume Controller clusters, you will break that connectivity if you replace the client SSH private key that is known to the SAN Volume Controller software.

Perform the following steps to replace the client SSH private key:

1. Sign off the SAN Volume Controller Console.
2. Stop the CIM Agent service. Go to **Start** → **Programs** → **IBM System Storage** → **SAN Volume Controller** → **Stop CIMOM Service**.
3. Perform the following steps to copy the client SSH private key into the appropriate SAN Volume Controller Console directory:
 - a. Open a command prompt window.
 - b. Issue the following command:

```
copy filename C:\Program Files\IBM\svconconsole\cimom\icat.ppk
```

Where *filename* is the path and file name of the client SSH private key.

4. Restart the CIM Agent service. Go to **Start** → **Programs** → **IBM System Storage** → **SAN Volume Controller** → **Start CIMOM Service**.
5. Log on to the SAN Volume Controller Console.
6. Click **Clusters** in the portfolio.
7. Check the status of the cluster.

Replacing the public SSH key for a SAN Volume Controller cluster

There are times when you must replace the SSH public key used by the SAN Volume Controller cluster. For example, if you change the SSH keys that are used by the IBM System Storage Productivity Center or the master console to communicate with the SAN Volume Controller Console or if you change the IP address of your SAN Volume Controller cluster, you must replace the cluster's SSH public key.

Perform the following steps to replace the public key used by the cluster:

1. Start the SAN Volume Controller Console by clicking on the desktop icon or by using your Web browser to go to `http://IP_address:9080/ica`, where *IP_address* is the IP address of the IBM System Storage Productivity Center or the master console. The Signon window is displayed. This might take a few moments to open.
2. Enter the user ID superuser and the password passw0rd. The Welcome window is displayed.
3. Click **Clusters** from the portfolio.

4. Check the **Select** box for the cluster for which you wish to replace the key.
5. Click **Maintain SSH Keys** from the task list and click **Go**. The SSH Public Key Maintenance panel is displayed.
6. Type your user name and password.
7. Click the **Maintain SSH Keys** option. The window opens to enable you to enter the client SSH public key information that is to be stored on the cluster.
8. Add the SSH client key by performing one of the following actions:
 - If you are adding the SSH client key for the IBM System Storage Productivity Center or the master console, click **Browse** and locate the public key you generated earlier.
 - If you are adding an SSH client key for another system, either click **Browse** and locate the public key or cut and paste the public key into the direct input field.
9. Click **Administrator**.
10. Type a name of your choice in the **ID** field that uniquely identifies the key to the cluster.
11. Click **Add Key**.
12. Click **Maintain SSH Keys**.
13. Click **Show IDs** to see all key IDs that are loaded on the SAN Volume Controller.

Resetting a refused SSH key

You can reset a refused SSH key relationship between the SAN Volume Controller Console and the SAN Volume Controller cluster.

Because the client SSH key pair must be coordinated across two systems, you might have to take one or more actions to reset the pair of keys.

Perform one or more of the following actions to reset the refused client SSH key pair:

- Replace the client SSH public key on the SAN Volume Controller cluster.
- Replace the client SSH private key known to the SAN Volume Controller software.

Resetting the SSH fingerprint

You can reset the Secure Shell (SSH) fingerprint for a cluster that is managed by the SAN Volume Controller Console for your configuration by using the Resetting the SSH Fingerprint panel.

You must have superuser administrator authority to reset the SSH fingerprint.

The SAN Volume Controller Console and the cluster communicate through the SSH protocol. In this protocol, the SAN Volume Controller Console acts as the SSH client and the cluster acts as the SSH host server. The SSH protocol requires that credentials are exchanged when communication between the SSH client and server begins. The SSH client places the accepted SSH host server fingerprint in cache. Any change to the SSH server fingerprint in future exchanges results in a challenge to the end user to accept the new fingerprint. When a new code load is performed on the cluster, new SSH server keys can be produced that result in the SSH client flagging the SSH host fingerprint as changed and, therefore, no longer valid.

The SAN Volume Controller Console displays the status of the cluster SSH server key in the **Availability Status** column of the Viewing Clusters panel.

Perform the following steps to reset the SSH fingerprint:

1. Click **Clusters** in the portfolio. The View Clusters panel is displayed.
Attention: Select a cluster that has an availability status of Invalid SSH Fingerprint. In some cases, this availability status results from a software upgrade that disrupts normal user operations.
2. Select the cluster that you want to reset the SSH fingerprint for and select **Reset SSH Fingerprint** from the list. Click **Go**. The Resetting the SSH Fingerprint panel is displayed.
3. Select **OK** when you are prompted with the message CMMVC3201W.

Availability status is changed to OK.

Chapter 6. Using the CLI

The SAN Volume Controller cluster command-line interface (CLI) is a collection of commands that you can use to manage the SAN Volume Controller.

Overview

The CLI commands use the Secure Shell (SSH) connection between the SSH client software on the host system and the SSH server on the SAN Volume Controller cluster.

Before you can use the CLI, you must have already created a cluster.

You must perform the following actions to use the CLI from a client system:

- Install and set up SSH client software on each system that you plan to use to access the CLI.
- Generate an SSH key pair on each SSH client.
- Store the SSH public key for each SSH client on the SAN Volume Controller.

Note: After the first SSH public key is stored, you can add additional SSH public keys using either the SAN Volume Controller Console or the CLI.

You can use the CLI to perform the following functions:

- Set up of the cluster, its nodes, and the I/O groups
- Analyze error logs
- Set up and maintenance of managed disks (MDisk) and MDisk groups
- Set up and maintenance of client public SSH keys on the cluster
- Set up and maintenance of virtual disks (VDisks)
- Set up of logical host objects
- Map VDisks to hosts
- Navigate from managed hosts to VDisks and to MDisks, and the reverse direction up the chain
- Set up and start Copy Services:
 - FlashCopy and FlashCopy consistency groups
 - Synchronous Metro Mirror and Metro Mirror consistency groups
 - Asynchronous Global Mirror and Global Mirror consistency groups

Configuring a PuTTY session for the CLI

You must configure a PuTTY session using the Secure Shell (SSH) key pair that you have generated before you can use the command-line interface (CLI).

Attention: Do not run scripts that create child processes that run in the background and call SAN Volume Controller commands. This can cause the system to lose access to data and cause data to be lost.

Perform the following steps to configure a PuTTY session for the CLI:

1. Select **Start** → **Programs** → **PuTTY** → **PuTTY**. The PuTTY Configuration window opens.

2. Click **Session** in the Category navigation tree. The Basic options for your PuTTY session are displayed.
3. Click **SSH** as the Protocol option.
4. Click **Only on clean exit** as the Close window on exit option. This ensures that connection errors are displayed.
5. Click **Connection** → **SSH** in the Category navigation tree. The options controlling SSH connections are displayed.
6. Click **2** as the Preferred SSH protocol version.
7. Click **Connection** → **SSH** → **Auth** in the Category navigation tree. The Options controller SSH authentication are displayed.
8. Click **Browse** or type the fully qualified file name and location of the SSH client and private key in the **Private key file for authentication** field. The file that you specify in this field is the one that you stored in the SAN Volume Controller software (for example, C:\Program Files\IBM\svconconsole\cimom\icat.ppk).
9. Click **Session** in the Category navigation tree. The Basic options for your PuTTY session are displayed.
10. Click **Default Settings** and then click **Save**.
11. Type the name or IP address of the SAN Volume Controller cluster in the **Host Name (or IP Address)** field.
12. Type **22** in the **Port** field. The SAN Volume Controller cluster uses the standard SSH port.
13. Type the name that you want to use to associate with this session in the **Saved Sessions** field. For example, you can name the session SAN Volume Controller Cluster 1.
14. Click **Save**.

You have now configured a PuTTY session for the CLI.

Preparing the SSH client system for the CLI

Before you can issue command-line interface (CLI) commands from the host to the cluster, you must prepare the Secure Shell (SSH) client system.

Microsoft Windows operating systems

The IBM System Storage Productivity Center (SSPC) and the master console for the SAN Volume Controller include the PuTTY client program, which is a Microsoft Windows SSH client program. The PuTTY client program can be installed on your SSPC or master console server in one of the following ways:

- If you purchased the SSPC or the master console hardware option from IBM, the PuTTY client program has been preinstalled on the hardware.
- You can use the master console software installation CD to install the PuTTY client program. The SSPC, master console hardware option, and the software-only master console each provide this CD.
- You can use the separate PuTTY client program-installation wizard, **putty-<version>-installer.exe**. You can download the PuTTY client program from the following Web site:

www.chiark.greenend.org.uk/~sgtatham/putty/

Note: Before you install the PuTTY client program, ensure that your Windows system meets the system requirements. See the *IBM System Storage Productivity Center Introduction and Planning Guide* for system requirements.

If you want to use an SSH client other than the PuTTY client, the following Web site offers SSH client alternatives for Windows:

www.openssh.org/windows.html

IBM AIX operating systems

For IBM AIX 5L™ 5.1 and 5.2 on Power architecture, you can obtain the OpenSSH client from the bonus packs, but you also must obtain its prerequisite, OpenSSL, from the IBM AIX toolbox for Linux applications for IBM Power Systems. For AIX 4.3.3, you can obtain the software from the AIX toolbox for Linux applications.

You can also obtain the AIX installation images from IBM developerWorks® at the following Web site:

oss.software.ibm.com/developerworks/projects/openssh

Linux operating systems

The OpenSSH client is installed by default on most Linux distributions. If it is not installed on your system, consult your Linux installation documentation or visit the following Web site:

www.openssh.org/portable.html

The OpenSSH client can run on a variety of additional operating systems. For more information about the openSSH client, visit the following Web site:

www.openssh.org/portable.html

Preparing the SSH client system to issue CLI commands

To issue command-line interface (CLI) commands to the cluster from a host, you must prepare the Secure Shell (SSH) client on the host so that the host is accepted by the SSH server on the cluster.

To use a host that requires a different type of SSH client, OpenSSH for example, follow the instructions for that software.

Perform the following steps to enable your host to issue CLI commands:

1. For the IBM System Storage Productivity Center or master console and Windows hosts:
 - a. Generate an SSH key pair using the PuTTY key generator.
 - b. Store the SSH clients public key on the cluster (using a browser that points to the SAN Volume Controller Console).
 - c. Configure the PuTTY session for the CLI.
2. For other types of hosts:
 - a. Follow the instructions that are specific to the SSH client to generate an SSH key pair.

- b. Store the SSH clients public key on the cluster (using a Web browser to point to the SAN Volume Controller Console or the CLI from an already established host).
- c. Follow the instructions that are specific to the SSH client to establish an SSH connection to the SAN Volume Controller cluster.

Preparing the SSH client on an AIX host

When you use AIX hosts, Secure Shell (SSH) logins are authenticated on the SAN Volume Controller cluster using the RSA-based authentication that is supported in the OpenSSH client available for AIX.

RSA-based authentication uses public-key cryptography to allow the encryption and decryption to use separate keys. Therefore, it is not possible to derive the decryption key from the encryption key. Initially, the user creates a public/private key pair for authentication purposes. The server (the SAN Volume Controller cluster in this case) knows the public key, and only the user (the AIX host) knows the private key. Because physical possession of the public key allows access to the cluster, the public key must be kept in a protected place. You can store the public key in the `/.ssh` directory on the AIX host with restricted access permissions.

When you use the AIX host to log into the SAN Volume Controller cluster, the SSH program on the SAN Volume Controller cluster sends the AIX host the key pair that it wants to use for authentication. The AIX server checks if this key is permitted, and if so, sends the SSH program that is running on behalf of the user a challenge. The challenge is a random number that is encrypted by the user's public key. The challenge can only be decrypted using the correct private key. The user's client (the AIX host) uses the private key to decrypt the challenge and prove that the user has the private key. The private key is not shown to the server (the SAN Volume Controller cluster) or to anyone who might be intercepting the transmissions between the AIX host and the SAN Volume Controller cluster.

Perform the following steps to set up an RSA key pair on the AIX host and the SAN Volume Controller cluster:

1. Create an RSA key pair by issuing a command on the AIX host that is similar to the following command:

```
ssh-keygen -t rsa1
```

Tip: Issue the command from the `$HOME/.ssh` directory.

This process generates two user named files. If you select the name *key*, the files are named *key* and *key.pub*. Where *key* is the name of the private key and *key.pub* is the name of the public key.

2. Store the private key from this key pair on the AIX host, in the `$HOME/.ssh` directory, in the `$HOME.ssh/identity` file. If you are using multiple keys, all of the keys must appear in the identity file.
3. Store the public key on the IBM System Storage Productivity Center or the master console of the SAN Volume Controller cluster. Typically this can be done with ftp; however, the IBM System Storage Productivity Center or the master console might have ftp disabled for security reasons, in which case an alternative method, such as secure copy is required. You can then use the SAN Volume Controller Console, to transfer the public key to the cluster. Select an access level of either administrator or service.

You can now access the cluster from the AIX host using an SSH command similar to the following:

```
ssh admin@my_cluster
```

Where *admin* means that you associated the key with an administrative ID and *my_cluster* is the name of the cluster IP.

Refer to your client's documentation for SSH on your host system for more host specific details regarding this task.

Issuing CLI commands from a PuTTY SSH client system

You can issue command-line interface (CLI) commands from a PuTTY SSH client system.

Perform the following steps to issue CLI commands:

1. Open a command prompt.
2. Issue the following command to set the path environment variable to include the PuTTY directory:

```
set path=C:\Program Files\putty;%path%
```

Where *Program Files* is the directory where PuTTY is installed.

3. Use the PuTTY plink utility to connect to the SSH server on the cluster.

Starting a PuTTY session for the CLI

You must start a PuTTY session to connect to the command-line interface (CLI).

This task assumes that you have already configured and saved a PuTTY session using the Secure Shell (SSH) key pair that you created for the CLI.

Perform the following steps to start a PuTTY session:

1. Select **Start** → **Programs** → **PuTTY** → **PuTTY**. The PuTTY Configuration window opens.
2. Select the name of your saved PuTTY session and click **Load**.
3. Click **Open**.

Note: If this is the first time that the PuTTY application is being used since you generated and uploaded the SSH key pair, a PuTTY Security Alert window is displayed. Click **Yes** to accept the change and trust the new key.

4. Type `admin` in the **login as:** field and press Enter.

Setting the cluster time using the CLI

You can use the command-line interface (CLI) to set the cluster time.

Perform the following steps to set the cluster time:

1. Issue the `svcinfo showtimezone` CLI command to display the current time-zone settings for the cluster. The cluster ID and the associated time zone are displayed.
2. Issue the `svcinfo lstimezones` CLI command to list the time zones that are available on the cluster. A list of valid time zone settings are displayed. The specific cluster ID and the assigned time zone are indicated in the list.
3. Issue the following CLI command to set the time zone for the cluster.

```
svctask settimezone -timezone time_zone_setting
```

Where *time_zone_setting* is the new time zone that have you chosen from the list of time zones that are available on the cluster.

4. Issue the following CLI command to set the time for the cluster:

```
svctask setclustertime -time 031809142005
```

Where *031809142005* is the new time that you want to set for the cluster. You must use the *MMDDHHmmYYYY* format to set the time for the cluster.

Viewing and updating license settings using the CLI

You can use the command-line interface (CLI) to view and update your license settings.

SAN Volume Controller 4.3.1 provides two license options: Physical Disk Licensing and Capacity Licensing. Perform the following steps to view and update your SAN Volume Controller license settings:

1. Issue the **svcinfolicense** CLI command to view the current license settings for the cluster.
2. Issue the **svctask chlicense** CLI command to change the licensed settings of the cluster.

Attention:

- License settings are entered when the cluster is first created; do not update the settings unless you have changed your license.
- To select Physical Disk Licensing, run the **svctask chlicense** command with one or more of the **physical_disks**, **physical_flash**, and **physical_remote** parameters.
- To select Capacity Licensing, run the **svctask chlicense** command with one or more of the **-flash**, **-remote**, and **-virtualization** parameters.

For detailed license command usage information, see the *IBM System Storage SAN Volume Controller Command-Line Interface User's Guide*.

Displaying cluster properties using the CLI

You can use the command-line interface (CLI) to display the properties for a cluster.

Perform the following step to display cluster properties:

Issue the **svcinfolcluster** command to display the properties for a cluster. The following is an example of the command you can issue:

```
svcinfolcluster -delim : ITSOSVC42A
```

where *ITSOSVC42A* is the name of the cluster.


```

IBM_2145:ITSOSVC42A:admin>svcinfolcluster -delim : ITSOSVC42A
id:0000020060806FB8
name:ITSOSVC42A
location:local
partnership:
bandwidth:
cluster_IP_address:9.71.50.32
cluster_service_IP_address:9.71.50.183
total_mdisk_capacity:59.8GB
space_in_mdisk_grps::2976.9GB
space_allocated_to_vdisks:147.2GB
total_free_space:2828.7GB
statistics_status:on
statistics_frequency:15
required_memory:8192
cluster_locale:en_US
SNMP_setting:none
SNMP_community:
SNMP_server_IP_address:[0.0.0.0]:23
subnet_mask:255.255.254.0
default_gateway:9.71.50.1
time_zone:522 UTC
email_setting:none
email_id:
code_level:4.1.0.12 (build 5.13.0610240000)
FC_port_speed:2Gb
console_IP:9.71.49.176:9080
id_alias:0000020064C05308
gm_link_tolerance:300
gm_inter_cluster_delay_simulation:0
gm_intra_cluster_delay_simulation:0
email_server:8.53.26.131
email_server_port:25
email_reply:manager@mycompany.com
email_contact:manager
email_contact_primary:01202 123456
email_contact_alternate:44-212-786543-4455
email_contact_location:city
email_state:running
email_user_count:2
inventory_mail_interval:0
cluster_IP_address_6:
cluster_service_IP_address_6:
prefix_6:
default_gateway_6:
total_vdiskcopy_capacity:40.00GB
total_used_capacity:22.50GB
total_overallocation:67
total_vdisk_capacity:30.00GB

```

Maintaining passwords for the front panel using the CLI

You can use the command-line interface (CLI) to view and change the status of the password reset feature for the SAN Volume Controller front panel.

The menu on the SAN Volume Controller front panel provides an option to reset the administrator password. This option resets the administrator password to a random string and displays the new administrator password on the SAN Volume Controller front panel. You can use this new administrator password to access the system. For password protection, change the administrator password at the next login.

Perform the following steps to view and change the status of the password reset feature:

1. Issue the `svctask setpwdreset` CLI command to view and change the status of the password reset feature for the SAN Volume Controller front panel. Passwords can consist of A - Z, a - z, 0 - 9, and underscore.
2. Record the administrator password because you cannot access the cluster without it.

Adding nodes to a cluster using the CLI

You can use the command-line interface (CLI) to add nodes to a cluster.

Before you add a node to a cluster, you must make sure that the switch zoning is configured such that the node being added is in the same zone as all other nodes in the cluster. If you are replacing a node and the switch is zoned by worldwide port name (WWPN) rather than by switch port, make sure that the switch is configured such that the node being added is in the same VSAN/zone.

Attention:

1. If you are re-adding a node to the SAN, ensure that you are adding the node to the same I/O group from which it was removed. Failure to do this can result in data corruption. You must use the information that was recorded when the node was originally added to the cluster. If you do not have access to this information, call the IBM Support Center to add the node back into the cluster without corrupting the data.
2. The LUNs that are presented to the ports on the new node must be the same as the LUNs that are presented to the nodes that currently exist in the cluster. You must ensure that the LUNs are the same before you add the new node to the cluster.
3. LUN masking for each LUN must be identical on all nodes in a cluster. You must ensure that the LUN masking for each LUN is identical before you add the new node to the cluster.
4. You must ensure that the model type of the new node is supported by the SAN Volume Controller software level that is currently installed on the cluster. If the model type is not supported by the SAN Volume Controller software level, upgrade the cluster to a software level that supports the model type of the new node. See the following Web site for the latest supported software levels:
www.ibm.com/storage/support/2145

Special procedures when adding a node to a cluster

Applications on the host systems direct I/O operations to file systems or logical volumes that are mapped by the operating system to virtual paths (vpaths), which are pseudo disk objects supported by the Subsystem Device Driver (SDD). SDD maintains an association between a VPath and a SAN Volume Controller virtual disk (VDisk). This association uses an identifier (UID) which is unique to the VDisk and is never reused. The UID allows SDD to directly associate vpaths with VDIs.

SDD operates within a protocol stack that contains disk and fibre channel device drivers that allow it to communicate with the SAN Volume Controller using the SCSI protocol over fibre channel as defined by the ANSI FCS standard. The addressing scheme provided by these SCSI and fibre-channel device drivers uses a combination of a SCSI logical unit number (LUN) and the worldwide node name (WWNN) for the fibre channel node and ports.

If an error occurs, the error recovery procedures (ERPs) operate at various tiers in the protocol stack. Some of these ERPs cause I/O to be redriven using the same WWNN and LUN numbers that were previously used.

SDD does not check the association of the VDisk with the VPath on every I/O operation that it performs.

Before you add a node to the cluster, you must check to see if any of the following conditions are true:

- The cluster has more than one I/O group.
- The node being added to the cluster uses physical node hardware or a slot which has previously been used for a node in the cluster.
- The node being added to the cluster uses physical node hardware or a slot which has previously been used for a node in another cluster and both clusters have visibility to the same hosts and back-end storage.

If any of the previous conditions are true, the following special procedures apply:

- The node must be added to the same I/O group that it was previously in. You can use the command-line interface (CLI) command **svcinfolnode** or the SAN Volume Controller Console to determine the WWN of the cluster nodes.
- Before you add the node back into the cluster, you must shut down all of the hosts using the cluster. The node must then be added before the hosts are rebooted. If the I/O group information is unavailable or it is inconvenient to shut down and reboot all of the hosts using the cluster, then do the following:
 - On all of the hosts connected to the cluster, unconfigure the fibre-channel adapter device driver, the disk device driver and multipathing driver before you add the node to the cluster.
 - Add the node to the cluster and then reconfigure the fibre-channel adapter device driver, the disk device driver, and multipathing driver.

Scenarios where the special procedures can apply

The following two scenarios describe situations where the special procedures can apply:

- Four nodes of an eight-node cluster have been lost because of the failure of a pair of 2145 UPS or four 2145 UPS-1U. In this case, the four nodes must be added back into the cluster using the CLI command **svctask addnode** or the SAN Volume Controller Console.
- A user decides to delete four nodes from the cluster and add them back into the cluster using the CLI command **svctask addnode** or the SAN Volume Controller Console.

Perform the following steps to add nodes to a cluster:

1. Issue the **svcinfolnode** CLI command to list the nodes that are currently part of the cluster and determine the I/O group for which to add the node.

The following is an example of the output that is displayed:

```
svcinfolnode -delim :
id:name:UPS_serial_number:WWNN:status:IO_group_id:
IO_group_name:config_node:UPS_unique_id:hardware
1:node1:I0L3ASH:500507680100002C:online:0:io_grp0:yes:202378101C0D18D8:other
....
```

2. Issue the **svcinfolnnodecandidate** CLI command to list nodes that are not assigned to a cluster and to verify that when a second node is added to an I/O group, it is attached to a different uninterruptible power supply.

The following is an example of the output that is displayed:

```
svcinfolnnodecandidate -delim :  
  
id:panel_name:UPS_serial_number:UPS_unique_id:hardware  
5005076801000001:000341:10L3ASH:202378101C0D18D8:other  
5005076801000009:000237:10L3ANF:202378101C0D1796:other  
50050768010000F4:001245:10L3ANF:202378101C0D1796:other  
....
```

3. Issue the **svctask addnode** CLI command to add a node to the cluster.

Important: Each node in an I/O group must be attached to a different uninterruptible power supply.

The following is an example of the CLI command you can issue to add a node to the cluster using the panel name parameter:

```
svctask addnode -panelname 000237  
-iogrp io_grp0 -name group1node2
```

Where *000237* is the panel name of the node, *io_grp0* is the name of the I/O group that you are adding the node to and *group1node2* is the name that you want to give to the node.

The following is an example of the CLI command you can issue to add a node to the cluster using the WWNN parameter:

```
svctask addnode -wwnodename 5005076801000001  
-iogrp io_grp1 -name group2node2
```

Where *5005076801000001* is the WWNN of the node, *io_grp1* is the name of the I/O group that you are adding the node to and *group2node2* is the name that you want to give to the node.

You can specify a name for the node or use the default name.

If you do not specify the name for the node, the node can later be identified by using the front panel name, which is printed on a label on the front of the SAN Volume Controller, or by using the WWNN of that node .

Record the following information for the new node:

- Node serial number
- WWNN
- All WWPNS
- I/O group that contains the node

4. If you did not specify a name when you issued the **svctask addnode** command, issue the **svctask chnode** CLI command to change the default name of a node to a name that can make it easy to identify in the cluster. The following is an example of the CLI command that you can issue:

```
svctask chnode -name group1node1 node1
```

Where *group1node1* is the new name for the node and *node1* is the default name that was assigned to the node.

5. Issue the **svcinfolnnode** CLI command to verify the final configuration.

The following is an example of the output that is displayed:

```

svcinfolnode -delim :

id:name:UPS_serial_number:WWNN:status:IO_group_id:
IO_group_name:config_node:UPS_unique_id:hardware
1:group1node1:10L3ASH:500507680100002C:online:0:io_grp0:yes:202378101C0D18D8:other
2:group1node2:10L3ANF:5005076801000009:online:0:io_grp0:no:202378101C0D1796:other
3:group2node1:10L3ASH:5005076801000001:online:1:io_grp1:no:202378101C0D18D8:other
4:group2node2:10L3ANF:50050768010000F4:online:1:io_grp1:no:202378101C0D1796:other
....

```

Note: If this command is issued quickly after you have added nodes to the cluster, the status of the nodes might be adding. The status is shown as adding if the process of adding the nodes to the cluster is still in progress. You do not have to wait for the status of all the nodes to be online before you continue with the configuration process.

Remember: Record the following information:

- Node serial number
- WWNN
- All WWPNS
- I/O group that contains the node

The nodes have been added to the cluster.

Displaying node properties using the CLI

You can use the command-line interface (CLI) to display node properties.

Perform the following steps to display the node properties:

1. Issue the **svcinfolnode** CLI command to display a concise list of nodes in the cluster.

The following is an example of the CLI command you can issue to list the nodes in the cluster:

```
svcinfolnode -delim :
```

The following is an example of the output that is displayed:

```

id:name:UPS_serial_number:WWNN:status:IO_group_id:
IO_group_name:config_node:UPS_unique_id:hardware
1:group1node1:10L3ASH:500507680100002C:online:0:io_grp0:yes:202378101C0D18D8:8G4
2:group1node2:10L3ANF:5005076801000009:online:0:io_grp0:no:202378101C0D1796:8G4
3:group2node1:10L3ASH:5005076801000001:online:1:io_grp1:no:202378101C0D18D8:8G4
4:group2node2:10L3ANF:50050768010000F4:online:1:io_grp1:no:202378101C0D1796:8G4

```

2. Issue the **svcinfolnode** CLI command and specify the node ID or name of the node that you want to receive detailed output.

The following is an example of the CLI command you can issue to list detailed output for a node in the cluster:

```
svcinfolnode -delim : group1_node1
```

Where *group1_node1* is the name of the node for which you want to view detailed output.

The following is an example of the output that is displayed:

```
id:1
name:group1node1
UPS_serial_number:10L3ASH
WWNN:500507680100002C
status:online
IO_group_id:0
IO_group_name:io_grp0
partner_node_id:2
partner_node_name:group1node2
config_node:yes
UPS_unique_id:202378101C0D18D8
port_id:500507680110002C
port_status:active
port_speed:2GB
port_id:500507680120002C
port_status:active
port_speed:2GB
port_id:500507680130002C
port_status:active
port_speed:2GB
port_id:500507680140003C
port_status:active
port_speed:2GB
hardware:8G4
```

Discovering MDisks using the CLI

You can use the command-line interface (CLI) to discover managed disks (MDisks).

When back-end controllers are added to the fibre-channel SAN and are included in the same switch zone as a SAN Volume Controller cluster, the cluster automatically discovers the back-end controller and integrates the controller to determine the storage that is presented to the SAN Volume Controller nodes. The SCSI logical units (LUs) that are presented by the back-end controller are displayed as unmanaged MDisks. However, if the configuration of the back-end controller is modified after this has occurred, the SAN Volume Controller cluster might be unaware of these configuration changes. You can request that the SAN Volume Controller cluster rescans the fibre-channel SAN to update the list of unmanaged MDisks.

Note: The automatic discovery that is performed by SAN Volume Controller cluster does not write anything to an unmanaged MDisk. You must instruct the SAN Volume Controller cluster to add an MDisk to an MDisk group or use an MDisk to create an image mode virtual disk (VDisk).

Perform the following steps to discover and then view a list of MDisks:

1. Issue the **svctask detectmdisk** CLI command to manually scan the fibre-channel network. The scan discovers any new MDisks that might have been added to the cluster and rebalances MDisk access across the available controller device ports.

Notes:

- a. Only issue the **svctask detectmdisk** command when you are sure that all of the disk controller ports are working and correctly configured in the controller and the SAN zoning. Failure to do this can result in errors that are not reported.
- b. Although it might appear that the **detectmdisk** command has completed, extra time might be required for it to run. The **detectmdisk** is asynchronous and returns a prompt while the

| command continues to run in the background. You can use the
| **lsdiscoverystatus** command to view the discovery status.

2. When the detection is complete, issue the **svcinfolismdiskcandidate** CLI command to show the unmanaged MDisks. These MDisks have not been assigned to an MDisk group.
3. Issue the **svcinfolismdisk** CLI command to view all of the MDisks.

You have now seen that the back-end controllers and switches have been set up correctly and that the SAN Volume Controller cluster recognizes the storage that is presented by the back-end controller.

The following example describes a scenario where a single back-end controller is presenting eight SCSI LUs to the SAN Volume Controller cluster:

1. Issue `svctask detectmdisk`.
2. Issue `svcinfolismdiskcandidate`.

The following output is displayed:

```
id
0
1
2
3
4
5
6
7
```

3. Issue `svcinfolismdisk -delim : -filtervalue mode=unmanaged`

The following output is displayed:

```
id:name:status:mode:mdisk_grp_id:mdisk_grp_name:
capacity:ctrl_LUN #:controller_name
0:mdisk0:online:unmanaged:::273.3GB:0000000000000000:controller0
1:mdisk1:online:unmanaged:::273.3GB:0000000000000001:controller0
2:mdisk2:online:unmanaged:::273.3GB:0000000000000002:controller0
3:mdisk3:online:unmanaged:::273.3GB:0000000000000003:controller0
4:mdisk4:online:unmanaged:::136.7GB:0000000000000004:controller0
5:mdisk5:online:unmanaged:::136.7GB:0000000000000005:controller0
6:mdisk6:online:unmanaged:::136.7GB:0000000000000006:controller0
7:mdisk7:online:unmanaged:::136.7GB:0000000000000007:controller0
```

Creating MDisk groups using the CLI

You can use the command-line interface (CLI) to create a managed disk (MDisk) group.

Attention: If you add an MDisk to an MDisk group as an MDisk, any data on the MDisk is lost. If you want to keep the data on an MDisk (for example, because you want to import storage that was previously not managed by a SAN Volume Controller), you must create image mode virtual disks (VDisks) instead.

Assume that the cluster has been set up and that a back-end controller has been configured to present new storage to the SAN Volume Controller.

Consider the following factors as you decide how many MDisk groups to create:

- A VDisk can only be created using the storage from one MDisk group. Therefore, if you create small MDisk groups, you might lose the benefits that are

provided by virtualization, namely more efficient management of free space and a more evenly distributed workload for better performance.

- If any MDisk in an MDisk group goes offline, all the VDIsks in the MDisk group go offline. Therefore you might want to consider using different MDisk groups for different back-end controllers or for different applications.
- If you anticipate regularly adding and removing back-end controllers or storage, this task is made simpler by grouping all the MDisks that are presented by a back-end controller into one MDisk group.
- All the MDisks in an MDisk group should have similar levels of performance or reliability, or both. If an MDisk group contains MDisks with different levels of performance, the performance of the VDIsks in this group is limited by the performance of the slowest MDisk. If an MDisk group contains MDisks with different levels of reliability, the reliability of the VDIsks in this group is that of the least reliable MDisk in the group.

Even with the best planning, circumstances can change and you must reconfigure your MDisk groups after they have been created. The data migration facilities that are provided by the SAN Volume Controller enable you to move data without disrupting I/O.

Choosing an MDisk group extent size

Consider the following factors as you decide the extent size of each new MDisk group:

- You must specify the extent size when you create a new MDisk group.
- You cannot change the extent size later; it must remain constant throughout the lifetime of the MDisk group.
- MDisk groups can have different extent sizes; however, this places restrictions on the use of data migration.
- The choice of extent size affects the total amount of storage that a SAN Volume Controller cluster can manage.

Table 13 shows the maximum amount of storage that can be managed by a cluster for each extent size. Because the SAN Volume Controller allocates a whole number of extents to each VDisk that is created, using a larger extent size might increase the amount of storage that is wasted at the end of each VDisk. Larger extent sizes also reduces the ability of the SAN Volume Controller to distribute sequential I/O workloads across many MDisks and therefore can reduce the performance benefits of virtualization.

Table 13. Extent size

Extent Size	Maximum storage capacity of cluster
16 MB	64 TB
32 MB	128 TB
64 MB	256 TB
128 MB	512 TB
256 MB	1 PB
512 MB	2 PB
1024 MB	4 PB
2048 MB	8 PB

Important: You can specify different extent sizes for different MDisk groups; however, you cannot migrate VDIs between MDisk groups with different extent sizes. If possible, create all your MDisk groups with the same extent size.

Perform the following steps to create an MDisk group:

Issue the **svctask mkmdiskgrp** CLI command to create an MDisk group. The following is an example of the CLI command you can issue to create an MDisk group:

```
svctask mkmdiskgrp -name maindiskgroup -ext 32  
-mdisk mdsk0:mdsk1:mdsk2:mdsk3
```

Where *maindiskgroup* is the name of the MDisk group that you want to create, 32 MB is the size of the extent you want to use, and *mdsk0*, *mdsk1*, *mdsk2*, *mdsk3* are the names of the four MDisks that you want to add to the group.

You created and added MDisks to an MDisk group.

The following example provides a scenario where you want to create an MDisk group, but you do not have any MDisks available to add to the group. You plan to add the MDisks at a later time.

1. Issue **svctask mkmdiskgrp -name bkpmdiskgroup -ext 32**.

Where *bkpmdiskgroup* is the name of the MDisk group that you want to create and 32 MB is the size of the extent you want to use.

2. You find four MDisks that you want to add to the MDisk group.

3. Issue **svctask addmdisk -mdisk msk4:msk5:msk6:msk7 bkpmdiskgroup**.

Where *msk4*, *msk5*, *msk6*, *msk7* are the names of the MDisks that you want to add to the MDisk group and *bkpmdiskgroup* is the name of the MDisk group for which you want to add MDisks.

You used the **svctask mkmdiskgrp** CLI command to create the MDisk group *bkpmdiskgroup* and later used the **svctask addmdisk** CLI command to add *msk4*, *msk5*, *msk6*, *msk7* to the MDisk group.

Adding MDisks to MDisk groups using the CLI

You can use the command-line interface (CLI) to add managed disks (MDisks) to MDisk groups.

The MDisks must be in unmanaged mode. Disks that already belong to an MDisk group cannot be added to another MDisk group until they have been deleted from their current MDisk group. You can delete an MDisk from an MDisk group under the following circumstances:

- If the MDisk does not contain any extents in use by a virtual disk (VDisk)
- If you can first migrate the extents in use onto other free extents within the group

Important: Do not add the MDisk using this procedure if you want to make an image mode VDisk with it.

Note: When you are adding MDisks to an MDisk group using the **svctask addmdisk** command or when you are creating an MDisk group using the **svctask mkmdiskgrp -mdisk** command, the SAN Volume Controller

performs tests on the MDisks in the list before the MDisks are allowed to become part of an MDisk group. These tests include checks of the MDisk identity, capacity, status, and the ability to perform both read and write operations. If these tests fail or exceed the time allowed, the MDisks are not added to the group. However, with the `svctask mkmdiskgrp -mdisk` command, the MDisk group is still created even if the tests fail, but it does not contain any MDisks. If tests fail, confirm that the MDisks are in the correct state and that they have been correctly discovered.

The following reasons contribute to a typical MDisk test failure:

- The MDisk is not visible to all SAN Volume Controller nodes in the cluster.
- The MDisk identity has changed from a previous discovery operation.
- The MDisk cannot perform read or write operations.
- The status of the MDisk is degraded, excluded, or offline.
- The MDisk does not exist.

The following reasons contribute to a typical MDisk test timeout:

- The disk controller system on which the MDisk resides is failing.
- A SAN fabric or cable fault condition exists that is preventing reliable communication with the MDisk.

Perform the following steps to add MDisks to MDisk groups:

1. Issue the `svcinfolsmdiskgrp` CLI command to list the existing MDisk groups.

The following is an example of the CLI command you can issue to list the existing MDisk groups:

```
svcinfolsmdiskgrp -delim :
```

The following is an example of the output that is displayed:

```
id:name:status:mdisk_count:vdisk_count:
capacity:extent_size:free_capacity:virtual_capacity:
used_capacity:real_capacity:overallocation:warning
0:mdiskgrp0:online:3:4:33.3GB:16:32.8GB:64.00MB:64.00MB:64.00MB:0:0
1:mdiskgrp1:online:2:1:26.5GB:16:26.2GB:16.00MB:16.00MB:16.00MB:0:0
2:mdiskgrp2:online:2:0:33.4GB:16:33.4GB:0.00MB:0.00MB:0.00MB:0:0
```

2. Issue the `svctask addmdisk` CLI command to add MDisks to the MDisk group.

The following is an example of the CLI command you can issue to add MDisks to an MDisk group:

```
svctask addmdisk -mdisk mdisk4:mdisk5:mdisk6:mdisk7 bkpmdiskgroup
```

Where `mdisk4:mdisk5:mdisk6:mdisk7` are the names of the MDisks that you want to add to the MDisk group and `bkpmdiskgroup` is the name of the MDisk group for which you want to add the MDisks.

Modifying the amount of available memory for Copy Service and VDisk Mirroring features using the CLI

You can use the command-line interface (CLI) to modify the amount of memory that is available for the VDisk Mirroring feature and the FlashCopy, Metro Mirror, or Global Mirror Copy Services features.

The following table provides an example of the amount of memory that is required for VDisk Mirroring and each Copy Service feature:

Feature	Grain size	1 MB of memory provides the following VDisk capacity for the specified I/O group
Metro Mirror or Global Mirror	256 KB	2 TB of total Metro Mirror and Global Mirror VDisk capacity
FlashCopy	256 KB	2 TB of total FlashCopy source VDisk capacity
FlashCopy	64 KB	512 GB of total FlashCopy source VDisk capacity
Incremental FlashCopy	256 KB	1 TB of total incremental FlashCopy source VDisk capacity
Incremental FlashCopy	64 KB	256 GB of total incremental FlashCopy source VDisk capacity
VDisk Mirroring	256 KB	2 TB of mirrored VDisk capacity

Notes:

- For multiple FlashCopy targets, you must consider the number of mappings. For example, for a mapping with a grain size of 256 KB, 8 KB of memory allows one mapping between a 16 GB source VDisk and a 16 GB target VDisk. Alternatively, for a mapping with a 256 KB grain size, 8 KB of memory allows two mappings between one 8 GB source VDisk and two 8 GB target VDIs.
- When creating a FlashCopy mapping, if you specify an I/O group other than the I/O group of the source VDisk, the memory accounting goes towards the specified I/O group, not towards the I/O group of the source VDisk.

To modify and verify the amount of memory that is available, perform the following steps:

- Issue the following command to modify the amount of memory that is available for VDisk Mirroring or a Copy Service feature:
`svctask chiogrp -feature flash|remote|mirror -size memory_size io_group_id | io_group_name`
 where *flash|remote|mirror* is the feature that you want to modify, *memory_size* is the amount of memory that you want to be available, and *io_group_id* | *io_group_name* is the ID or name of the I/O group for which you want to modify the amount of available memory.
- Issue the following command to verify that the amount of memory has been modified:
`svcinfo lsiogrp object_id | object_name`
 where *object_id* | *object_name* is the ID or name of the I/O group for which you have modified the amount of available memory.

The following information is an example of the output that is displayed.

```
id 0
name io_grp 0
node_count 2
vdisk_count 28
host_count 2
flash_copy_total_memory 20.0MB
flash_copy_free_memory 20.0MB
remote_copy_total_memory 20.0MB
remote_copy_free_memory 20.0MB
mirroring_total_memory 10.0MB
mirroring_free_memory 10.0MB
```

Creating VDisks using the CLI

You can use the command-line interface (CLI) to create a virtual disk (VDisk).

This task assumes that the cluster has been setup and that you have created managed disk (MDisk) groups. You can establish an empty MDisk group to hold the MDisks that are used for image mode VDisks.

Note: If you want to keep the data on an MDisk, create image mode VDisks. This task describes how to create a VDisk with striped virtualization.

Perform the following steps to create VDisks:

1. Issue the **svcinfolsmdiskgrp** CLI command to list the available MDisk groups and the amount of free storage in each group.

The following is an example of the CLI command you can issue to list MDisk groups:

```
svcinfolsmdiskgrp -delim :
```

The following is an example of the output that is displayed:

```
id:name:status:mdisk_count:vdisk_count:capacity:extent_size:free_capacity:
virtual_capacity:used_capacity:real_capacity:overallocation:warning
0:mdiskgrp0:degraded:4:0:34.2GB:16:34.2GB:0:0:0:0
1:mdiskgrp1:online:4:6:200GB:16:100GB:400GB:75GB:100GB:200:80
```

2. Decide which MDisk group you want to provide the storage for the VDisk.
3. Issue the **svcinfolsiogrp** CLI command to show the I/O groups and the number of VDisks assigned to each I/O group.

Note: It is normal for clusters with more than one I/O group to have MDisk groups that have VDisks in different I/O groups. You can use FlashCopy to make copies of VDisks regardless of whether the source and target VDisk are in the same I/O group. If you plan to use intracluster Metro Mirror or Global Mirror, both the master and auxiliary VDisk must be in the same I/O group.

The following is an example of the CLI command you can issue to list I/O groups:

```
svcinfolsiogrp -delim :
```

The following is an example of the output that is displayed:

```
id:name:node_count:vdisk_count
0:io_grp0:2:0
1:io_grp1:2:0
2:io_grp2:0:0
3:io_grp3:0:0
4:recovery_io_grp:0:0
```

4. Decide which I/O group you want to assign the VDisk to. This determines which SAN Volume Controller nodes in the cluster process the I/O requests from the host systems. If you have more than one I/O group, make sure you distribute the VDisks between the I/O groups so that the I/O workload is shared evenly between all SAN Volume Controller nodes.
5. Issue the **svctask mkvdisk** CLI command to create a VDisk. See the *IBM System Storage SAN Volume Controller Command-Line Interface User's Guide* for more information on this command.

The following is an example of the CLI command you can issue to create a VDisk using the I/O group ID and MDisk group ID:

```
svctask mkvdisk -name mainvdisk1 -iogrp 0
  -mdiskgrp 0 -vtype striped -size 256 -unit gb
```

where *mainvdisk1* is the name that you want to call the VDisk, *0* is the ID of the I/O group that want the VDisk to use, *0* is the ID of the MDisk group that you want the VDisk to use, and *256* is the capacity of the VDisk.

The following is an example of the CLI command that you can issue to create a VDisk using the I/O group and MDisk group name:

```
svctask mkvdisk -name bkpvdisk1 -iogrp io_grp1
  -mdiskgrp bkpmdiskgroup -vtype striped -size 256 -unit gb
```

where *bkpvdisk1* is the name that you want to call the VDisk, *io_grp1* is the name of the I/O group that want the VDisk to use, *bkpmdiskgroup* is the name of the MDisk group that you want the VDisk to use, and *256* is the capacity of the VDisk.

The following is an example of the the CLI command that you can issue to create a space-efficient VDisk using the I/O group and MDisk group name:

```
svctask mkvdisk -iogrp io_grp1 -mdiskgrp bkpmdiskgroup -vtype striped
  -size 10 unit gb -rsize 20% -autoexpand -grainsize 32
```

where *io_grp1* is the name of the I/O group that you want the VDisk to use and *20%* is how much real storage to allocate to the VDisk, as a proportion of its virtual size. In this example, the size is 10 GB so that 2 GB will be allocated.

The following is an example of the CLI command that you can issue to create a VDisk with two copies using the I/O group and MDisk group name:

```
svctask mkvdisk -iogrp io_grp1 -mdiskgrp grpa:grpb
  -size 500 -vtype striped -copies 2
```

where *io_grp1* is the name of the I/O group that you want the VDisk to use, *grpa* is the name of the MDisk group for the primary copy of the VDisk and *grpb* is the name of the MDisk group for the second copy of the VDisk, and *2* is the number of VDisk copies.

Note: If you want to create two VDisk copies of different types, create the first copy using the `mkvdisk` command and then add the second copy using the `addvdiskcopy` command.

6. Issue the `svcinfo lsvdisk` CLI command to list all the VDIs that have been created.

Adding a copy to a VDisk using the CLI

You can use the command-line interface (CLI) to add a mirrored copy to a virtual disk (VDisk). Each VDisk can have a maximum of two copies.

The `addvdiskcopy` command adds a copy to an existing VDisk, which changes a nonmirrored VDisk into a mirrored VDisk.

Use the `-copies` parameter to specify the number of copies to add to the VDisk; this is currently limited to the default value of **1** copy. Use the `-mdiskgrp` parameter to specify the managed disk group that will provide storage for the copy; the `svcinfo lsmdiskgrp` CLI command lists the available managed disk groups and the amount of available storage in each group.

For image copies, you must specify the virtualization type using the `-vtype` parameter and an MDisk that is in unmanaged mode using the `-mdisk` parameter. This MDisk must be in the unmanaged mode. The `-vtype` parameter is optional for sequential (`seq`) and striped VDIs. The default virtualization type is **striped**.

Issue the `addvdiskcopy` CLI command to add a mirrored copy to a VDisk:

```
svctask addvdiskcopy -mdiskgrp 0 vdisk8
```

where `0` is the name of the managed disk group and `vdisk8` is the VDisk to which the copy will be added.

The command returns the IDs of the newly created VDisk copies.

Deleting a copy from a VDisk using the CLI

You can use the command-line interface (CLI) to delete a mirrored copy from a virtual disk (VDisk).

The `rmvdiskcopy` CLI command deletes the specified copy from the specified VDisk. The command fails if all other copies of the VDisk are not synchronized; in this case, you must specify the `-force` parameter, delete the VDisk, or wait until the copies are synchronized. You must specify the `vdisk_name` | `vdisk_id` parameter last on the command line.

Issue the `rmvdiskcopy` CLI command to delete a mirrored copy from a VDisk:

```
svctask rmvdiskcopy -copy 1 vdisk8
```

where `1` is the ID of the copy to delete and `vdisk8` is the virtual disk to delete the copy from.

The command does not return any output.

Creating host objects using the CLI

You can use command-line interface (CLI) to create host objects.

Perform the following steps to create host objects:

1. Issue the `svctask mkhost` CLI command to create a logical host object. Assign your worldwide port name (WWPN) for the host bus adapters (HBAs) in the hosts.

The following is an example of the CLI command you can issue to create a host:

```
svctask mkhost -name demohost1 -hbawwpn 210100e08b251dd4
```

Where `demohost1` is the name of the host and `210100e08b251dd4` is the WWPN of the HBA.

2. Issue the `svctask addvdiskcopy` CLI command to add a copy to an existing VDisk.

The following is an example of the CLI command that you can issue to add a copy to a VDisk with one VDisk copy:

```
svctask addvdiskcopy -mdiskgrp grpb bkpvdisk1
```

where `grpb` is the MDisk group for the added copy.

3. Issue the `svctask addhostport` CLI command to add ports to the host.

The following is an example of the CLI command you can issue to add a port to the host:
`svctask addhostport -hbawpn 210100e08b251dd5 demohost1`

This command adds another HBA WWPN called `210100e08b251dd5` to the host that was created in step 1 on page 200.

Creating VDisk-to-host mappings using the CLI

You can use the command-line interface (CLI) to create virtual disk (VDisk)-to-host mappings.

Perform the following steps to create VDisk-to-host mappings:

Issue the **svctask mkvdiskhostmap** CLI command to create VDisk-to-host mappings.

The following is an example of the CLI command you can issue to create VDisk-to-host mappings:

```
svctask mkvdiskhostmap -host demohost1 mainvdisk1
```

Where *demohost1* is the name of the host and *mainvdisk1* is the name of the VDisk.

Creating FlashCopy mappings using the CLI

You can use the command-line interface (CLI) to create FlashCopy mappings.

A FlashCopy mapping specifies the source and target virtual disk (VDisk). Source VDIsks and target VDIsks must meet the following requirements:

- They must be the same size.
- They must be managed by the same cluster.

A VDisk can be the source in up to 256 mappings. A mapping is started at the point in time when the copy is required.

Perform the following steps to create FlashCopy mappings:

1. The source and target VDisk must be the exact same size. Issue the **svcinfolsvdisk -bytes** CLI command to find the size (capacity) of the VDisk in bytes.
2. Issue the **svctask mkfcmap** CLI command to create a FlashCopy mapping.

The following CLI command example creates a FlashCopy mapping and sets the copy rate:

```
svctask mkfcmap -source mainvdisk1 -target bkpvdisk1  
-name main1copy -copyrate 75
```

Where *mainvdisk1* is the name of the source VDisk, *bkpvdisk1* is the name of the VDisk that you want to make the target VDisk, *main1copy* is the name that you want to call the FlashCopy mapping, and *75* is the copy rate.

The following is an example of the CLI command you can issue to create FlashCopy mappings without the copy rate parameter:

```
svctask mkfcmap -source mainvdisk2 -target bkpvdisk2  
-name main2copy
```

Where *mainvdisk2* is the name of the source VDisk, *bkpvdisk2* is the name of the VDisk that you want to make the target VDisk, *main2copy* is the name that you want to call the FlashCopy mapping.

Note: The default copy rate of 50 is used if you do not specify a copy rate.

3. Issue the **svcinfolsfcmmap** CLI command to check the attributes of the FlashCopy mappings that have been created:

The following is an example of a CLI command that you can issue to view the attributes of the FlashCopy mappings:

```
svcinfolsfcmmap -delim :
```

Where **-delim** species the delimiter. The following is an example of the output that is displayed:

```
id:name:source_vdisk_id:source_vdisk_name:target_vdisk_id:target_vdisk_name:
group_id:group_name:status:progress:copy_rate:clean_progress:incremental
0:main1copy:77:vdisk77:78:vdisk78:::idle_or_copied:0:75:100:off
1:main2copy:79:vdisk79:80:vdisk80:::idle_or_copied:0:50:100:off
```

Creating a FlashCopy consistency group and adding mappings using the CLI

You can use the command-line interface (CLI) to create and add mappings to a FlashCopy consistency group.

If you have created several FlashCopy mappings for a group of virtual disks (VDisks) that contain elements of data for the same application, it can be convenient to assign these mappings to a single FlashCopy consistency group. You can then issue a single prepare or start command for the whole group. For example, you can copy all of the files for a database at the same time.

Perform the following steps to add FlashCopy mappings to a new FlashCopy consistency group:

1. Issue the **svctask mkfcconsistgrp** CLI command to create a FlashCopy consistency group.

The following is an example of the CLI command you can issue to create a FlashCopy consistency group:

```
svctask mkfcconsistgrp -name FCcgrp0 -autodelete
```

Where **FCcgrp0** is the name of the FlashCopy consistency group. The **-autodelete** parameter specifies to delete the consistency group when the last FlashCopy mapping is deleted or removed from the consistency group.

2. Issue the **svcinfolsfconsistgrp** CLI command to display the attributes of the group that you have created.

The following is an example of the CLI command you can issue to display the attributes of a FlashCopy consistency group:

```
svcinfolsfconsistgrp -delim : FCcgrp0
```

The following is an example of the output that is displayed:

```
id:1
name:FCcgrp0
status:idle_or_copied
autodelete:on
FC_mapping_id:0
FC_mapping_name:fcmap0
FC_mapping_id:1
FC_mapping_name:fcmap1
```

Note: For any group that has just been created, the status reported is empty

3. Issue the **svctask chfcmap** CLI command to add FlashCopy mappings to the FlashCopy consistency group:

The following are examples of the CLI commands you can issue to add Flash Copy mappings to the FlashCopy consistency group:

```
svctask chfcmap -consistgrp FCcgrp0 main1copy
svctask chfcmap -consistgrp FCcgrp0 main2copy
```

Where **FCcgrp0** is the name of the FlashCopy consistency group and *main1copy*, *main2copy* are the names of the FlashCopy mappings.

4. Issue the **svcinfolsfcmmap** CLI command to display the new attributes of the FlashCopy mappings.

The following is an example of the output that is displayed:

```
svcinfolsfcmmap -delim :
id:name:source_vdisk_id:source_vdisk_name:target_vdisk_id:
target_vdisk_name:group_id:group_name:status:progress:copy_rate
0:main1copy:28:maindisk1:29:bkpdisk1:1:FCcgrp0:idle_copied::75
1:main2copy:30:maindisk2:31:bkpdisk2:1:FCcgrp0:idle_copied::50
```

5. Issue the **svcinfolsfconsgistgrp** CLI command to display the detailed attributes of the group.

The following is an example of a CLI command that you can issue to display detailed attributes:

```
svcinfolsfconsgistgrp -delim : FCcgrp0
```

Where **FCcgrp0** is the name of the FlashCopy consistency group, and **-delim** specifies the delimiter.

The following is an example of the output that is displayed:

```
id:1
name:FCcgrp0
status:idle_or_copied
autodelete:off
FC_mapping_id:0
FC_mapping_name:main1copy
FC_mapping_id:1
FC_mapping_name:main2copy
```

Preparing and starting a FlashCopy mapping using the CLI

Before you start the FlashCopy process using the command-line interface (CLI), you must prepare a FlashCopy mapping.

Starting a FlashCopy mapping creates a point-in-time copy of the data on the source virtual disk (VDisk) and writes it to the target VDisk for the mapping.

Perform the following steps to prepare and start a FlashCopy mapping:

1. Issue the **svctask prestartfcmap** CLI command to prepare the FlashCopy mapping.

To run the following command, the FlashCopy mapping cannot belong to a consistency group.

```
svctask prestartfcmap main1copy
```

Where *main1copy* is the name of the FlashCopy mapping.

The mapping enters the preparing state and moves to the prepared state when it is ready.

2. Issue the **svcinfolsfcmmap** CLI command to check the state of the mapping.

The following is an example of the output that is displayed:

```
svcinfolsfcmmap -delim :
id:name:source_vdisk_id:source_vdisk_name:target_vdisk_id:
target_vdisk_name:group_id:group_name:status:progress:copy_rate
0:main1copy:0:mainvdisk1:1:bkpvdisk1:::prepared:0:50
```

3. Issue the **svctask startfcmmap** CLI command to start the FlashCopy mapping. The following is an example of the CLI command you can issue to start the FlashCopy mapping:

```
svctask startfcmmap main1copy
```

Where *main1copy* is the name of the FlashCopy mapping.

4. Issue the **svcinfolsfcmmapprogress** CLI command with the FlashCopy mapping name or ID to check the progress of the mapping.

The following is an example of the output that is displayed; the FlashCopy mapping ID 0 is 47% completed.

```
svcinfolsfcmmapprogress -delim :
id:progress
0:47
```

You have created a point-in-time copy of the data on a source VDisk and written that data to a target VDisk. The data on the target VDisk is only recognized by the hosts that are mapped to it.

Preparing and starting a FlashCopy consistency group using the CLI

You can use the command-line interface (CLI) to prepare and start a FlashCopy consistency group to start the FlashCopy process.

Successful completion of the FlashCopy process creates a point-in-time copy of the data on the source virtual disk (VDisk) and writes it to the target VDisk for each mapping in the group. When you have assigned several mappings to a FlashCopy consistency group, you only have to issue a single prepare command to prepare every FlashCopy mapping in the group, and you only have to issue a single start command to start every FlashCopy mapping in the group.

Perform the following steps to prepare and start a FlashCopy consistency group:

1. Issue the **svctask prestartfcconsistgrp** CLI command to prepare the FlashCopy consistency group before the copy process can be started.

Remember: You only have to issue a single prepare command for the whole group to prepare all of the mappings simultaneously.

The following is an example of the CLI command you can issue to prepare the FlashCopy consistency group:

```
svctask prestartfcconsistgrp maintobkpfcopy
```

Where *maintobkpfcopy* is the name of the FlashCopy consistency group. The group enters the preparing state, and then moves to the prepared state when it is ready.

2. Issue the **svcinfolsfcconsistgrp** command to check the status of the FlashCopy consistency group.

The following is an example of the CLI command that you can issue to check the status of the FlashCopy consistency group.

```
svcinfolsfcconsistgrp -delim :
```

The following is an example of the output that is displayed:

```
id:name:status
1:maintobkpfcopy:prepared
```

3. Issue the **svctask startfcconsistgrp** CLI command to start the FlashCopy consistency group to make the copy.

Remember: You only have to issue a single start command for the whole group to start all the mappings simultaneously.

The following is an example of the CLI command that you can issue to start the FlashCopy consistency group mappings:

```
svctask startfcconsistgrp maintobkpfcopy
```

Where *maintobkpfcopy* is the name of the FlashCopy consistency group. The FlashCopy consistency group enters the copying state, and then returns to the *idle_copied* state when complete.

4. Issue the **svcinfo lsfconsistgrp** command to check the status of the FlashCopy consistency group.

The following is an example of the CLI command that you can issue to check the status of the FlashCopy consistency group:

```
svcinfo lsfconsistgrp -delim : maintobkpfcopy
```

Where *maintobkpfcopy* is the name of the FlashCopy consistency group.

The following is an example of the output that is displayed when the process is still copying:

```
id:name:status
1:maintobkpfcopy:copying
```

The following is an example of the output that is displayed when the process has finished copying:

```
id:1
name:maintobkpfcopy
status:idle_copied
autodelete:off
FC_mapping_id:0
FC_mapping_name:main1copy
FC_mapping_id:1
FC_mapping_name:main2copy
```

Creating Metro Mirror and Global Mirror partnerships using the CLI

You can use the command-line interface (CLI) to create Metro Mirror and Global Mirror partnerships between two clusters.

Perform the following steps to create Metro Mirror and Global Mirror partnerships:

1. To create Metro Mirror and Global Mirror partnerships, run the **svctask mkpartnership** command. For example, enter:

```
svctask mkpartnership remote_cluster_id
```

Where *remote_cluster_id* is the ID of the remote cluster. When running the **svctask mkpartnership** command, you can also specify a background copy bandwidth by using the **-bandwidth *bandwidth_in_mbps*** parameter.

2. Run the **svctask mkpartnership** command from the remote cluster. For example, enter:

```
svctask mkpartnership local_cluster_id
```

Where *local_cluster_id* is the ID of the local cluster. When running the **svctask mkpartnership** command, you can also specify a background copy bandwidth by using the **-bandwidth** *bandwidth_in_mbps* parameter.

Modifying Metro Mirror and Global Mirror partnerships using the CLI

You can use the command-line interface (CLI) to modify Metro Mirror and Global Mirror partnerships.

Perform the following steps to modify Metro Mirror and Global Mirror partnerships:

1. To modify Metro Mirror and Global Mirror partnerships, run the **svctask chpartnership** command. For example, enter:

```
svctask chpartnership -bandwidth bandwidth_in_mbps remote_cluster_id
```

Where *bandwidth_in_mbps* is the new bandwidth from the local cluster to the remote cluster, and *remote_cluster_id* is the ID of the remote cluster.

2. Run the **svctask chpartnership** command from the remote cluster. For example, enter:

```
svctask chpartnership -bandwidth bandwidth_in_mbps local_cluster_id
```

Where *bandwidth_in_mbps* is the new bandwidth from the remote cluster to the local cluster, and *local_cluster_id* is the ID of the local cluster.

Starting and stopping Metro Mirror and Global Mirror partnerships using the CLI

You can use the command-line interface (CLI) to start and stop Metro Mirror and Global Mirror partnerships.

Perform the following steps to start and stop Metro Mirror and Global Mirror partnerships:

1. To start a Metro Mirror or Global Mirror partnership, run the **svctask chpartnership** command from either cluster. For example, enter:

```
svctask chpartnership -start remote_cluster_id
```

Where *remote_cluster_id* is the ID of the remote cluster. The **svctask mkpartnership** command starts the partnership by default.

2. To stop a Metro Mirror or Global Mirror partnership, run the **svctask chpartnership** command from either cluster.

For example, enter:

```
svctask chpartnership -stop remote_cluster_id
```

Where *remote_cluster_id* is the ID of the remote cluster.

Deleting Metro Mirror and Global Mirror partnerships using the CLI

You can use the command-line interface (CLI) to delete Metro Mirror and Global Mirror partnerships.

Perform the following steps to delete Metro Mirror and Global Mirror partnerships:

1. If a Metro Mirror or Global Mirror partnership has configured relationships or groups, you must stop the partnership before you can delete it. For example, enter:

```
svctask chpartnership -stop remote_cluster_id
```

Where *remote_cluster_id* is the ID of the remote cluster.

2. To delete a Metro Mirror and Global Mirror partnership, run the **svctask rmpartnership** command from either cluster. For example, enter:

```
svctask rmpartnership remote_cluster_id
```

Where *remote_cluster_id* is the ID of the remote cluster.

Determining the WWPNs of a node using the CLI

You can determine the worldwide port names (WWPNs) of a node using the command-line interface (CLI).

Perform the following steps to determine the WWPNs of a node:

1. Issue the **svcinflsnnode** CLI command to list the nodes in the cluster.
2. Record the name or ID of the node for which you want to determine the WWPNs.
3. Issue the **svcinflsnnode** CLI command and specify the node name or ID that was recorded in step 2.

The following is an example of the CLI command you can issue:

```
svcinflsnnode node1
```

Where *node1* is the name of the node for which you want to determine the WWPNs.

4. Record the four port IDs (WWPNs).

Determining the VDisk name from the device identifier on the host

You can use the command-line interface (CLI) to determine the virtual disk (VDisk) name from the device identifier on the host.

Each VDisk that is exported by the SAN Volume Controller is assigned a unique device identifier. The device identifier uniquely identifies the VDisk and can be used to determine which VDisk corresponds to the volume that the host sees.

Perform the following steps to determine the VDisk name from the device identifier:

1. Find the device identifier. For example, if you are using the subsystem device driver (SDD), the disk identifier is referred to as the virtual path (vpath) number. You can issue the following SDD command to find the vpath serial number:

```
datapath query device
```

For other multipathing drivers, refer to the documentation that is provided with your multipathing driver to determine the device identifier.

2. Find the host object that is defined to the SAN Volume Controller and corresponds with the host that you are working with.
 - a. Find the worldwide port numbers (WWPNs) by looking at the device definitions that are stored by your operating system. For example, on AIX the WWPNs are in the ODM and if you use Windows you have to go into the HBA Bios.
 - b. Verify which host object is defined to the SAN Volume Controller for which these ports belong. The ports are stored as part of the detailed view, so you must list each host by issuing the following CLI command:

```
svcinflshost name/id
```

Where *name/id* is the name or ID of the host.

- c. Check for matching WWPNs.

3. Issue the following command to list the VDisk-to-host mappings:

```
svcinfolshostvdiskmap hostname
```

Where *hostname* is the name of the host.
4. Find the VDisk UID that matches the device identifier and record the VDisk name or ID.

Determining the host that a VDisk is mapped to

You can determine the host that a virtual disk (VDisk) is mapped to using the command-line interface (CLI).

Perform the following steps to determine the host that the VDisk is mapped to:

1. Find the VDisk name or ID that you want to check.
2. Issue the following CLI command to list the hosts that this VDisk is mapped to:

```
svcinfolsvdiskhostmap vdiskname/id
```

Where *vdiskname/id* is the name or ID of the VDisk.
3. Find the host name or ID to determine which host this VDisk is mapped to.
 - If no data is returned, the VDisk is not mapped to any hosts.

Determining the relationship between VDIsks and MDisks using the CLI

You can determine the relationship between virtual disks (VDisks) and managed disks (MDisks) using the command-line interface (CLI).

Select one or more of the following options to determine the relationship between VDIsks and MDisks:

- To display a list of the IDs that correspond to the MDisks that comprise the VDisk, issue the following CLI command:

```
svcinfolsvdiskmember vdiskname/id
```

where *vdiskname/id* is the name or ID of the VDisk.
- To display a list of IDs that correspond to the VDIsks that are using this MDisk, issue the following CLI command:

```
svcinfolsmdiskmember mdiskname/id
```

where *mdiskname/id* is the name or ID of the MDisk.
- To display a table of VDisk IDs and the corresponding number of extents that are being used by each VDisk, issue the following CLI command:

```
svcinfolsmdiskextent mdiskname/id
```

where *mdiskname/id* is the name or ID of the MDisk.
- To display a table of MDisk IDs and the corresponding number of extents that each MDisk provides as storage for the given VDisk, issue the following CLI command:

```
svcinfolsvdiskextent vdiskname/id
```

where *vdiskname/id* is the name or ID of the VDisk.

Determining the relationship between MDisks and RAID arrays or LUNs using the CLI

You can determine the relationship between managed disks (MDisks) and RAID arrays or LUNs using the command-line interface (CLI).

Each MDisk corresponds with a single RAID array, or with a single partition on a given RAID array. Each RAID controller defines a LUN number for this disk. The LUN number and controller name or ID are needed to determine the relationship between MDisks and RAID arrays or partitions.

Perform the following steps to determine the relationship between MDisks and RAID arrays:

1. Issue the following command to display a detailed view of the MDisk:
`svcinfo lsmdisk mdiskname`
Where *mdiskname* is the name of the MDisk for which you want to display a detailed view.
2. Record the controller name or controller ID and the controller LUN number.
3. Issue the following command to display a detailed view of the controller:
`svcinfo lscontroller controllername`
Where *controllername* is the name of the controller that you recorded in step 2.
4. Record the vendor ID, product ID, and WWNN. You can use this information to determine what is being presented to the MDisk.
5. From the native user interface for the given controller, list the LUNs it is presenting and match the LUN number with that noted in step 1. This tells you the exact RAID array or partition that corresponds with the MDisk.

Increasing the size of your cluster using the CLI

You can increase throughput by adding more nodes to the cluster. The nodes must be added in pairs and assigned to a new I/O group.

Perform the following steps to increase the size of your cluster:

1. Add a node to your cluster and repeat this step for the second node.
2. If you want to balance the load between the existing I/O groups and the new I/O groups, you can migrate your virtual disks (VDisks) to new I/O groups. Repeat this step for all VDisks that you want to assign to the new I/O group.

Adding a node to increase the size of a cluster using the CLI

You can add a node to increase the size of a cluster using the command-line interface (CLI).

Attention: If you are adding a node that was previously removed from a cluster, ensure that you are adding the node to the same I/O group from which it was removed. Failure to do this can result in data corruption. If you do not know the I/O group name or ID that it was removed from, contact the IBM Support Center to add the node to the cluster without corrupting data.

Perform the following steps to add a node and increase the size of a cluster:

1. Issue the following command to verify that the node is detected on the fabric and to obtain the worldwide node names (WWNNs) of the nodes on the cluster:
`svcinfo lsnodecandidate`
2. Record the WWNN.
3. Issue the following command to determine the I/O group where the node should be added:
`svcinfo lsiogrp`

4. Record the name or ID of the first I/O group that has a node count of zero (0). You will need the ID for the next step.
5. Record the following information for future reference:
 - Node serial number.
 - Worldwide node name.
 - All of the worldwide port names.
 - The name or ID of the I/O group that contains the node.
6. Issue the following command to add the node to the cluster:


```
svctask addnode -wwnodename WWNN -iogrp newiogrpname/id [-name newnodename]
```

 Where *WWNN* is the WWNN of the node, *newiogrpname/id* is the name or ID of the I/O group that you want to add the node to and *newnodename* is the name that you want to assign to the node.
7. Issue the following command to verify that the node is online:


```
svcinfolnode
```

If the disk controller uses mapping to present RAID arrays or partitions to the cluster and the WWNNs or the worldwide port names have changed, you must modify the port groups that belong to the cluster.

Migrating a VDisk to a new I/O group using the CLI

You can use the command-line interface (CLI) to migrate a virtual disk (VDisk) to a new I/O group to increase the size of your cluster.

You can migrate a VDisk to a new I/O group to manually balance the workload across the nodes in the cluster. However, you might end up with a pair of nodes that are overworked and another pair that are not worked. Follow this procedure to migrate a single VDisk to a new I/O group. Repeat for other VDIs as required.

Attention: This is a disruptive procedure. Access to the VDisk is lost while you follow this procedure. Migration commands fail if the target or source VDisk is offline, or if there is insufficient quorum disk space to store the metadata. Correct the offline or quorum disk condition and reissue the command.

Perform the following steps to migrate a single VDisk:

1. Quiesce all I/O operations for the VDisk. You might have to determine the hosts that are using this VDisk in advance.
2. Before migrating the VDisk, it is essential that for each device identifier that is presented by the VDisk you intend to move, the subsystem device driver (SDD) or other multipathing driver configuration is updated to remove the device identifiers. Failure to do this can result in data corruption. See the *IBM System Storage Multipath Subsystem Device Driver User's Guide* or the documentation that is provided with your multipathing driver for details about how to dynamically reconfigure device identifiers for the given host operating system.
3. Issue the following command to check if the VDisk is part of a relationship or mapping:


```
svcinfolsvdisk vdiskname/id
```

 Where *vdiskname/id* is the name or ID of the VDisk.
 - a. Find the **FC_id** and **RC_id** fields. If these are not blank, the VDisk is part of a mapping or relationship.

- b. Stop or delete any FlashCopy mappings, Global Mirror, or Metro Mirror relationships that use this VDisk.
4. Issue the following command to migrate the VDisk:

```
svctask chvdisk -iogrp newiogrpname/id -node preferred_node vdiskname/id
```

where *preferred_node* is the name of the node that you want to move the VDisk, *newiogrpname/id* is the name or ID of the I/O group where you want to migrate the VDisk and *vdiskname/id* is the name or ID of the VDisk that you want to migrate.
5. Discover the new device identifiers and check that each device identifier presents the correct number of paths. See the *IBM System Storage Multipath Subsystem Device Driver User's Guide* or the documentation that is provided with your multipathing driver for details about how to discover device identifiers for the given host operating system.

Validating and repairing mirrored VDisk copies using the CLI

You can use the **repairvdiskcopy** command from the command-line interface (CLI) to validate and repair mirrored VDisk copies.

Attention: Run the **repairvdiskcopy** command only if all VDisk copies are synchronized.

When you issue the **repairvdiskcopy** command, you must use only one of the **-validate**, **-medium**, or **-resync** parameters. You must also specify the name or ID of the VDisk to be validated and repaired as the last entry on the command line. After you issue the command, no output is displayed.

-validate

Use this parameter if you only want to verify that the mirrored VDisk copies are identical. If any difference is found, the command stops and logs an error that includes the logical block address (LBA) and the length of the first difference. You can use this parameter, starting at a different LBA each time to count the number of differences on a VDisk.

-medium

Use this parameter to convert sectors on all VDisk copies that contain different contents into virtual medium errors. Upon completion, the command logs an event, which indicates the number of differences that were found, the number that were converted into medium errors, and the number that were not converted. Use this option if you are unsure what the correct data is, and you do not want an incorrect version of the data to be used.

-resync

Use this parameter to overwrite contents from the specified primary VDisk copy to the other VDisk copy. The command corrects any differing sectors by copying the sectors from the primary copy to the copies being compared. Upon completion, the command process logs an event, which indicates the number of differences that were corrected. Use this action if you are sure that either the primary VDisk copy data is correct or that your host applications can handle incorrect data.

-startlba lba

Optionally, use this parameter to specify the starting Logical Block Address (LBA) from which to start the validation and repair. If you previously used the **validate** parameter, an error was logged with the LBA where the first difference, if any, was found. Reissue **repairvdiskcopy** with that LBA to avoid

reprocessing the initial sectors that compared identically. Continue to reissue `repairvdiskcopy` using this parameter to list all the differences.

Issue the following command to validate and, if necessary, automatically repair mirrored copies of the specified VDisk:

```
svctask repairvdiskcopy -resync -startlba 20 vdisk8
```

Notes:

1. Only one **repairvdiskcopy** command can run on a VDisk at a time.
2. Once you start the **repairvdiskcopy** command, you cannot use the command to stop processing.
3. The primary copy of a mirrored VDisk cannot be changed while the **repairvdiskcopy -resync** command is running.
4. If there is only one mirrored copy, the command returns immediately with an error.
5. If a copy being compared goes offline, the command is halted with an error. The command is not automatically resumed when the copy is brought back online.
6. In the case where one copy is readable but the other copy has a medium error, the command process automatically attempts to fix the medium error by writing the read data from the other copy.
7. If no differing sectors are found during **repairvdiskcopy** processing, an informational error is logged at the end of the process.

Checking the progress of validation and repair of VDisk copies using the CLI

Use the `lsrepairvdiskcopyprogress` command to display the progress of mirrored VDisk validation and repairs. You can specify a VDisk copy using the **-copy id** parameter. To display the VDIsks that have two or more copies with an active task, specify the command with no parameters; it is not possible to have only one VDisk copy with an active task.

To check the progress of validation and repair of mirrored VDIsks, issue the following command:

```
svcinfolrepairvdiskcopyprogress -delim :
```

The following example shows how the command output is displayed:

```
vdisk_id:vdisk_name:copy_id:task:progress:estimated_completion_time
0:vdisk0:0:medium:50:070301120000
0:vdisk0:1:medium:50:070301120000
```

Repairing a space-efficient VDisk using the CLI

You can use the **repairsevdiskcopy** command from the command-line interface to repair the metadata on a space-efficient virtual disk (VDisk).

The **repairsevdiskcopy** command automatically detects and repairs corrupted metadata. The command holds the VDisk offline during the repair, but does not prevent the disk from being moved between I/O groups.

If a repair operation completes successfully and the volume was previously offline because of corrupted metadata, the command brings the volume back online. The only limit on the number of concurrent repair operations is the number of virtual disk copies in the configuration.

When you issue the **repairsevdiskcopy** command, you must specify the name or ID of the VDisk to be repaired as the last entry on the command line. Once started, a repair operation cannot be paused or cancelled; the repair can only be terminated by deleting the copy.

Attention: Use this command only to repair a space-efficient VDisk that has reported corrupt metadata.

Issue the following command to repair the metadata on a space-efficient VDisk:
`svctask repairsevdiskcopy vdisk8`

After you issue the command, no output is displayed.

Notes:

1. Because the volume is offline to the host, any I/O that is submitted to the volume while it is being repaired fails.
2. When the repair operation completes successfully, the corrupted metadata error is marked as fixed.
3. If the repair operation fails, the volume is held offline and an error is logged.

Checking the progress of the repair of a space-efficient VDisk using the CLI

Issue the `lsrepairsevdiskcopyprogress` command to list the repair progress for space-efficient VDisk copies of the specified VDisk. If you do not specify a VDisk, the command lists the repair progress for all space-efficient copies in the cluster.

Note: Only run this command after you run the `svctask repairsevdiskcopy` command, which you must only run as required by the Directed Maintenance Procedures or by IBM support.

Recovering from offline VDIsks using the CLI

If a node or an I/O group fails, you can use the command-line interface (CLI) to recover offline virtual disks (VDIsks).

If you have lost both nodes in an I/O group and have, therefore, lost access to all the VDIsks that are associated with the I/O group, you must perform one of the following procedures to regain access to your VDIsks. Depending on the failure type, you might have lost data that was cached for these VDIsks and the VDIsks are now offline.

Data loss scenario 1

One node in an I/O group has failed and failover has started on the second node. During the failover process, the second node in the I/O group fails before the data in the write cache is written to hard disk. The first node is successfully repaired but its hardened data is not the most recent version that is committed to the data

store; therefore, it cannot be used. The second node is repaired or replaced and has lost its hardened data, therefore, the node has no way of recognizing that it is part of the cluster.

Perform the following steps to recover from an offline VDisk when one node has down-level hardened data and the other node has lost hardened data:

1. Recover the node and add it back into the cluster.
2. Delete all FlashCopy, Metro Mirror, and Global Mirror mappings and relationships that use the offline VDisks.
3. Run the **recovervdisk**, **recovervdiskbyiogrp** or **recovervdiskbycluster** command.
4. Recreate all FlashCopy, Metro Mirror, and Global Mirror mappings and relationships that use the VDisks.

Data loss scenario 2

Both nodes in the I/O group have failed and have been repaired. The nodes have lost their hardened data, therefore, the nodes have no way of recognizing that they are part of the cluster.

Perform the following steps to recover from an offline VDisk when both nodes have lost their hardened data and cannot be recognized by the cluster:

1. Delete all FlashCopy, Metro Mirror, and Global Mirror mappings and relationships that use the offline VDisks.
2. Run the **recovervdisk**, **recovervdiskbyiogrp** or **recovervdiskbycluster** command.
3. Recreate all FlashCopy, Metro Mirror, and Global Mirror mappings and relationships that use the VDisks.

Recovering a node and returning it to the cluster using the CLI

After a node or an I/O group fails, you can use the command-line interface (CLI) to recover a node and return it to the cluster.

Perform the following steps to recover a node and return it to the cluster:

1. Issue the following command to verify that the node is offline:
`svcinflsnode`
2. Issue the following command to remove the old instance of the offline node from the cluster:
`svctask rmnode nodename/id`

Where *nodename/id* is the name or ID of the node.

3. Issue the following command to verify that the node can be seen on the fabric:
`svcinflsnodecandidate`

Note: Remember the worldwide node names (WWNNs) for each node because you will need them in the following step.

4. If the nodes are repaired by replacing the front panel module or a node is repaired by replacing it with another node, then the WWNN for the node will change. In this case, the following additional steps are required:
 - a. At the end of the recovery process, you must discover the new paths and check that each device identifier presents the correct number of paths. For

example, if you are using the system device driver (SDD), the device identifier is referred to as the virtual path (vpath) number. See the *IBM System Storage Multipath Subsystem Device Driver User's Guide* or the documentation that is provided with your multipathing driver for details about how to dynamically reconfigure and add device identifiers for the given host operating system.

- b. You might also need to modify the configuration of your disk controllers. If your controller uses a mapping technique to present its RAID arrays or partitions to the cluster, you must modify the port groups that belong to the cluster because the WWNN or WWPNS of the node have changed.

Attention: If more than one I/O group is affected, ensure that you are adding the node to the same I/O group from which it was removed. Failure to do this can result in data corruption. Use the information that was recorded when the node was originally added to the cluster. This can avoid a possible data corruption exposure if the node must be removed from and re-added to the cluster. If you do not have access to this information, call the IBM Support Center to add the node back into the cluster without corrupting the data. If you are adding the node into the cluster for the first time, you must record the following information:

- Node serial number
 - WWNN
 - All WWPNS
 - I/O group that contains the node
5. Issue the following command to add the node back into the cluster:

```
svctask addnode -wwnname WWNN -iogrp  
IOGRPNAME/ID [-name NODENAME]
```

Where *WWNN* is the worldwide node name, *IOGRPNAME/ID* is the I/O group name or ID and *NODENAME* is the name of the node.

6. Issue the following command to verify that the node is online:

```
svcinfolnode
```

Recovering offline VDisks using the CLI

You can recover offline virtual disks (VDisks) using the command-line interface (CLI).

Perform the following steps to recover offline VDisks:

1. Issue the following CLI command to list all VDisks that are offline and belong to an I/O group, enter:

```
svcinfolsvdisk -filtervalue IO_group_name=  
IOGRPNAME/ID:status=offline
```

where *IOGRPNAME/ID* is the name of the I/O group that failed.

2. To acknowledge data loss for a VDisk with a *fast_write_state* of **corrupt** and bring the VDisk back online, enter:

```
svctask recovervdisk vdisk_id | vdisk_name
```

where *vdisk_id* | *vdisk_name* is the name or ID of the VDisk.

Notelist:

- If the specified VDisk is space-efficient or has space-efficient copies, the **recovervdisk** command starts the space-efficient repair process.

- If the specified VDisk is mirrored, the **recovervdisk** command starts the resynchronization process.
3. To acknowledge data loss for all virtual disks in an I/O group with a *fast_write_state* of **corrupt** and bring them back online, enter:


```
svctask recovervdiskbyiogrp io_group_id | io_group_name
```

 where *io_group_id* | *io_group_name* is the name or ID of the I/O group.

Notelist:

- If any VDisk is space-efficient or has space-efficient copies, the **recovervdiskbyiogrp** command starts the space-efficient repair process.
 - If any VDisk is mirrored, the **recovervdiskbyiogrp** command starts the resynchronization process.
4. To acknowledge data loss for all VDIs in the cluster with a *fast_write_state* of **corrupt** and bring them back online, enter:


```
svctask recovervdiskbycluster
```

Notelist:

- If any VDisk is space-efficient or has space-efficient copies, the **recovervdiskbycluster** command starts the space-efficient repair process.
- If any VDisk is mirrored, the **recovervdiskbycluster** command starts the resynchronization process.

Moving offline VDIs to their original I/O group using the CLI

You can move offline virtual disks (VDIs) to their original I/O group using the command-line interface (CLI).

Beginning with SAN Volume Controller 4.3.1, the recovery I/O group is no longer used for VDisk recovery, but it is possible that VDIs were moved to the I/O group before the upgrade.

After a node or an I/O group fails, you can use the following procedure to move offline VDIs to their original I/O group.

Attention: Do not move VDIs to an offline I/O group. Ensure that the I/O group is online before you move the VDIs back to avoid any further data loss.

Perform the following steps to move offline VDIs to their original I/O group:

1. Issue the following command to move the VDisk back into the original I/O group:

```
svctask chvdisk -iogrp IOGRPNAME/ID -force
vdiskname/ID
```

where *IOGRPNAME/ID* is the name or ID of the original I/O group and *vdiskname/ID* is the name or ID of the offline VDisk.

2. Issue the following command to verify that the VDIs are now online:

```
svcinfolsvdisk -filtervalue IO_group_name=
IOGRPNAME/ID
```

where *IOGRPNAME/ID* is the name or ID of the original I/O group.

Informing the SAN Volume Controller of changes to host HBAs using the CLI

You can use the command-line interface (CLI) to inform the SAN Volume Controller of a change to a defined host object.

Because it is sometimes necessary to replace the HBA that connects the host to the SAN, you must inform the SAN Volume Controller of the new worldwide port names (WWPNs) that this HBA contains.

Ensure that your switch is zoned correctly.

Perform the following steps to inform the SAN Volume Controller of a change to a defined host object:

1. Issue the following CLI command to list the candidate HBA ports:

```
svcinfolshbaportcandidate
```

You should see a list of the HBA ports that are available for addition to host objects. One or more of these HBA ports should correspond with the one or more WWPNs that belong to the new HBA port.

2. Locate the host object that corresponds with the host in which you have replaced the HBA. The following CLI command lists all the defined host objects:

```
svcinfolshost
```

3. Issue the following CLI command to list the WWPNs that are currently assigned to the host object:

```
svcinfolshost hostobjectname
```

where *hostobjectname* is the name of the host object.

4. Issue the following CLI command to add the new ports to the existing host object:

```
svctask addhostport -hbawwpn one or more existing WWPNs separated by : hostobjectname/ID
```

where *one or more existing WWPNs separated by :* is the WWPNs that are currently assigned to the host object and *hostobjectname/ID* is the name or ID of the host object.

5. Issue the following CLI command to remove the old ports from the host object:

```
svctask rmhostport -hbawwpn one or more existing WWPNs separated by : hostobjectname/ID
```

where *one or more existing WWPNs separated by :* is the WWPNs that are currently assigned to the host object and *hostobjectname/ID* is the name or ID of the host object.

Any mappings that exist between the host object and the virtual disks (VDisks) are automatically applied to the new WWPNs. Therefore, the host sees the VDisks as the same SCSI LUNs as before.

See the *IBM System Storage Multipath Subsystem Device Driver User's Guide* or the documentation that is provided with your multipathing driver for additional information about dynamic reconfiguration.

Expanding VDisks

You can use the command-line interface (CLI) or the SAN Volume Controller Console to expand a virtual disk (VDisk).

VDisks that are mapped for FlashCopy or that are in Metro Mirror relationships cannot be expanded.

Ensure that you have run Windows Update and have applied all recommended updates to your system before you attempt to expand a VDisk that is mapped to a Windows host.

Determine the exact size of the source or master VDisk by issuing the following CLI command:

```
svcinfo lsvdisk -bytes vdiskname
```

where *vdiskname* is the name of the VDisk for which you want to determine the exact size.

VDisks can be expanded under Windows concurrently with I/O operations.

You can expand VDisks for the following reasons:

- To increase the available capacity on a particular VDisk that is already mapped to a host.
- To increase the size of a VDisk so that it matches the size of the source or master VDisk and so that it can be used in a FlashCopy mapping or Metro Mirror relationship.

A VDisk that is not mapped to any hosts and does not contain any data can be expanded at any time. If the VDisk contains data that is in use, you can expand the VDisks if your host has a supported AIX or Microsoft Windows operating system.

The following table provides the supported operating systems and requirements for expanding VDisks that contain data:

Operating system	Supported	Requirement
AIX	Yes	AIX version 5.2 or later
HP-UX	No	-
Linux	No	-
SUN Solaris	No	-
Microsoft Windows NT®	No	-
Microsoft Windows	Yes	Windows version 2000 or later

Expanding a VDisk that is mapped to an AIX host

The SAN Volume Controller supports the ability to dynamically expand the size of a virtual disk (VDisk) if the AIX host is using AIX version 5.2 or later.

The **chvg** command options provide the ability to expand the size of a physical volume that the Logical Volume Manager (LVM) uses, without interruptions to the use or availability of the system. See the *AIX System Management Guide Operating System and Devices* for more information.

Expanding a VDisk that is mapped to a Windows host using the CLI

You can use the command-line interface (CLI) to dynamically expand the size of a virtual disk (VDisk) that is mapped to a Microsoft Windows host.

Perform the following steps to expand a VDisk that is mapped to a Windows host:

1. Issue the following CLI command to expand the VDisk:

```
svctask expandvdisksize -size disk_size -unit  
b | kb | mb | gb | tb | pb vdisk_name/vdisk_id
```

where *disk_size* is the capacity by which you want to expand the VDisk, *b* | *kb* | *mb* | *gb* | *tb* | *pb* is the data unit to use in conjunction with the capacity and *vdisk_name/vdisk_id* is the name of the VDisk or the ID of the VDisk to expand.

2. On the Windows host, start the Computer Management application and open the Disk Management window under the Storage branch.

You will see the VDisk that you expanded now has some unallocated space at the end of the disk.

You can expand dynamic disks without stopping I/O operations in most cases. However, in some applications the operating system might report I/O errors. When this problem occurs, either of the following entries might be recorded in the System event log:

```
Event Type: Information  
Event Source: dmio  
Event Category: None  
Event ID: 31  
Description: dmio:  
Harddisk0 write error at block ##### due to  
disk removal
```

```
Event Type: Information  
Event Source: dmio  
Event Category: None  
Event ID: 34  
Description: dmio:  
Harddisk0 is re-online by PnP
```

Attention: This is a known problem with Windows 2000 and is documented in the Microsoft knowledge base as article Q327020. If either of these errors are seen, run Windows Update and apply the recommended fixes to resolve the problem.

If the Computer Management application was open before you expanded the VDisk, use the Computer Management application to issue a rescan command.

If the disk is a Windows basic disk, you can create a new primary or extended partition from the unallocated space.

If the disk is a Windows dynamic disk, you can use the unallocated space to create a new volume (simple, striped, mirrored) or add it to an existing volume.

Shrinking a virtual disk using the CLI

You can reduce the size of a virtual disk (VDisk) using the command-line interface (CLI).

VDisks can be reduced in size, if it is necessary. You can make a target or auxiliary VDisk the same size as the source or master VDisk when you create FlashCopy[®] mappings, Metro Mirror relationships, or Global Mirror relationships. However, if the VDisk contains data, do not shrink the size of the disk.

Attention:

1. The SAN Volume Controller arbitrarily reduces the capacity of the VDisk by removing one or more extents from those that are allocated to the VDisk. You cannot control which extents are removed so you cannot guarantee that it is unused space that is removed.
2. If the VDisk contains data that is being used, *do not attempt under any circumstances to shrink a VDisk without first backing up your data.*
3. For performance reasons, some operating systems or file systems use the outer edge of the disk.

You can use the **shrinkvdisksize** command to shrink the physical capacity that is allocated to the particular VDisk by the specified amount. You can also shrink the virtual capacity of a space-efficient VDisk without altering the physical capacity assigned to the VDisk.

For more information about the command parameters, see the *IBM System Storage SAN Volume Controller Command-Line Interface User's Guide*.

Perform the following steps to shrink a VDisk:

1. Validate that the VDisk is not mapped to any host objects. If the VDisk is mapped, data is displayed.
2. You can determine the exact capacity of the source or master VDisk. Issue the following command:

```
svcinfolsvdisk -bytes vdiskname
```

3. Shrink the VDisk by the required amount. Issue the following command:

```
svctask shrinkvdisksize -size capacitytoshrinkby -unit  
unitsforreduction vdiskname/ID
```

Migrating extents using the CLI

To improve performance, you can migrate extents using the command-line interface (CLI).

The SAN Volume Controller provides various data migration features. These can be used to move the placement of data both *within* MDisk groups and *between* MDisk groups. These features can be used concurrently with I/O operations. There are two ways in which you can migrate data:

1. Migrating data (extents) from one MDisk to another (within the same MDisk group). This can be used to remove hot or overutilized MDisks.
2. Migrating VDIs from one MDisk group to another. This can be used to remove hot MDisk groups. For example, you can reduce the utilization of a group of MDisks.

3. Migration commands fail if the target or source VDisk is offline, or if there is insufficient quorum disk space to store the metadata. Correct the offline or quorum disk condition and reissue the command.

Notes:

1. The source MDisk must not currently be the source MDisk for any other migrate extents operation.
2. The destination MDisk must not be the destination MDisk for any other migrate extents operation.

You can determine the usage of particular MDisks by gathering I/O statistics about MDisks and VDIs. Once you have gathered this data, you can analyze it to determine which MDisks are hot. The procedure then takes you through querying and migrating extents to elsewhere in the same MDisk group. This procedure can only be performed using the command line tools.

To migrate extents to remove possible problems, perform the following:

1. Isolate any MDisks that are overutilized. You can determine this by requesting an I/O statistics dump and analyzing the output. To start I/O statistics gathering, issue the following CLI command:

```
svctask startstats -interval 15
```

This command generates a new I/O statistics dump file approximately every 15 minutes.

2. Wait for at least 15 minutes after issuing the **svctask startstats** CLI command and then issue the following CLI command:

```
svcinfo lsiostatsdumps
```

This command lists the I/O statistics files that have been generated. These are prefixed with *m* and *Nm* for MDisk statistics and *v* for VDisk statistics.

3. Use secure copy (*scp*) to retrieve the dumps files for analysis. For example, issue the following AIX CLI command:

```
scp clusterip:/dumps/iostats/m_*
```

This command copies all the MDisk statistics files to the AIX host in the current directory.

4. Analyze the dumps to determine which MDisks are hot. You can also determine which VDIs are being heavily utilized so that you can spread data more evenly across all the MDisks in the group.
5. Stop the statistics collection by issuing the following CLI command:

```
svctask stopstats
```

After you have determined the MDisks that are hot, you can migrate some of the data onto other MDisks within the same MDisk group.

1. Determine the number of extents that are in use by each VDisk for the given MDisk by issuing the following CLI command:

```
svcinfo lsmdiskextent mdiskname
```

This command returns the number of extents that each VDisk is using on the given MDisk. You should pick some of these to migrate elsewhere in the group.

2. Determine the other MDisks that reside in the same MDisk group.

- a. To determine the MDisk group that the MDisk belongs to, issue the following CLI command:

```
svcinfolsmdisk mdiskname | ID
```

- b. List the MDisks in the group by issuing the following CLI command:

```
svcinfolsmdisk -filtervalue mdisk_grp_name=mdiskgrpname
```

3. Select one of these MDisks as the target MDisk for the extents. You can determine how many free extents exist on an mdisk by issuing the following CLI command:

```
svcinfolsfreeextents mdiskname
```

You can issue the **svcinfolsmdiskextent *newmdiskname*** command for each of the target MDisks to ensure that you are not just moving the over-utilization to another MDisk. Check that the VDisk that owns the set of extents to be moved does not already own a large set of extents on the target MDisk.

4. For each set of extents, issue the following CLI command to move them to another MDisk:

```
svctask migrateexts -source mdiskname | ID -exts num_extents  
-target newmdiskname | ID -threads 4 vdiskid
```

Where *num_extents* is the number of extents on the *vdiskid*. The *newmdiskname* | *ID* value is the name or ID of the MDisk to migrate this set of extents to.

Note: The number of threads indicates the priority of the migration processing, where 1 is the lowest priority and 4 is the highest priority.

5. Repeat the previous steps for each set of extents that you are moving.
6. You can check the progress of the migration by issuing the following CLI command:

```
svcinfolsmigrate
```

Migrating VDisks between MDisk groups using the CLI

You can migrate virtual disks (VDisks) between managed disk (MDisk) groups using the command-line interface (CLI).

You can determine the usage of particular MDisks by gathering input/output (I/O) statistics about MDisks and VDisks. After you have gathered this data, you can analyze it to determine which VDisks or MDisks are hot. You can then migrate VDisks from one MDisk group to another.

Perform the following steps to gather statistics about MDisks and VDisks:

1. Isolate any VDisks that are overused. You can determine this by requesting an I/O statistics dump and analyzing the output.

To start I/O statistics gathering, issue the following CLI command:

```
svctask startstats -interval 15
```

This command generates a new I/O statistics dump file approximately every 15 minutes.

2. Wait for at least 15 minutes after issuing the **svctask startstats** command and then issue the following command:

```
svcinfolsiostatsdumps
```

This command lists the I/O statistics files are generated. These files are prefixed with **m** and **Nm** for MDisk statistics and **v** for VDisk statistics.

3. Use secure copy (**scp** command) to retrieve the dump files for analyzing. For example, issue the following:

```
scp clusterip:/dumps/iostats/v_*
```

This copies all the VDisk statistics files to the AIX host in the current directory.

4. Analyze the dumps to determine which VDIs are hot. It might be helpful to also determine which MDIs are being used heavily as you can spread the data that they contain more evenly across all the MDIs in the group by migrating the extents.
5. Stop the statistics collection again. Issue the following command:

```
svctask stopstats
```

After you analyze the I/O statistics data, you can determine which VDIs are hot. You also need to determine the MDisk group that you want to move this VDisk to. Either create a new MDisk group or determine an existing group that is not yet overly used. To do this, check the I/O statistics files that you generated and then ensure that the MDIs or VDIs in the target MDisk group are used less than those in the source group.

You can use data migration or VDisk mirroring to migrate data between MDisk groups. Data migration uses the command **svctask migratevdisk**. VDisk mirroring uses the commands **svctask addvdiskcopy** and **svctask rmvdiskcopy**.

When you issue the **svctask migratevdisk** command, a check is made to ensure that the destination of the migration has enough free extents to satisfy the command. If it does, the command proceeds. The command takes some time to complete.

Notelist:

- You cannot use the SAN Volume Controller data migration function to move a VDisk between MDisk groups that have different extent sizes.
- Migration commands fail if the target or source VDisk is offline, or if there is insufficient quorum disk space to store the metadata. Correct the offline or quorum disk condition and reissue the command.

When you use data migration, it is possible for the free destination extents to be consumed by another process; for example, if a new VDisk is created in the destination MDisk group or if more migration commands are started. In this scenario, after all the destination extents are allocated, the migration commands suspend and an error is logged (error ID 020005). To recover from this situation, use either of the following methods:

- Add additional MDIs to the target MDisk group. This provides additional extents in the group and allows the migrations to be restarted. You must mark the error as fixed before you reattempt the migration.
- Migrate one or more VDIs that are already created from the MDisk group to another group. This frees up extents in the group and allows the original migrations to be restarted.

Perform the following steps to use the **svctask migratevdisk** command to migrate VDIs between MDisk groups:

1. After you determine the VDisk that you want to migrate and the new MDisk group you want to migrate it to, issue the following CLI command:

```
svctask migratevdisk -vdisk vdiskname/ID -mdiskgrp
newmdiskgrname/ID -threads 4
```
2. You can check the progress of the migration by issuing the following CLI command:

```
svcinfolsmigrate
```

When you use data migration, the VDisk goes offline if either MDisk group fails. VDisk mirroring can be used to minimize the impact to the VDisk because the VDisk goes offline only if the source MDisk group fails.

Perform the following steps to use VDisk mirroring to migrate VDIs between MDisk groups:

1. After you determine the VDisk that you want to migrate and the new MDisk group that you want to migrate it to, issue the following command:

```
svctask addvdiskcopy -mdiskgrp newmdiskgrname/ID vdiskname/ID
```
2. The copy ID of the new copy is returned. The copies now synchronize such that the data is stored in both MDisk groups. You can check the progress of the synchronization by issuing the following command:

```
svcinfolsvdisksyncprogress
```
3. After the synchronization is complete, remove the copy from the original I/O group to free up extents and decrease the utilization of the MDisk group. To remove the original copy, issue the following command:

```
svctask rmdiskcopy -copy original copy id vdiskname/ID
```

Migrating a VDisk between I/O groups using the CLI

Ensure that you are familiar with migrating a virtual disk (VDisk) between I/O groups.

Attention:

- These migration tasks are disruptive. The cached data that is held within the cluster must first be written to disk before the allocation of the VDisk can be changed.
- Migration commands fail if the target or source VDisk is offline, or if there is insufficient quorum disk space to store the metadata. Correct the offline or quorum disk condition and reissue the command.

Modifying the I/O group that services the VDisk cannot be done concurrently with I/O operations. It also requires a rescan at the host level to ensure that the multipathing driver is notified that the allocation of the preferred node has changed and the ports by which the VDisk is accessed has changed. This should only be done in the situation where one pair of nodes has become over utilized.

Perform the following steps to migrate a VDisk between I/O groups:

1. Synchronize all file systems that are mounted on the given VDisk.
2. Stop all I/O operations to the VDisk.
3. Issue the following CLI command to migrate the VDisk into a new I/O group:

```
svctask chvdisk -iogrp iogrp_name_or_id -node preferred_node vdisk
```

where *iogrp_name_or_id* is the name or ID of the I/O group that you want to migrate the VDisk to, *preferred_node* is the name of the node that you want to move the VDisk to, and *vdisk* is the name of the VDisk that you want to migrate.

4. Resynchronize the VDisk to host mapping. See the *IBM System Storage Multipath Subsystem Device Driver User's Guide* or the documentation that is provided with your multipathing driver for more information.
5. Restart the I/O operations to the VDisk.

Creating an image mode VDisk using the CLI

You can use the command-line interface (CLI) to import storage that contains existing data and continue to use this storage. You can also use the advanced functions, such as Copy Services, data migration, and the cache. These disks are known as image mode virtual disks (VDisks).

Make sure you are aware of the following before you create image mode VDisks:

1. Unmanaged-mode managed disks (MDisks) that contain existing data cannot be differentiated from unmanaged-mode MDisks that are blank. Therefore, it is vital that you control the introduction of these MDisks to the cluster by adding these disks one at a time. For example, map a single LUN from your RAID controller to the cluster and refresh the view of MDisks. The newly detected MDisk is displayed.
2. *Do not* manually add an unmanaged-mode MDisk that contains existing data to an MDisk group. If you do, the data is lost. When you use the command to convert an image mode VDisk from an unmanaged-mode disk, you will select the MDisk group where it should be added.

See the following Web site for more information:

www.ibm.com/storage/support/2145

For complete instructions on the CLI commands, see the *IBM System Storage SAN Volume Controller Command-Line Interface User's Guide*.

Perform the following steps to create an image mode VDisk:

1. Stop all I/O operations from the hosts. Unmap the logical disks that contain the data from the hosts.
2. Create one or more MDisk groups.
3. Map a single RAID array or logical unit from your RAID controller to the cluster. You can do this through a switch zoning or a RAID controller based on your host mappings. The array or logical unit appears as an unmanaged-mode MDisk to the SAN Volume Controller.
4. Issue the **svcinfolsmdisk** command to list the unmanaged-mode MDisks.
If the new unmanaged-mode MDisk is not listed, you can perform a fabric-level discovery. Issue the **svctask detectmdisk** command to scan the fibre-channel network for the unmanaged-mode MDisks.

Note: The **svctask detectmdisk** command also rebalances MDisk access across the available controller device ports.

5. Convert the unmanaged-mode MDisk to an image mode virtual disk. Issue the **svctask mkvdisk** command to create an image mode virtual disk object.
6. Map the new VDisk to the hosts that were previously using the data that the MDisk now contains. You can use the **svctask mkvdiskhostmap** command to

create a new mapping between a VDisk and a host. This makes the image mode VDisk accessible for I/O operations to the host.

After the VDisk is mapped to a host object, the VDisk is detected as a disk drive with which the host can perform I/O operations.

If you want to virtualize the storage on an image mode VDisk, you can transform it into a striped VDisk. Migrate the data on the image mode VDisk to managed-mode disks in another MDisk group. Issue the **svctask migratevdisk** command to migrate an entire image mode VDisk from one MDisk group to another MDisk group.

Migrating to an image mode virtual disk using the CLI

You can use the command-line interface (CLI) to migrate data to an image mode virtual disk (VDisk).

The **svctask migratetoimage** CLI command allows you to migrate the data from an existing VDisk onto a different managed disk (MDisk).

When the **svctask migratetoimage** CLI command is issued, it migrates the data of the user specified source VDisk onto the specified target MDisk. When the command completes, the VDisk is classified as an image mode VDisk.

Note: Migration commands fail if the target or source VDisk is offline, or if there is insufficient quorum disk space to store the metadata. Correct the offline or quorum disk condition and reissue the command.

The MDisk specified as the target must be in an unmanaged state at the time the command is run. Issuing this command results in the inclusion of the MDisk into the user specified MDisk group.

Issue the following CLI command to migrate data to an image mode VDisk:

```
svctask migratetoimage -vdisk vdiskname/ID
  -mdisk newmdiskname/ID -mdiskgrp newmdiskgrpname/ID
  -threads 4
```

where *vdiskname/ID* is the name or ID of the VDisk, *newmdiskname/ID* is the name or ID of the new MDisk, and *newmdiskgrpname/ID* is the name or ID of the new MDisk group.

Deleting a node from a cluster using the CLI

You can use the command-line interface (CLI) to remove a node from a cluster.

After the node is deleted, the other node in the I/O group enters write-through mode until another node is added back into the I/O group.

By default, the **rmnode** command flushes the cache on the specified node before taking the node offline. In some circumstances, such as when the system is already degraded (for example, when both nodes in the I/O group are online and the virtual disks within the I/O group are degraded), the system ensures that data loss does not occur as a result of deleting the only node with the cache data.

To take the specified node offline immediately without flushing the cache or ensuring data loss does not occur, run the **rmnode** command with the **-force** parameter using the SAN Volume Controller CLI.

Attention:

- If you are removing a single node and the remaining node in the I/O group is online, the data can be exposed to a single point of failure if the remaining node fails.
- If both nodes in the I/O group are online and the VDisks are already degraded prior to deleting the node, redundancy to the VDisks is already degraded and loss of access to data and loss of data might occur if the **-force** option is used.
- Removing the last node in the cluster destroys the cluster. Before you delete the last node in the cluster, ensure that you want to destroy the cluster.
- The **-force** option should be used with caution. For more information, see the *IBM System Storage SAN Volume Controller Command-Line Interface User's Guide*.

Perform the following steps to delete a node:

1. Determine the VDisks that are still assigned to this I/O group:
 - a. Issue the following CLI command to request a filtered view of the VDisks:

```
svcinfo lsvdisk -filtervalue IO_group_name=name
```

Where *name* is the name of the I/O group.
 - b. Issue the following CLI command to list the hosts that this VDisk is mapped to:

```
svcinfo lsvdiskhostmap vdiskname/id
```

Where *vdiskname/id* is the name or ID of the VDisk.
- If VDisks are assigned to this I/O group that contain data that you want to continue to access, back up the data or migrate the VDisks to a different (online) I/O group.
2. If this is *not* the last node in the cluster, turn the power off to the node that you intend to remove. This step ensures that the multipathing device driver, such as the subsystem device driver (SDD), does not rediscover the paths that are manually removed before you issue the delete node request.

Attention:

- a. If you are removing the configuration node, the **rmnode** command causes the configuration node to move to a different node within the cluster. This process may take a short time, typically less than a minute. The cluster IP address remains unchanged, but any SSH client attached to the configuration node might need to reestablish a connection. The SAN Volume Controller Console reattaches to the new configuration node transparently.
 - b. If you turn on the power to the node that has been removed and it is still connected to the same fabric or zone, it attempts to rejoin the cluster. At this point, the cluster causes the node to remove itself from the cluster and the node becomes a candidate for addition to this cluster or another cluster.
 - c. If you are adding this node into the cluster, ensure that you add it to the same I/O group that it was previously a member of. Failure to do so can result in data corruption.
3. Before you delete the node, update the multipathing device driver configuration on the host to remove all device identifiers that are presented by the VDisk that you intend to remove. If you are using the subsystem device driver (SDD), the device identifiers are referred to as virtual paths (vpaths).

Attention: Failure to perform this step can result in data corruption.

See the *IBM System Storage Multipath Subsystem Device Driver User's Guide* for details about how to dynamically reconfigure SDD for the given host operating system.

4. Issue the following CLI command to delete a node from the cluster:

```
svctask rmnode node_name_or_id
```

Where *node_name_or_id* is the name or ID of the node.

Performing the cluster maintenance procedure using the CLI

You can use the command-line interface (CLI) to perform the cluster maintenance procedure.

Perform the following steps for cluster maintenance:

1. Issue the `svctask finderr` command to analyze the error log for the highest severity of unfixed errors. This command scans the error log for any unfixed errors. Given a priority ordering defined within the code, the highest priority of unfixed errors is returned.
2. Issue the `svctask dumperrlog` command to dump the contents of the error log to a text file.
3. Locate and fix the error.
4. Issue the `svctask clearerrlog` command to clear all entries from the error log, including status events and any unfixed errors. Only issue this command when you have either rebuilt the cluster or have fixed a major problem that has caused many entries in the error log that you do not want to fix individually.

Note: Clearing the error log does not fix the errors.

5. Issue the `svctask cherrstate` command to toggle the state of an error between unfixed and fixed.

Modifying the cluster IP addresses using the CLI

You can use the command-line interface (CLI) to change the IP addresses that are associated with a cluster.

Attention: When you specify a new IP address for a cluster, the existing communication with the cluster is broken. You must reconnect to the cluster with the new IP address.

Perform the following steps to change the cluster IP address:

1. Issue the `svcinfo lscluster` command to list the current IP addresses that are used by the cluster.
2. Record the current IP addresses for future reference.
3. To change an IPv4 cluster IP address, issue the following command:

```
svctask chcluster -clusterip cluster_ip_address
```

where *cluster_ip_address* is the new IP address for the cluster.
4. To change an IPv4 cluster IP address to an IPv6 cluster IP address, issue the following command:

```
svctask chcluster -clusterip_6 cluster_ip_address
```

where *cluster_ip_address* is the new IPv6 address for the cluster.
5. Issue the following command to change an IPv4 cluster gateway address:

- ```
svctask chcluster -gw cluster_gateway_address
```
- where *cluster\_gateway\_address* is the new gateway address for the cluster.
6. Issue the following command to change an IPv6 cluster gateway address:

```
svctask chcluster -gw_6 cluster_gateway_address
```

where *cluster\_gateway\_address* is the new gateway address for the cluster.
  7. Issue the following command to change an IPv4 cluster subnet mask:

```
svctask chcluster -mask cluster_subnet_mask
```

where *cluster\_subnet\_mask* is the new subnet mask for the cluster.
  8. For IPv6 addresses, you can issue the following command to set the network prefix for the cluster:

```
svctask chcluster -prefix_6 network_prefix
```

where *network\_prefix* is the new prefix.
  9. Optionally, if you want to delete all of the IPv4 addresses in the cluster after you have changed all addresses to IPv6, issue the following command:

```
svctask chcluster -rmip
```
  10. Optionally, if you want to delete all of the IPv6 addresses in the cluster after you have changed all addresses to IPv4, issue the following command:

```
svctask chcluster -rmip_6
```

See the *IBM System Storage SAN Volume Controller Command-Line Interface User's Guide* for more information on the **svctask chcluster** command.

---

## Changing the cluster gateway address using the CLI

You can use the command-line interface (CLI) to change the gateway address for a cluster.

Perform the following steps to change the cluster gateway address:

1. Issue the **svcinfo lscluster** command to list the current gateway address of the cluster.
2. Record the current gateway address for future reference.
3. Issue the following command to change an IPv4 cluster gateway address:

```
svctask chcluster -gw cluster_gateway_address
```

where *cluster\_gateway\_address* is the new gateway address for the cluster.
4. Issue the following command to change an IPv6 cluster gateway address:

```
svctask chcluster -gw_6 cluster_gateway_address
```

where *cluster\_gateway\_address* is the new gateway address for the cluster.

See the *IBM System Storage SAN Volume Controller Command-Line Interface User's Guide* for more information on the **svctask chcluster** command.

---

## Changing the subnet mask for an IPv4 cluster using the CLI

You can use the command-line interface (CLI) to change the subnet mask for an IPv4 cluster.

Perform the following steps to change the cluster subnet mask:

1. Issue the **svcinfo lscluster** command to list the current subnet mask of the cluster.
2. Record the current subnet mask for future reference.

- Issue the following command to change the cluster subnet mask:  

```
svctask chcluster -mask cluster_subnet_mask
```

 Where *cluster\_subnet\_mask* is the new subnet mask for the cluster.

## Maintaining SSH keys using the CLI

You can use the command-line interface (CLI) to maintain SSH keys.

**Attention:** After you add a cluster, close the Maintaining SSH Keys panel.

Perform the following steps to maintain SSH keys:

- Issue the **svcinfo lsshkeys** CLI command to list the SSH keys that are available on the cluster.
- Issue the **svctask addsshkey** CLI command to install a new SSH key on the cluster. The key file must first be copied onto the cluster. Each key is associated with an ID string that you define that can consist of up to 30 characters. Up to 100 keys can be stored on a cluster. You can add keys to provide either administrator access or service access. For example, issue the following:

```
svctask addsshkey -user service -file /tmp/id_rsa.pub
-label testkey
```

Where */tmp/id\_rsa.pub* is the name of the file that the SSH key will be saved in and *testkey* is the label to associate with this key.

- You can issue the **svctask rmsshkey** CLI command to remove an SSH key from the cluster.
- You can issue the **svctask rmallsshkeys** CLI command to remove all of the SSH keys from the cluster.

## Setting up SNMP error notifications using the CLI

You can set up error notifications using the command-line interface (CLI).

The error notification settings apply to the entire cluster. You can specify the types of errors that cause the cluster to send a notification. The cluster sends a Simple Network Management Protocol (SNMP) notification. The SNMP setting represents the kind of error.

The following table describes the three types of SNMP notification:

| Notification type    | Description                                                                              |
|----------------------|------------------------------------------------------------------------------------------|
| <b>All</b>           | Report all errors at or above the threshold limit, including information events.         |
| <b>Hardware Only</b> | Report all errors at or above the threshold limit, excluding information events.         |
| <b>None</b>          | Do not report any errors or information events. This option disables error notification. |

If you specify **All** or **Hardware Only**, errors are reported to the SNMP destinations of your choice. To specify an SNMP destination, you *must* provide a valid IP address and SNMP community string.

**Note:** A valid community string can contain up to 60 letters or digits, without any spaces. A maximum of six SNMP destinations can be specified. When you

create the cluster or enable error notification for the first time, you are asked to specify only one SNMP destination. You can add five additional destinations by using the Error Notification options.

The SAN Volume Controller uses the error notifications settings to call home if errors occur. You must specify **All** or **Hardware Only** and send the trap to the IBM System Storage Productivity Center or the master console if you want the SAN Volume Controller to call home when errors occur.

Perform the following step to configure the error-notification settings:

Issue the **svctask setevent** CLI command to specify the action that you want to take when an error or event is logged to the error log. You can select if the cluster raises an SNMP trap. For example, you can issue one of the following CLI commands to set up error notification:

```
svctask setevent -snmptrap all or hardware_only
-snmpip 9.11.255.634,9.11.265.635 -community mysancommunity,myothersancommunity
```

where **all** or **hardware\_only** is the type of SNMP notification that you want to set, **9.11.255.634,9.11.265.635** are the IP addresses of the host systems that are running the SNMP manager software, and **mysancommunity,myothersancommunity** are the SNMP community strings that you want to use.

```
svctask setevent -snmptrap none
```

where **none** indicates that you do not want to report any errors or information events.

---

## Setting up e-mail notifications for errors and inventory events using the CLI

You can use the command-line interface (CLI) to set up your system to send error notification and inventory reports to the IBM Support Center.

See the *IBM System Storage SAN Volume Controller Command-Line Interface User's Guide* for information about the parameters that are used for these commands.

Perform the following steps to set up, manage, and activate e-mail error and inventory notifications:

1. Enable your system to use the e-mail notification function. To do this, issue the **svctask setemail** CLI command.

The following example enables e-mail error and inventory notifications and specifies the IP address, port number, and physical location of the SMTP e-mail server. It also specifies a contact phone number, name, and e-mail address. After you issue the command, no output is displayed.

```
svctask setemail -serverip 9.20.153.255 -port 25 -primary 01234567890
-contact 'manager2008' -reply manager2008@ibm.com
-location 'room 256 floor 1 IBM'
```

2. Add e-mail recipients of error and inventory notifications. To do this, issue the **svctask mkemailuser** CLI command. You can add up to twelve recipients, one recipient at a time.

The following example adds e-mail recipient **manager2008** and designates that **manager2008** receive e-mail notifications that contain all error types.

```
svctask mkemailuser -address manager2008@ibm.com -errtype all -usertype local
```

3. Optionally, generate a report that lists e-mail notification settings for e-mail recipients, or change or delete e-mail recipients.
  - To generate a report that lists the e-mail notification settings for all e-mail recipients, an individual e-mail recipient, or a specified type of e-mail recipient, issue the **svctask lsemailuser** CLI command.
  - To change the settings for a recipient, issue the **svctask chemailuser** CLI command. You must specify the user ID or name of the e-mail recipient for whom you are modifying settings.
  - To delete a recipient, issue the **svctask rmemailuser** CLI command. You must specify the user ID or name of the e-mail recipient that you want to remove.
4. Activate the e-mail and inventory notification function. To do this, issue the **svctask startemail** CLI command. There are no parameters for this command.

**Note:** Inventory information is automatically reported to IBM when you activate error reporting.

5. Optionally, test the e-mail notification function to ensure that it is operating correctly and send an inventory e-mail notification.
  - To send a test e-mail notification to one or more recipients, issue the **svctask testemail** CLI command. You must either specify **all** or the user ID or user name of an e-mail recipient that you want to send a test e-mail to.
  - To send an inventory e-mail notification to all recipients that are enabled to receive inventory e-mail notifications, issue the **svctask sendinventoryemail** CLI command. There are no parameters for this command.

## Call Home and inventory e-mail information

The SAN Volume Controller can use Call Home e-mail and Inventory Information e-mail to provide necessary data and event notifications to you and to the IBM Support Center.

### Call Home e-mail

Call Home support is initiated for the following reasons or types of data:

- Problem or event notification: Data is sent when there is a problem or an informational event.
- Communication tests: You can test for the successful installation and communication infrastructure.
- Inventory information: A notification is sent to provide the necessary status and hardware information to IBM service personnel.

To send data and notifications to IBM service personnel, use one of the following e-mail addresses:

- For SAN Volume Controller nodes located in North America, Latin America, South America or the Caribbean Islands, use `callhome1@de.ibm.com`
- For SAN Volume Controller nodes located anywhere else in the world, use `callhome0@de.ibm.com`

Call Home e-mail can contain any combination of the following types of information:

- Contact name
- Contact phone number
- Offshift phone number

- Contact e-mail
- Machine location
- Record type
- Machine type
- Machine serial number
- Error ID
- Error code
- Software version
- FRU part number
- Cluster name
- Node ID
- Error sequence number
- Time stamp
- Object type
- Object ID
- Problem data

### Inventory information e-mail

Inventory information e-mail is a type of Call Home notification. Inventory information can be sent to IBM to assist IBM service personnel in evaluating your SAN Volume Controller system. Because inventory information is sent using the Call Home e-mail function, you must meet the Call Home function requirements and enable the Call Home e-mail function before you can attempt to send inventory information e-mail. You can adjust the contact information, adjust the frequency of inventory e-mail, or manually send an inventory e-mail using the SAN Volume Controller Console or the SAN Volume Controller command-line interface. Inventory information is automatically reported to IBM when you activate error reporting.

Inventory information that is sent to IBM can include the following information about the cluster on which the Call Home function is enabled:

- Time stamp
- Contact information, including name and phone number. This is initially set to the contact information that was set for the Call Home e-mail function. However, you can change the contact information specifically for inventory e-mail using the SAN Volume Controller Console or the **mkemailuser** or **chemailuser** CLI commands.
- Machine location. This is the machine location that is set for the Call Home e-mail function.
- Software level
- License information. This is the same information that it output from the **svcinfo lslicense** command.
- Cluster vital product data (VPD). The cluster VPD is the same information that is output from the **svcinfo lscluster** command, including the following items:
  - Cluster name and IDs
  - Cluster location
  - Bandwidth
  - IP addresses

- Memory capacities
- SNMP settings
- Time zone setting
- E-mail settings
- Microcode level
- Fibre-channel port speed
- Node VPD for each node in the cluster. The node VPD is the same information that is output from the `svcinfo lsnodevpd` command, including the following items:
  - System part number
  - Number of various hardware parts, such as fans, processors, memory slots, fibre-channel cards, and SCSI/IDE devices
  - Part numbers of the various hardware parts
  - BIOS information
  - System manufacturing information, such as system product and manufacturer
  - Firmware level for the service processor
- Software VPD, including the following items:
  - Code level
  - Node name
  - Ethernet status
  - Worldwide node name (WWNN)
  - MAC address
- Processor information, including the following items for each processor:
  - Location of processor
  - Type of cache
  - Size of cache
  - Manufacturer
  - Version
  - Speed
  - Status (enabled or disabled)
- Memory information, including the following items:
  - Part number
  - Device location
  - Bank location
  - Size
- Fibre-channel card information, including the following items:
  - Part number
  - Port number
  - Device serial number
  - Manufacturer
- SCSI/IDE device information, including the following items:
  - Part number
  - Bus ID
  - Device ID
  - Model



- Revision level
- Serial number
- Approximate capacity
- Front panel assembly information, including the following items:
  - Part number
  - ID
  - Location
- Uninterruptible power supply information, including the following items:
  - Electronics part number
  - Battery part number
  - Uninterruptible power supply assembly part number
  - Input power cable part number
  - Uninterruptible power supply serial number
  - Uninterruptible power supply type
  - Uninterruptible power supply internal part number
  - ID
  - Firmware levels

---

## Changing cluster passwords using the CLI

You can use the command-line interface (CLI) to change the administrator and service passwords.

Passwords only affect the SAN Volume Controller Console that accesses the cluster. To restrict access to the CLI, you must control the list of SSH client keys that are installed on the cluster.

Perform the following steps to change the administrator and service passwords:

1. Issue the following command to change the administrator users password:

```
svtask chcluster -admpwd admin_password
```

Where *admin\_password* is the new administrator password that you want to use.

2. Issue the following command to change the service users password:

```
svtask chcluster -servicepwd service_password
```

Where *service\_password* is the new service password that you want to use.

---

## Changing the locale setting using the CLI

You can use the command-line interface (CLI) to specify the locale for a SAN Volume Controller cluster. The language that you select as your locale setting is used to display command results and error messages in the CLI.

The following locales are available:

- 0 US English (default)
- 3 Japanese

Issue the **svcservicetask setlocale** CLI command with the ID for the locale.

For example, issue the following CLI command to change the locale setting from US English to Japanese:

```
svcservicetask setlocale 3
```

where 3 is the ID for the Japanese locale setting.

---

## Viewing the feature log using the CLI

You can use the command-line interface (CLI) to view the feature log.

Perform the following steps to view the feature log:

1. Issue the **svcinfolfeaturedumps** command to return a list of dumps in the /dumps/feature destination directory. The feature log is maintained by the cluster. The feature log records events that are generated when license parameters are entered or when the current license settings have been breached.
2. Issue the **svcservicemodeinfo lfeaturedumps** command to return a list of the files that exist of the type specified on the given node.

---

## Analyzing the error log using the CLI

You can use the command-line interface (CLI) to analyze the error log.

Perform the following steps to analyze the error log:

Issue any of the following CLI commands to list error log files:

- **svcinfolerrlogbydisk**
- **svcinfolerrlogbydiskgroup**
- **svcinfolerrlogbyvdisk**
- **svcinfolerrlogbyhost**
- **svcinfolerrlogbynode**
- **svcinfolerrlogbyiogrp**
- **svcinfolerrlogbyfcconsistgrp**
- **svcinfolerrlogbyfcmap**
- **svcinfolerrlogbyrcconsistgrp**
- **svcinfolerrlogbyrcrelationship**

These CLI commands list the error log by type and return a list of dumps in the appropriate directory. For example, the **svcinfolerrlogbydisk** CLI command displays the error log by managed disks (MDisks).

You can display the whole log or filter the log so that only errors, events, or unfixed errors are displayed. You can also request that the output is sorted either by error priority or by time. For error priority, the most serious errors are the lowest-numbered errors. Therefore, the most serious errors are displayed first in the table. For time, either the older or the latest entry can be displayed first in the output.

---

## Shutting down a cluster using the CLI

You can use the command-line interface (CLI) to shut down a cluster.

If you want to remove all input power to a cluster (for example, the machine room power must be shutdown for maintenance), you must shut down the cluster before the power is removed. If you do not shut down the cluster before turning off input

power to the uninterruptible power supply, the SAN Volume Controller nodes detect the loss of power and continue to run on battery power until all data that is held in memory is saved to the internal disk drive. This increases the time that is required to make the cluster operational when input power is restored and severely increases the time that is required to recover from an unexpected loss of power that might occur before the uninterruptible power supply batteries have fully recharged.

When input power is restored to the uninterruptible power supply units, they start to recharge. However, the SAN Volume Controller nodes do not permit any I/O activity to be performed to the virtual disks (VDisks) until the uninterruptible power supply is charged enough to enable all the data on the SAN Volume Controller nodes to be saved in the event of an unexpected power loss. This might take as long as two hours. Shutting down the cluster prior to removing input power to the uninterruptible power supply units prevents the battery power from being drained and makes it possible for I/O activity to resume as soon as input power is restored.

Before shutting down a cluster, quiesce all I/O operations that are destined for this cluster. Failure to do so can result in failed I/O operations being reported to your host operating systems.

**Attention:** If you are shutting down the entire cluster, you lose access to all VDisks that are provided by this cluster. Shutting down the cluster also shuts down all SAN Volume Controller nodes. This shutdown causes the hardened data to be dumped to the internal hard drive.

Begin the following process of quiescing all I/O to the cluster by stopping the applications on your hosts that are using the VDisks that are provided by the cluster.

1. Determine which hosts are using the VDisks that are provided by the cluster.
2. Repeat the previous step for all VDisks.

When input power is restored, you must press the power button on the uninterruptible power supply units before you press the power buttons on the SAN Volume Controller nodes.

Perform the following steps to shut down a cluster:

1. Issue the following command to shut down a cluster:  
`svctask stopcluster`

The following output is displayed:

Are you sure that you want to continue with the shut down?

2. Type `y` to shut down the entire cluster.



---

## Chapter 7. Backing up and restoring the cluster configuration

You can back up and restore the cluster configuration data after preliminary tasks are completed.

Cluster configuration data provides information about your cluster and the objects that are defined in it. The backup and restore functions of the **svconfig** command can only back up and restore your cluster configuration data. You must regularly back up your application data using the appropriate backup methods.

Information about the following objects is included in the cluster configuration data:

- Storage system
- Hosts
- I/O groups
- Managed disks (MDisks)
- MDisk groups
- Nodes
- Virtual disks (VDisks)
- VDisk-to-host mappings
- SSH keys
- FlashCopy mappings
- FlashCopy consistency groups
- Metro Mirror relationships
- Metro Mirror consistency groups
- Global Mirror relationships
- Global Mirror consistency groups

You can maintain your cluster configuration data by performing the following tasks:

- Backing up the cluster configuration data
- Restoring the cluster configuration data
- Deleting unwanted backup configuration data files

---

### Backing up the cluster configuration

You can backup your cluster configuration data from the Backing up a Cluster Configuration panel.

Before you backup your cluster configuration data, the following prerequisites must be met:

- No independent operations that change the cluster configuration can be running while the backup command is running.
- No object name can begin with an underscore.

**Note:**

- The default object names for controllers, I/O groups and managed disks (MDisks) do not restore correctly if the ID of the object is different than what is recorded in the current cluster configuration data file.
- All other objects with default names are renamed during the restore process. The new names appear in the format *name\_r*. Where *name* is the name of the object in your cluster.

This task assumes that you have already launched the SAN Volume Controller Console.

The backup function is designed to back up information about your cluster configuration, such as virtual disks (VDisks), local Metro Mirror information, local Global Mirror information, managed disk (MDisk) groups, and nodes. All other data that you have written to the VDIs is *not* backed up. Any application that uses the VDIs on the cluster as storage, must back up its application data using appropriate backup methods.

You must regularly back up your cluster configuration data and your application data to avoid data loss. If a cluster is lost after a severe failure occurs, both cluster configuration and application data is lost. You must reinstate the cluster to the exact state it was in prior to the failure and then recover the application data.

The backup function creates three files that provide information about the backup process and cluster configuration. When you use the SAN Volume Controller Console to perform the backup, these files are created in the `\console\backup\cluster` directory of the IBM System Storage Productivity Center or the master console. Where *console* is the directory where the SAN Volume Controller Console is installed and *cluster* is the name of the cluster for which you want to back up the cluster configuration data.

The following table describes the three files that are created by the backup process:

| File name             | Description                                                                                                 |
|-----------------------|-------------------------------------------------------------------------------------------------------------|
| svc.config.backup.xml | This file contains your cluster configuration data.                                                         |
| svc.config.backup.sh  | This file contains the names of the commands that were issued to create the backup of the cluster.          |
| svc.config.backup.log | This file contains details about the backup, including any error information that might have been reported. |

If the `svc.config.backup.xml` file already exists in the directory, it is renamed to `svc.config.backup.bak`. After the file is renamed the new `svc.config.backup.xml` is written.

Perform the following steps to backup your cluster configuration data:

1. Click **Service and Maintenance** → **Backup Configuration** in the portfolio. The Backing up a Cluster Configuration panel is displayed.
2. Click **Backup**.

---

## Backing up the cluster configuration using the CLI

You can backup your cluster configuration data using the command-line interface (CLI).

Before you backup your cluster configuration data, the following prerequisites must be met:

- No independent operations that change the cluster configuration can be running while the backup command is running.
- No object name can begin with an underscore.
- All objects should have non-default names, that is, names that are not assigned by the SAN Volume Controller.

**Note:**

- The default object names for controllers, I/O groups and managed disks (MDisks) do not restore correctly if the ID of the object is different than what is recorded in the current cluster configuration data file.
- All other objects with default names are renamed during the restore process. The new names appear in the format *name\_r*. Where *name* is the name of the object in your cluster.

The backup feature of the **svconfig** CLI command is designed to back up information about your cluster configuration, such as virtual disks (VDisks), local Metro Mirror information, local Global Mirror information, managed disk (MDisk) groups, and nodes. All other data that you have written to the VDIs is *not* backed up. Any application that uses the VDIs on the cluster as storage, must back up its application data using the appropriate backup methods.

You must regularly back up your cluster configuration data and your application data to avoid data loss. If a cluster is lost after a severe failure occurs, both cluster configuration and application data is lost. You must reinstate the cluster to the exact state it was in prior to the failure and then recover the application data.

Perform the following steps to backup your cluster configuration data:

1. Back up all of the application data that you have stored on your VDIs using your preferred backup method.

2. Open a command prompt.

3. Issue the following command to log onto the cluster:

```
ssh -l admin your_cluster_name -p 22
```

Where *your\_cluster\_name* is the name of the cluster for which you want to backup cluster configuration data.

4. Issue the following CLI command to remove all of the existing cluster configuration backup and restore files that are located on your configuration node in the **/tmp** directory.

```
svconfig clear -all
```

5. Issue the following CLI command to backup your cluster configuration:

```
svconfig backup
```

The following output is an example of the messages that are displayed during the backup process:

```

CMMVC6112W io_grp io_grp1 has a default name
CMMVC6112W io_grp io_grp2 has a default name
CMMVC6112W mdisk mdisk14 ...
CMMVC6112W node node1 ...
CMMVC6112W node node2 ...
.....
CMMVC6136W No SSH key file svc.config.renee.admin.key
CMMVC6136W No SSH key file svc.config.service.service.key

```

The **svconfig backup** CLI command creates three files that provide information about the backup process and cluster configuration. These files are created in the /tmp directory of the configuration node.

The following table describes the three files that are created by the backup process:

| File name             | Description                                                                                                 |
|-----------------------|-------------------------------------------------------------------------------------------------------------|
| svc.config.backup.xml | This file contains your cluster configuration data.                                                         |
| svc.config.backup.sh  | This file contains the names of the commands that were issued to create the backup of the cluster.          |
| svc.config.backup.log | This file contains details about the backup, including any error information that might have been reported. |

- Issue the following command to exit the cluster:

```
exit
```

- Issue the following command to copy the backup files to a location that is not in your cluster:

```
scp -P 22 admin@your_cluster:/tmp/svc.config.backup.*
/offclusterstorage/
```

Where *your\_cluster* is the name of your cluster and *offclusterstorage* is the location where you want to store the backup files.

You must copy these files to a location outside of your cluster because the /tmp directory on this node becomes inaccessible if the configuration node changes. The configuration node might change in response to an error recovery action or to a user maintenance activity.

**Tip:** To maintain controlled access to your cluster configuration data, copy the backup files to a location that is password protected.

- Ensure that the copies of the backup files are stored in the location that you specified in step 7.

You can rename the backup files to include the configuration node name either at the start or end of the file names so you can easily identify these files when you are ready to restore your configuration.

Issue the following command to rename the backup files that are stored on a Linux or AIX host:

```
mv /offclusterstorage/svc.config.backup.xml
/offclusterstorage/svc.config.backup.xml_myconfignode
```

Where *offclusterstorage* is the name of the directory where the backup files are stored and *myconfignode* is the name of your configuration node.



To rename the backup files that are stored on a Windows host, right-click on the name of the file and select **Rename**.

---

## Downloading backup configuration data files

You can use the SAN Volume Controller Console to download backup configuration data files to your IBM System Storage Productivity Center or master console.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to download the backup configuration data files to your IBM System Storage Productivity Center or master console:

1. Click **Service and Maintenance** → **List Dumps** in the portfolio. The List Dumps panel is displayed.
2. Click **Software Dumps**. The Software Dumps panel is displayed.
3. Find the name of your backup configuration data file.
4. Right-click on your backup configuration data file and click **Save Target As**.
5. Select the location where you want to save the file and click **Save**.

---

## Restoring the cluster configuration using the CLI

You can restore your cluster configuration data using the command-line interface (CLI).

Before you restore your cluster configuration data, the following prerequisites must be met:

- You have administrator authority.
- You have a copy of your backup cluster configuration files on a server that is accessible to the cluster.
- You have a backup copy of your application data.
- You know the current license settings for your cluster.
- You have not removed any hardware since the last backup of your cluster configuration. If you had to replace a faulty node, the new node must use the same worldwide node name (WWNN) as the faulty node that it replaced.

**Note:** You can add new hardware, but you must not remove any hardware because the removal can cause the restore process to fail.

- No changes have been made to the fabric of the cluster since the last backup of your cluster configuration. If changes are made, you must back up your cluster configuration again.

The restore must be performed to a single node cluster. You can restore the configuration using any node as the configuration node. However, if you do not use the node that was the configuration node when the cluster was first created, the unique identifier (UID) of the VDisks that are within the I/O groups can change. This can affect IBM TotalStorage Productivity Center for Fabric, VERITAS Volume Manager, and any other programs that record this information.

The SAN Volume Controller analyzes the backup configuration data file and the cluster to verify that the required disk controller system nodes are available.

Before you begin, hardware recovery must be complete. The following hardware must be operational: hosts, SAN Volume Controller, disk controller systems, disks, and the SAN fabric.

**Important:** There are two phases during the restore process: prepare and execute. You must not make any changes to the fabric or cluster between these two phases.

Perform the following steps to restore your cluster configuration data:

1. Select delete cluster from the front panel on each node in the cluster that does *not* display Cluster : on the front panel. If the front panel of the node displays Cluster :, the node is already a candidate node.
2. Create a new cluster from the front panel of any node in the cluster. If possible, use the node that was originally the configuration node for the cluster.
3. Generate a Secure Shell (SSH) key pair for the SAN Volume Controller Console.
4. Generate an SSH key pair for all of the hosts to use to access the CLI.
5. Log on to the SAN Volume Controller Console.
6. Finish creating the cluster by using the SAN Volume Controller Console.  
After the cluster is created and configured, you should be able to connect to the cluster using the IBM System Storage Productivity Center, master console or the CLI.

7. Issue the following command to log onto the cluster:

```
ssh -l admin your_cluster_name -p 22
```

Where *your\_cluster\_name* is the name of the cluster for which you want to restore the cluster configuration.

8. Issue the following CLI command to ensure that only the configuration node is online.

```
svcinfolnode
```

The following is an example of the output that is displayed:

```
id name status IO_group_id IO_group_name config_node
1 node1 online 0 io_grp0 yes
```

9. Verify that the most recent version of your **/tmp/svc.config.backup.xml** configuration file has been copied to your SSPC. The most recent file is located on your configuration node in the **/tmp** or **/dumps** directory. In addition, a **/dumps/svc.config.cron.xml\_node\_name** configuration file is created daily on the configuration node. In certain cases, you might prefer to copy an earlier configuration file. If necessary, back up your configuration file as described in “Backing up the cluster configuration using the CLI” on page 241.

10. Issue the following CLI command to remove all of the existing backup and restore cluster configuration files that are located on your configuration node in the **/tmp** directory:

```
svconfig clear -all
```

11. Copy the **svc.config.backup.xml** file from the IBM System Storage Productivity Center or master console to the **/tmp** directory of the cluster using the PuTTY **pscp** program. Perform the following steps to use the PuTTY **pscp** program to copy the file:
  - a. Open a command prompt from the IBM System Storage Productivity Center or master console.

- b. Set the path in the command line to use pscp with the following format:  
`set PATH=C:\path\to\putty\directory;%PATH%`
  - c. Issue the following command to specify the location of your private SSH key for authentication:  
`pscp <private key location> source [source...] [user@]host:target`
12. Issuing the following CLI command to compare the current cluster configuration with the backup configuration data file:  
`svconfig restore -prepare`  
 This CLI command creates a log file in the /tmp directory of the configuration node. The name of the log file is `svc.config.restore.prepare.log`.
13. Issue the following command to copy the log file to another server that is accessible to the cluster:  
`pscp -i <private key location> [user@]host:source target`
14. Open the log file from the server where the copy is now stored.
15. Check the log file for errors.
- If there are errors, correct the condition which caused the errors and reissue the command. You must correct all errors before you can proceed to step 16.
  - If you need assistance, contact the IBM Support Center.
16. Issue the following CLI command to restore the cluster configuration:  
`svconfig restore -execute`
- Note:** Issuing this CLI command on a single node cluster adds the other nodes and hosts to the cluster.
- This CLI command creates a log file in the /tmp directory of the configuration node. The name of the log file is `svc.config.restore.execute.log`.
17. Issue the following command to copy the log file to another server that is accessible to the cluster:  
`scp -P 22 admin@your_cluster:/tmp/svc.config.restore.execute.log /offclusterstorage/`
- Where *your\_cluster* is the name of your cluster and *offclusterstorage* is the location where you want to store the log file.
18. Open the log file from the server where the copy is now stored.
19. Check the log file to ensure that no errors or warnings have occurred.

**Note:** You might receive a warning that states that a licensed feature is not enabled. This means that after the recovery process, the current license settings do not match the previous license settings. The recovery process continues normally and you can enter the correct license settings in the SAN Volume Controller Console at a later time.

The following output is displayed after a successful cluster configuration restore:

```
IBM_2145:your_cluster_name:admin>
```

You can remove any unwanted configuration backup and restore files from the /tmp directory on your configuration by issuing the `svconfig clear -all` CLI command.

---

## Deleting backup configuration files

You can delete a backup cluster configuration from the Deleting a Cluster Configuration panel.

This task assumes that you have already launched the SAN Volume Controller Console.

Perform the following steps to delete backup configuration files:

1. Click **Service and Maintenance** → **Delete Backup** in the portfolio. The Deleting a Cluster Configuration panel is displayed.
2. Click **OK**.

---

## Deleting backup configuration files using the CLI

You can use the command-line interface (CLI) to delete backup configuration files.

Perform the following steps to delete backup configuration files:

1. Issue the following command to log onto the cluster:  

```
ssh -l admin your_cluster_name -p 22
```

Where *your\_cluster\_name* is the name of your cluster.
2. Issue the following CLI command to erase all of the files that are stored in the /tmp directory:  

```
svconfig clear -all
```

---

## Chapter 8. Upgrading the SAN Volume Controller software

The SAN Volume Controller software can be upgraded while you run day-to-day operations.

However, performance is degraded during the software upgrade process. Only the following commands can be issued during the software upgrade:

- All svcinfo commands
- svctask rmnode

**Note:** Applying a software upgrade takes a varying length of time. Plan for at least one hour because there is a 30 minute delay that allows the multipathing software to recover.

Software and microcode for the SAN Volume Controller and its attached adapters is tested and released as a single package. The package number increases each time a new release is made. The package includes Linux, Apache and the SAN Volume Controller software.

If you upgrade to more than one level above your current level, you might be required to install the intermediate level. For example, if you are upgrading from level 1 to level 3, you might have to install level 2 before you can install level 3. Details for any prerequisite levels are provided with the source files.

**Attention:**

- If you apply the software upgrade while a node is in service mode, the node is deleted from the cluster. All status information that is stored on the node is deleted and data loss can occur if the cluster depends solely on this node.
- Ensure that you have no unfixed errors in the log and that the cluster date and time are correctly set. Start the Directed Maintenance Procedures (DMPs) and ensure that you fix any outstanding errors before you attempt to concurrently upgrade the software.

### Metro Mirror and Global Mirror

When you upgrade software where the cluster participates in one or more intercluster relationships, update the clusters one at a time. Do not upgrade the clusters concurrently because you can lose synchronization and availability.

You can create new Metro Mirror or Global Mirror partnerships between two clusters with different software levels.

---

## Installing or upgrading the SAN Volume Controller software

The SAN Volume Controller software can be installed or upgraded after you download the software package from the SAN Volume Controller Web site.

### Software package

The software installation or upgrade procedure copies the new software level to the cluster and starts an automatic installation process. During the installation process, each node is restarted. While each node restarts, there might be some

degradation in the maximum I/O rate that can be sustained by the cluster. The amount of time that is needed to install or upgrade the software is dependent on the size of the cluster and the size of the software update package. The size of the software update package is determined by the number of components that are being replaced. After all the nodes in the cluster are successfully restarted with the new software level, the new software level is automatically committed.

## Installation operation

The installation operation can normally be performed concurrently with normal user I/O operations. If any restrictions apply to the operations that can be performed during the upgrade, these restrictions are documented on the SAN Volume Controller Web site that you use to download the software packages. During the software upgrade procedure, only the following SAN Volume Controller commands are operational from the time the install process starts to the time that the new software level is committed, or until the process has been backed-out. All other commands fail with a message that indicates a software upgrade is in progress.

- All `svcin` commands
- `svctask rmnode`

To determine when your software upgrade process has completed, you will be notified through the SAN Volume Controller Console or, if you are using the command-line interface, examine the error log.

Because of the operational limitations that occur during the software upgrade process, the software installation is a user task.

---

## Copying the SAN Volume Controller software upgrade files using PuTTY scp

PuTTY scp (`pscp`) provides a file transfer application for secure shell (SSH) to copy files either between two directories on the configuration node or between the configuration node and another host.

To use the `pscp` application, you must have the appropriate permissions on the source and destination directories on your respective hosts.

The `pscp` application is available when you install an SSH client on your host system. You can access the `pscp` application through a command prompt.

Perform the following steps to use the `pscp` application:

1. Start a PuTTY session.
2. Configure your PuTTY session to access your SAN Volume Controller cluster.
3. Save your PuTTY configuration session. For example, you can name your saved session `SVCPUTTY`.
4. Open a command prompt.
5. Issue the following command to set the path environment variable to include the PuTTY directory:  

```
set path=C:\Program Files\putty;%path%
```

where *Program Files* is the directory where PuTTY is installed.
6. Issue the following command to copy the package onto the node where the CLI runs:

```
directory_software_upgrade_files pscp -load saved_putty_configuration
software_upgrade_file_name admin@cluster_ip_address:/home/admin/upgrade
```

where *directory\_software\_upgrade\_files* is the directory that contains the software upgrade files, *saved\_putty\_configuration* is the name of the PuTTY configuration session, *software\_upgrade\_file\_name* is the name of the software upgrade file, and *cluster\_ip\_address* is the IP address of your cluster.

If there is insufficient space to store the software upgrade file on the cluster, the copy process fails. Perform one of the following steps to provide sufficient space:

- Issue the **svctask cleardumps** CLI command to free space on the cluster and repeat step 6 on page 248.
- Issue the following command from the cluster to transfer the error logs to the IBM System Storage Productivity Center or the master console:

```
pscp -unsafe -load saved_putty_configuration
admin@cluster_ip_address:/dump/elogs/* your_preferred_directory
```

where *saved\_putty\_configuration* is the name of the PuTTY configuration session, *cluster\_ip\_address* is the IP address of your cluster, and *your\_preferred\_directory* is the directory where you want to transfer the error logs.

After you have transferred the error logs to the IBM System Storage Productivity Center or the master console, repeat step 6 on page 248.

---

## Upgrading the SAN Volume Controller software automatically

When new nodes are added to the cluster, the software upgrade file is automatically downloaded to the new nodes from the SAN Volume Controller cluster.

If you add a new node that has or requires a software level that is higher than the software level available on the cluster, the new node is *not* configured into the cluster. The new node must be downgraded to the software level of the cluster before it can join the cluster. If a node is added to the cluster that does not have software installed or has an old software level that cannot be recognized by the cluster, a node rescue must be performed to force a reinstallation of the software.

If the new node requires a level of software that is higher than the software level that is available on the cluster, the entire cluster must be upgraded before the new node can be added to the cluster.

### Error counts

During the software upgrade if you are using IBM Subsystem device driver (SDD) as the multipathing software on the host, increased I/O error counts are displayed by the **datapath query device** or **datapath query adapter** commands if active I/O operations exist between the hosts and the SANs during a software upgrade. See the *IBM System Storage Multipath Subsystem Device Driver User's Guide* for more information about the **datapath query** commands.

During the software upgrade, each node of a working pair is upgraded sequentially. The node that is being upgraded is temporarily unavailable and all I/O operations to that node fails. As a result, the I/O error counts increase and the failed I/O operations are directed to the partner node of the working pair. Applications should not see any I/O failures.

---

## Upgrading the SAN Volume Controller software using the SAN Volume Controller Console

You can upgrade the cluster software using the SAN Volume Controller Console.

**Attention:** Before you start a software upgrade, you must check for offline or degraded VDisks. An offline VDisk can cause write data that has been modified to be pinned in the SAN Volume Controller cache. This prevents VDisk failover and causes a loss of I/O access during the software upgrade. If the `fast_write_state` is empty, a VDisk can be offline and not cause errors during the software upgrade.

Perform the following steps if you are using Internet Explorer:

1. Click **Tools** in the menu bar.
2. Select the **Internet Options** → **Connections** tab.
3. Click on **LAN Settings...** and ensure that the box marked **Use a proxy server for your LAN (These settings will not apply to dial-up or VPN connections)** is unchecked.
4. Click **OK** twice to accept the settings.

Perform the following steps if you are using Netscape:

1. Click **Edit** in the menu bar.
2. Click on **Preferences....** Expand the Advanced section and select **Proxies**.
3. Select the **Direct connection to the Internet** button and click **OK** to accept the settings.

**Tip:** The software upgrade files can be quite large. If you experience problems while uploading the software upgrade files to the cluster, you should disable proxies on the Web browser from where you will upload the file. This shortens the file upload time. If you disable proxies, you might not be able to connect to external Web sites. Therefore, you must make a record of your existing settings before you disable proxies in case you have to restore access to other Web sites.

Perform the following steps to upgrade the software:

1. Download the SAN Volume Controller code from the following Web site:  
[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)
  - If you want to write the SAN Volume Controller code to a CD, you must download the CD image.
  - If you do not want to write the SAN Volume Controller code to a CD, you must download the install image.
2. Start a SAN Volume Controller Console session.
3. Launch the SAN Volume Controller application.
4. Click **Service and Maintenance** in the portfolio.
5. Click **Upgrade Software** to check the installed software level or to install a new level of software on the cluster. The Software Upgrade panel is displayed.
6. Click **Upload**. The Software upgrade - file upload panel is displayed.
7. Click **Browse** and select the SAN Volume Controller software file that you downloaded in step 1.
8. Click **Upload** to copy the SAN Volume Controller software file to the cluster.  
Before you begin the software upgrade, you must be aware of the following:



- The install process fails under the following conditions:
    - All the nodes that are configured in the cluster are not present. You cannot use the force flag to force the install process. If any node that is configured to be a member of the cluster is not present, the node must either be deleted from the cluster or be brought online before you can upgrade the software. Furthermore, if a node has been deleted from the cluster such that any I/O group has only one member, the software upgrade also fails. This is because the upgrade process causes a loss of access to data. The force flag can be used to override this restriction if you are prepared to loose access to data during the upgrade.
    - If the software that is installed on the remote cluster is not compatible with the new software or if there is an intercluster communication error that does not allow the software to check that the software is compatible.
  - The software upgrade is distributed to all the nodes in the cluster using fibre-channel connections between the nodes.
  - Nodes are updated one at a time.
  - Nodes will run the new software, concurrently with normal cluster activity.
  - While the node is updated, it does not participate in I/O activity in the I/O group. As a result, all I/O activity for the VDIs in the I/O group is directed to the other node in the I/O group by the host multipathing software.
  - There is a 30 minute delay between node updates. The delay allows time for the host multipathing software to rediscover paths to the nodes which have been upgraded, so that there is no loss of access when another node in the I/O group is updated.
  - The software update is not committed until all nodes in the cluster have been successfully updated to the new software level. If all nodes successfully restart with the new software level, the new level is committed. When the new level is committed, the cluster vital product data (VPD) is updated to reflect the new software level.
  - You cannot invoke the new functions of the upgraded software until all member nodes are upgraded and the update has been committed.
  - Because the software upgrade process takes some time, the install command completes as soon as the software level is verified by the cluster. To determine when the upgrade has completed, you must either display the software level in the cluster VPD or look for the Software upgrade complete event in the error/event log. If any node fails to restart with the new software level or fails at any other time during the process, the software level is backed-off.
  - During a software upgrade the version number of each node is updated when the software has been installed and the node has been restarted. The cluster software version number is updated when the new software level is committed.
  - When the software upgrade starts an entry is made in the error or event log and another entry is made when the upgrade completes or fails.
9. Click **Apply upgrade**. The Applying Software Upgrade panel is displayed. The Applying Software Upgrade panel enables you to select the upgrade and apply it to the cluster. A list of the software levels that you can apply to the cluster is displayed.

When a new software level is applied, it is automatically installed on all the nodes that are in the cluster.

**Note:** The software upgrade can take up to 30 minutes per node.

---

## Upgrading the SAN Volume Controller software using the CLI

You can use the command-line interface (CLI) to install software upgrades.

**Attention:** Before you start a software upgrade, you must check for offline or degraded VDisks. An offline VDisk can cause write data that has been modified to be pinned in the SAN Volume Controller cache. This prevents VDisk failover and causes a loss of I/O access during the software upgrade. If the `fast_write_state` is empty, a VDisk can be offline and not cause errors during the software upgrade.

Perform the following steps to upgrade the software:

1. Download the SAN Volume Controller code from the following Web site:  
[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)
  - If you want to write the SAN Volume Controller code to a CD, you must download the CD image.
  - If you do not want to write the SAN Volume Controller code to a CD, you must download the install image.
2. Use PuTTY scp (pscp) to copy the software upgrade files to the node.
3. Ensure that the software upgrade file has been successfully copied.

Before you begin the software upgrade, you must be aware of the following:

- The install process fails under the following conditions:
  - All the nodes that are configured in the cluster are not present. You cannot use the force flag to force the install process. If any node that is configured to be a member of the cluster is not present, the node must either be deleted from the cluster or be brought online before you can upgrade the software. Furthermore, if a node has been deleted from the cluster such that any I/O group has only one member, the software upgrade also fails. This is because the upgrade process causes a loss of access to data. The force flag can be used to override this restriction if you are prepared to loose access to data during the upgrade.
  - If the software that is installed on the remote cluster is not compatible with the new software or if there is an intercluster communication error that does not allow the software to check that the software is compatible.
- The software upgrade is distributed to all the nodes in the cluster using fibre-channel connections between the nodes.
- Nodes are updated one at a time.
- Nodes will run the new software, concurrently with normal cluster activity.
- While the node is updated, it does not participate in I/O activity in the I/O group. As a result, all I/O activity for the VDisks in the I/O group is directed to the other node in the I/O group by the host multipathing software.
- While the node is updated, the other node in the I/O group notices that its partner node is not participating in the cluster and attempts to flush the writeback cache and set it into write-through mode. This flush is not guaranteed to be successful or to complete and as a result concurrent software update creates a single point of data loss. If the remaining node in an I/O group experiences a failure during a software update of its partner, the only valid copy of dirty data in the writeback cache can be lost.

- There is a 30 minute delay between node updates. The delay allows time for the host multipathing software to rediscover paths to the nodes which have been upgraded, so that there is no loss of access when another node in the I/O group is updated.
  - The software update is not committed until all nodes in the cluster have been successfully updated to the new software level. If all nodes successfully restart with the new software level, the new level is committed. When the new level is committed, the cluster vital product data (VPD) is updated to reflect the new software level.
  - You cannot invoke the new functions of the upgraded software until all member nodes are upgraded and the update has been committed.
  - Because the software upgrade process takes some time, the install command completes as soon as the software level is verified by the cluster. To determine when the upgrade has completed, you must either display the software level in the cluster VPD or look for the Software upgrade complete event in the error/event log. If any node fails to restart with the new software level or fails at any other time during the process, the software level is backed-off.
  - During a software upgrade the version number of each node is updated when the software has been installed and the node has been restarted. The cluster software version number is updated when the new software level is committed.
  - When the software upgrade starts an entry is made in the error or event log and another entry is made when the upgrade completes or fails.
4. Issue the following CLI command to start the software upgrade process:  
`svcservicetask applysoftware -file software_upgrade_file`  
 where *software\_upgrade\_file* is the name of the software upgrade file.
  5. Issue the following CLI command to check the status of the software upgrade process:  
`svcinfolsoftwareupgradestatus`
  6. Perform the following steps to verify that the software upgrade successfully completed:
    - a. Issue the **svctask dumperrlog** CLI command to send the contents of the error log to a text file.  
 The following output is displayed in the text file if the software is successfully upgraded:

```
Upgrade completed successfully
```

- b. Issue the **svcinfolnodevpd** CLI command for each node that is in the cluster. The software version field displays the new software level.

When a new software level is applied, it is automatically installed on all the nodes that are in the cluster.

**Note:** The software upgrade can take up to 30 minutes per node.

---

## Performing a disruptive software upgrade using the CLI

You can use the command-line interface (CLI) to perform a disruptive software upgrade.

The SAN Volume Controller only supports concurrent software upgrades. To ensure that a software upgrade is coordinated across all nodes in the cluster, the nodes must be able to communicate with each other across the fibre-channel SAN. However, if this is not possible, you can perform a disruptive software upgrade.

Perform the following steps to complete the disruptive software upgrade process:

1. Stop any host applications and unmount the file systems that use storage that is managed by the SAN Volume Controller. If you are shutting down your hosts, this occurs as the host is shutdown. If you are not shutting down your hosts, you must manually stop host applications and unmount the file systems on each host. This step ensures that the hosts stop issuing I/O operations and that any data in the file system caches is flushed.
2. Issue the `svctask stopcluster` CLI command to shutdown the cluster. This CLI command stops the SAN Volume Controller from issuing I/O to backend controllers and flushes data from the SAN Volume Controller nodes cache.
3. Rezone the switch so that the SAN Volume Controller nodes are in one zone. Ensure that this zone does not include a host HBA or a backend controller (keep the old switch configuration so it can be restored during step 6). This step isolates the SAN Volume Controller from the rest of the SAN.
4. Power on all the SAN Volume Controller nodes and wait for them to reform a cluster.

**Note:** Because the SAN Volume Controller has been isolated from the backend storage, errors that indicate the backend storage is unavailable are logged.

5. Perform the software upgrade in the same manner as for a concurrent software upgrade.
6. Restore the original switch configuration.
7. Clear any error logs that were produced in step 4 indicating that backend storage is unavailable. Check that all backend storage is now online and accessible to the SAN Volume Controller nodes.
8. Remount file systems and start host applications.

---

## Performing the node rescue

If it is necessary to replace the hard disk drive or if the software on the hard disk drive is corrupted, you can use the node rescue procedure to reinstall the SAN Volume Controller software.

Similarly, if you have replaced the service controller, you should use the node rescue procedure to ensure that the service controller has the correct software.

**Attention:** If you recently replaced both the service controller and the disk drive as part of the same repair operation, node rescue fails.

To provide an alternate boot device, a minimal operating system is also available in nonvolatile memory on the service controller. If it is necessary to replace the hard disk drive or the software on the hard disk drive has become corrupted, the node cannot boot and the hardware boot indicator remains on the front panel display or the boot operation does not progress. If this occurs, use the node rescue procedure to reinstall the SAN Volume Controller software.

Node rescue works by booting the operating system from the service controller and running a program that copies all the SAN Volume Controller software from any other node that can be found on the fibre-channel fabric.

**Attention:** When running node rescue operations, only run one node rescue operation on the same SAN, at any one time. Wait for one node rescue operation to complete before starting another.

Perform the following steps to complete the node rescue:

1. Ensure that the fibre-channel cables are connected.
2. Ensure that at least one other node is connected to the fibre-channel fabric.
3. Ensure that the SAN zoning allows a connection between at least one port of this node and one port of another node. It is better if multiple ports can connect. This is particularly important if the zoning is by worldwide port name (WWPN) and you are using a new service controller. In this case, you might need to use SAN monitoring tools to determine the WWPNs of the node. If you need to change the zoning, remember to set it back when the service procedure is complete.
4. Turn off the node.
5. Press and hold the left and right buttons on the front panel.
6. Press the power button.
7. Continue to hold the left and right buttons until the node-rescue-request symbol is displayed on the front panel (Figure 29).



Figure 29. Node rescue display

The node rescue request symbol displays on the front panel display until the node starts to boot from the service controller. If the node rescue request symbol displays for more than two minutes, go to the hardware boot MAP to resolve the problem. When the node rescue starts, the service display shows the progress or failure of the node rescue operation.

**Note:** If the recovered node was part of a cluster, the node is now offline. Delete the offline node from the cluster and then add the node back into the cluster. If node recovery was used to recover a node that failed during a software upgrade process, it is not possible to add the node back into the cluster until the upgrade or downgrade process has completed. This can take up to four hours for an eight-node cluster.

---

## Recovering from software upgrade problems automatically

The cluster automatically stops the software upgrade process if any of the nodes fail to upgrade to the new software level.

In this case, any nodes that have already upgraded to the new software level are downgraded to the original software level. If a node fails to restart during this downgrade process, the process is suspended. The following scenarios can cause the downgrade process to suspend:

- A node (other than the node that is currently upgrading) is offline, restarted or asserted
- A node fails to update to the new software level
- A node is deleted while it is in the process of updating

You must check the error log to determine the reason for the failure before you attempt to upgrade the cluster again.

---

## Recovering from software upgrade problems manually

When a new software level is committed, you might not be able to return to a previous software level because some data structures might have been changed such that they cannot be used with the previous software level. Therefore, if you have any problems, you must install the newest level of the software.

**Attention:** This procedure causes a loss of *all* data that is currently configured in the cluster. This procedure must only be used as a last resort and should only be done if you have recently backed-up your data.

In extreme conditions where you cannot wait for a software update and you need to return to the previous software level, you can use the following procedure.

**Attention:** This procedure causes the total loss of the SAN Volume Controller cluster. This procedure must only be used as a last resort.

Perform the following steps to reset from software upgrade problems:

1. Power off all but one of the nodes that are in the cluster.
2. Set the powered-on node to service access mode.
3. Use the service access mode functions to force the download of the older software level.
4. Repeat the action for each of the failed nodes.
5. Use a node with a new software level to create a new cluster.

---

## Chapter 9. Upgrading the SAN Volume Controller Console

You can download the SAN Volume Controller Console software and upgrade or reinstall an existing SAN Volume Controller Console installation.

### Overview of the upgrade or reinstallation process

The following list provides an overview of the upgrade or reinstallation tasks, as well as any configuration tasks that you must perform after you upgrade or reinstall the SAN Volume Controller Console:

1. Upgrade or reinstall the SAN Volume Controller Console in graphical mode with the help of an installation wizard. If errors were generated during the upgrade or reinstallation process, you must remove and reinstall the SAN Volume Controller Console.
2. Verify that the following services that are associated with the SAN Volume Controller Console are installed and started:
  - Service Location Protocol
  - IBM System Storage SAN Volume Controller Pegasus Server
  - IBM WebSphere® Application Server V6 - SVC
3. Use a Web browser to access the SAN Volume Controller Console.
4. Identify the clusters that are to be managed by the SAN Volume Controller Console.

---

### Using graphical mode for upgrading SAN Volume Controller Console and PuTTY

You can upgrade the SAN Volume Controller Console and the PuTTY client software in graphical mode. You can also use this process for reinstalling an existing installation.

Before you can upgrade or reinstall the SAN Volume Controller Console and PuTTY in graphical mode, you must ensure that you have performed the following tasks:

- Ensure that your system meets the IBM System Storage Productivity Center hardware and software requirements provided in the *IBM System Storage Productivity Center Introduction and Planning Guide*
- Download the SAN Volume Controller Console zip file from the following Web site:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

After you have downloaded the zip file, you can extract the contents and write it to a CD or you can extract the contents to a directory on your system and perform the installation tasks from that directory.

During the upgrade or reinstallation process, you use the IBM System Storage SAN Volume Controller Console Launchpad application. The Launchpad allows you to select from the following options:

#### Console overview

Provides information about the SAN Volume Controller Console and its components.

**Readme file**

Provides any last minute product information that is not provided in the topics for installing the SAN Volume Controller Console.

**Configuration guide**

Provides instructions for installing and configuring the SAN Volume Controller Console.

**License agreement**

Provides information about the license for the SAN Volume Controller Console.

**SAN Volume Controller Web site**

Opens the SAN Volume Controller product Web site.

**Installation wizard**

Starts the SAN Volume Controller Console installation program.

**Post installation tasks**

Details information about validating the installation, accessing the SAN Volume Controller Console URL and adding the SAN Volume Controller Console cluster to the SAN Volume Controller Console management facility.

**Exit** Exits the SAN Volume Controller Console LaunchPad program.

The SAN Volume Controller Console installation program determines if this is a reinstallation or an upgrade of the SAN Volume Controller Console. If the installation wizard determines that the SAN Volume Controller Console was previously installed on the system, it does a comparison of the current version, release, modification, and fix code level with that of the code that is currently installed on the system.

- If the level is the same, this is a reinstallation.
- If the new code has a higher level, it is an upgrade.
- If the new code level is lower than the level on the system, the installation is not valid.

Perform the following steps to upgrade the SAN Volume Controller Console:

1. Log on to the system as a local system administrator.
2. Perform one of the following steps:
  - If you wrote the contents of the zip file to a CD and you have autorun mode set on your system, insert the CD into the drive. The IBM System Storage SAN Volume Controller Console Launchpad application starts.
  - If you wrote the contents of the zip file to a CD and you do not have autorun mode set on your system, insert the CD into the drive. Open a command prompt window and change to the W2K directory on the CD. Issue the following command:  
Launchpad  
The IBM System Storage SAN Volume Controller Console Launchpad application panel is displayed.
  - If you did not write the contents of the zip file to a CD, open a command prompt window and change to the following directory:  
*extract\_directory*\W2K  
Where *extract\_directory* is the directory where you extracted the zip file. Issue the following command:



#### Launchpad

The IBM System Storage SAN Volume Controller Console Launchpad application panel is displayed.

3. Click **Readme file** in the LaunchPad window to read installation information that is specific to this SAN Volume Controller Console software level.
4. Click **Installation wizard** in the LaunchPad window to start the installation.

**Note:** The LaunchPad panel remains open behind the installation wizard so that you can access product information during the installation process. You can click **Exit** if you want to close LaunchPad.

There might be a slight delay while the software loads on your system. After the software loads, a command prompt window opens to display the following message:

```
Initializing InstallShield Wizard...
Preparing Java <tm> Virtual Machine
.....
.....
```

The Welcome panel for the installation wizard is displayed. The Welcome panel provides the names of the documentation that you should read before you continue with the installation.

5. Click **Next** to continue or **Cancel** to exit the installation. If you click Next, the license agreement panel is displayed.
6. Read the license agreement information and perform one of the following steps:
  - Select **I accept the terms of the license agreement** and click **Next** to accept the license agreement.
  - Select **I do not accept the terms of the license agreement** and click **Cancel** to exit the installation.
7. Wait while the installation wizard verifies that your system meets all of the requirements. You might have to perform additional steps before the installation process can start if any of the following apply:
  - If you do not have PuTTY installed on your system, you must install PuTTY before you can continue with the installation. You can use the **putty-<version>-installer.exe** file that is located in the SSHClient/PuTTY folder that is included as part of the SAN Volume Controller Console zip file to install PuTTY on your system.
  - If you have a Service Location Protocol (SLP) service that is different from the SLP that the SAN Volume Controller Console requires, the installation wizard displays an error and asks you to stop the installation and remove this SLP service from the system.
  - If the SLP, the IBM System Storage SAN Volume Controller Pegasus Server, or IBM WebSphere Application Server V6 - SVC services are started, you are asked if you want to continue the installation. If you choose to continue the installation, you must stop all the applications that use these services.

When the panel with the option to Preserve Configuration is displayed, you can choose to preserve the current configuration. If you chose to preserve the current configuration, the installation program skips the next steps and goes directly to the Installation Confirmation panel. If you do not preserve the current configuration, the Destination Directory panel is displayed.

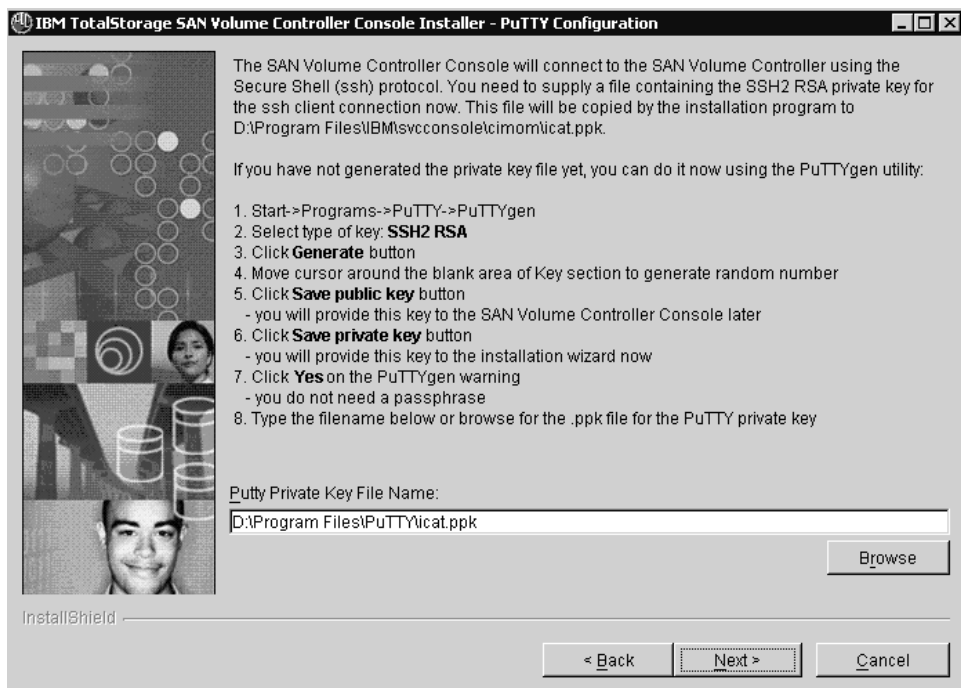
8. Select one of the following options from the Destination Directory panel:
  - Click **Next** to accept the default directory.

- Click **Browse** to select a different directory for installation and then click **Next** to continue the installation process.
- Click **Cancel** to exit the installation process.

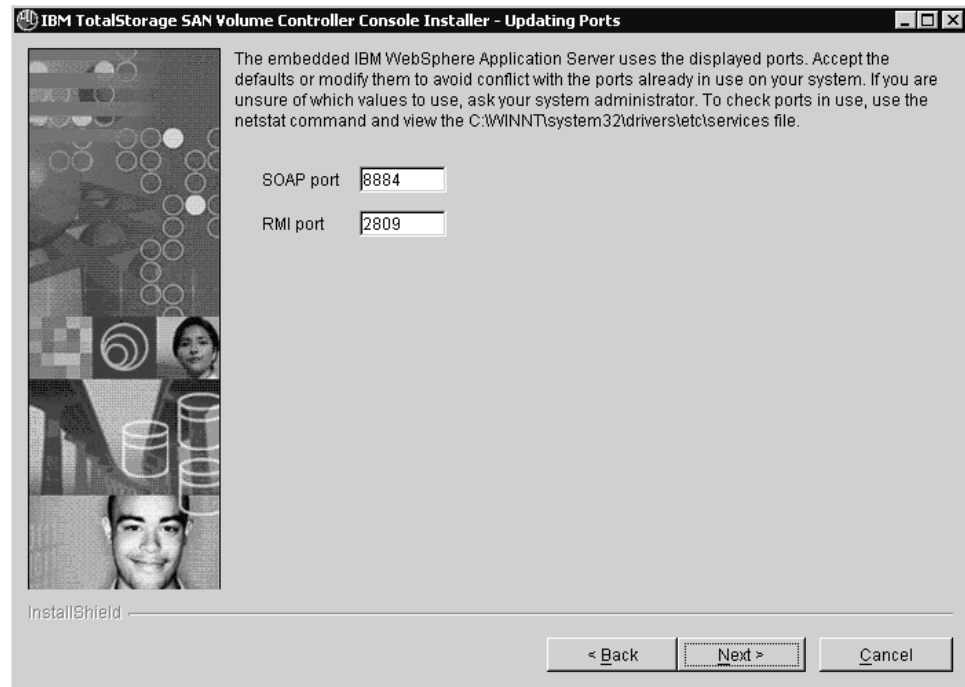
**Notes:**

- The directory name, including the drive letter, can be a maximum of 44 characters.
- If the program detects insufficient space for the SAN Volume Controller Console installation in the chosen destination, an error message is displayed. You can free some space on the destination drive and then click **Next** or you can stop the installation program by clicking **Cancel**. You can also click **Back**, and select a different destination.

After you click **Next**, the PuTTY Configuration panel is displayed.



9. Enter the name and location of your PuTTY SSH2 RSA private key file or click **Browse** to select the private key file. If you do not have a PuTTY private key file, follow the steps that are displayed on the PuTTY configuration panel to generate a private and public key. Click **Next** to continue. The Updating Ports panel is displayed
10. Update the default port assignments and the default communication protocol by typing the unique port numbers and selecting the desired communication protocol for the products that have been registered on your system. To check the ports that are in use, issue the `netstat -a` command and view the `C:\WINNT\system32\drivers\etc\services` file. Click **Next** to continue. The Updating Embedded WAS Ports panel is displayed.



11. Update the default ports assignments by typing unique port numbers for the products that have been registered on your system. To check the ports that are in use, issue the `netstat -a` command and view the `C:\WINNT\system32\drivers\etc\services` file. Click **Next** to continue.
12. Click **Install** to confirm the installation location and file size and to start the installation. Click **Cancel** to exit the installation wizard or click **Back** to go to the previous panel. The Installation Progress panel indicates how much of the installation has been completed. Installation usually takes 3 - 10 minutes depending on the configuration of your workstation.

**Note:** If you click **Cancel** a pop-up panel opens and asks you to confirm the cancellation of the installation wizard. Click **Yes** to confirm the cancellation or click **No** to continue the installation. If you confirm the cancellation, the information that you entered or selected in the previous panel is not saved and you must restart the installation process.

After the completion of a successful installation of the SAN Volume Controller Console, the installer attempts to start the following services:

- Service Location Protocol
  - IBM System Storage SAN Volume Controller Pegasus Server
  - IBM WebSphere Application Server V6 - SVC
13. Review the log file for error messages when the Finish panel is displayed. The log file is located in `install_directory\logs\install.log`, where `install_directory` is the directory where the SAN Volume Controller Console was installed. The `install.log` file contains a trace of the installation process.

**Note:** At the bottom of the Finish panel, there is a check box labeled **View post installation tasks**. If you check this box and click **Finish**, the wizard will exit and the post installation tasks text file is displayed. If you do not check this box, you can view the post installation tasks from the LaunchPad window.

14. Click **Finish** to exit the installation wizard.  
  
**Note:** If the installation wizard determines that a system restart is necessary, you must restart your system. After you restart the system, the installation wizard continues with the installation.
15. If you did not review the post-installation tasks from the installation Finish panel, review the post installation tasks from the LaunchPad window.
  - a. Click **Post installation tasks** in the LaunchPad window.
  - b. Follow the instructions in this file to complete the post installation tasks for the SAN Volume Controller Console.
16. Click **Exit** to exit the LaunchPad window.
17. Use the Services component of the Windows Computer Management utility to verify that the following services Status is set to Started and Startup Type is set to Automatic:
  - Service Location Protocol
  - IBM System Storage SAN Volume Controller Pegasus Server
  - IBM WebSphere Application Server V6 - SVC

---

## Verifying the Windows services associated with the SAN Volume Controller Console

You must verify that the Windows services that are associated with your SAN Volume Controller Console are correctly installed and started.

Perform the following steps to verify that the services are correctly installed:

**Important:** Do not close the Services window until you are instructed to close it.

1. Verify the installation of the Service Location Protocol (SLP).
  - a. Verify that the SLP is started. Select **Start** → **Settings** → **Control Panel**.
  - b. Double-click the **Administrative Tools** icon.
  - c. Double-click the **Services** icon.
  - d. Find **Service Location Protocol** in the **Services** list. For this component, the **Status** column is marked Started.
  - e. If the SLP is not started, right-click **Service Location Protocol** and select **Start**. Wait for the **Status** column to change to Started.
2. Verify the installation of the SAN Volume Controller Console.
  - a. Find **IBM System Storage SAN Volume Controller Pegasus Server** in the **Services** list. For this component, the **Status** column is marked Started.
  - b. If the service is not started, right click **IBM System Storage SAN Volume Controller Pegasus Server** and select **Start** from the pop-up menu. Wait for the **Status** column to change to Started.
3. Verify the installation of the IBM WebSphere Application Server V6 - SVC service.
  - a. Find IBM WebSphere Application Server V6 - SVC in the **Services** list. For this component, the **Status** column is marked Started.
  - b. If the **IBM WebSphere Application Server V6 - SVC** service is not started, right click **IBM WebSphere Application Server V6 - SVC** and select **Start** from the pop-up menu. Wait for the **Status** column to change to Started.
  - c. Close the Services window.
  - d. Close the Administrative Tools window.

---

## Uninstalling the SAN Volume Controller Console

You can uninstall the SAN Volume Controller Console from your system.

1. Log on to the system as a local system administrator.
2. Stop the CIM agent service. Go to **Start** → **Programs** → **IBM System Storage** → **SAN Volume Controller** → **Stop CIMOM Service**.
3. Stop the IBM WebSphere Application Server V6 - SVC service:
  - a. Click **Start** → **Settings** → **Control Panel**.
  - b. In the Control Panel window, double-click on the **Administrative Tools** icon.
  - c. Double-click the **Services** icon. The Services window opens.
  - d. In the Services window, find IBM WebSphere Application Server V6 - SVC. Click on the service to select it.
  - e. If the **Status** column shows Started, right-click the service and click **Stop** on the menu.
  - f. Wait for the service to stop.
4. Stop the SLP service:

**Attention:** Use caution if you have other applications that use the SLP service; you must stop those applications because the removal process deletes the SLP service. You must also stop the configuration utilities for the SAN Volume Controller Console if they are running.

- a. In the Services window, select the Service Location Protocol service.
- b. If it is running (the **Status** column shows Started), right-click the service, then click **Stop** on the menu.

**Note:** If you did not stop the CIM agent service, the system now asks if you want to stop it. Because the CIM agent service is dependent on the SLP service that you just stopped, you must stop the CIM agent service as described in step 2.

- c. Wait for the services to stop.
- d. Close the Services window.
- e. Close the Administrative Tools window.
5. Use the Windows Add/Remove Programs facility to remove the SAN Volume Controller Console and the SLP components.
  - a. From the Windows menu bar, click **Start** → **Settings** → **Control Panel**. Double-click **Add/Remove Programs**.
  - b. Click **IBM System Storage SAN Volume Controller Console** from the list of currently installed programs and click **Remove** to remove the product. The Welcome panel for the Uninstaller opens.
6. Click **Next** to continue or click **Cancel** to stop the removal of the SAN Volume Controller Console. The program detects whether the SLP, CIM agent, and the IBM WebSphere Application Server V6 - SVC services are running. If any of these services are found to be running, the uninstaller stops these services before proceeding with the uninstallation. You should consider at this point whether applications other than the SAN Volume Controller Console are dependent on the services.
7. Click **Next** to have the program stop the services for you or click **Cancel** to exit the removal process if you wish to manually stop the services and any dependent applications. Instructions for stopping the services begin in step 2. You must then restart the removal process from the Windows Add/Remove facility. The Confirmation panel opens.

8. Click **Remove** to continue or click **Cancel** to stop the removal of the SAN Volume Controller Console. Click **Back** to return to the previous panel. The Uninstallation Progress panel opens.
9. Wait for the program to remove the SAN Volume Controller Console product. The Finish panel for the Uninstaller opens.
10. This panel indicates the result of the removal process (successful or failed). Click **Finish** to complete the removal process and exit the wizard.

**Note:** If the Uninstaller cannot remove information from the system, a **Next** button is displayed instead of a **Finish** button. Click **Next** to open the Reboot panel. If the reboot panel opens, you can choose to either restart your computer now or restart your computer at a later time. Click **Finish** to complete the removal process and exit the wizard.

11. Close the Add/Remove Programs window.
12. If the system has not been restarted since the SAN Volume Controller Console was removed, restart the system now.
13. Log on to the system as a local system administrator.

**Note:** The removal process saves files uniquely related to the configuration in a backup directory under the destination path where you installed the SAN Volume Controller Console. Save these files if you plan to reinstall the application. Otherwise you can remove the backup folder and files. An example of the default destination path is: C:\Program Files\IBM\svccconsole.

14. Empty your Windows Recycle Bin to reclaim the disk space that was made available during the removal process.

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## Chapter 10. Replacing or adding nodes to an existing cluster

You can replace cluster nodes to upgrade to newer hardware models; you can also add cluster nodes to increase your cluster's workload capability.

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### Replacing nodes nondisruptively

You can replace SAN Volume Controller 2145-4F2, SAN Volume Controller 2145-8F2, or SAN Volume Controller 2145-8F4 nodes with SAN Volume Controller 2145-8G4 or SAN Volume Controller 2145-8A4 nodes. The following procedures are nondisruptive, because changes to your SAN environment are not required. This is because the replacement (new) node uses the same worldwide node name (WWNN) as the node you are replacing.

This task assumes that the following conditions have been met:

- The existing cluster software must be at a version that supports the new node. If a node is being replaced by a SAN Volume Controller 2145-8G4 node, the cluster software version must be 4.2.0 or higher. If a node is being replaced by a SAN Volume Controller 2145-8A4 node, the cluster software version must be 4.3.1 or higher.
- All nodes that are configured in the cluster are present and online
- All errors in the cluster error log are addressed and marked as fixed
- There are no virtual disks (VDisks), managed disks (MDisks), or controllers with a status of degraded or offline
- The replacement node is not powered on
- The replacement node is not connected to the SAN
- You have a 2145 UPS-1U unit (feature code 8115) for each new SAN Volume Controller 2145-8G4 or 2145-8A4 node.
- You have backed up the cluster configuration and saved the `svc.config.backup.xml` file.

#### Important:

1. Do not continue this task if any of the conditions listed above are not met unless you are instructed to do so by the IBM Support Center.
2. Review all of the steps listed below before you perform this task.
3. Do not perform this task if you are not familiar with SAN Volume Controller environments or the procedures described in this task.
4. If you plan to reuse the node that you are replacing, ensure that the WWNN of the node is set to a unique number on your SAN. If you do not ensure that the WWNN is unique, the WWNN and WWPN are duplicated in the SAN environment and can cause issues.

**Tip:** You can change the WWNN of the node you are replacing to the factory default WWNN of the replacement node to ensure that the number is unique.

5. Both the node ID and the node name change during this task. After the cluster assigns the node ID, the ID cannot be changed. However, you can change the node name after this task is complete.

Perform the following steps to replace active nodes in a cluster:

1. Perform the following steps to determine the cluster configuration node, and the ID, name, I/O group ID, and I/O group name for the node that you want to replace. If you already know the physical location of the node that you want to replace, you can skip this step and proceed to step 2.

**Tip:** If any of the nodes you want to replace are the cluster configuration node, replace it last.

- a. Issue the following command from the command-line interface (CLI):

```
svcinfolnode -delim :
```

The following is an example of the output that is displayed for this command:

```
IBM_2145:ITSOCL1:admin>svcinfolnode -delim :
id:name:UPS_serial_number:WWNN:status:IO_group_id:
 IO_group_name:config_node:UPS_unique_id:hardware
1:ITSOCL1_N1:1000739007:50050768010037E5:online:0:io_grp0:yes:
 20400001C3240007:8G4
2:ITSOCL1_N2:1000739004:50050768010037DC:online:0:io_grp0:no:
 20400001C3240004:8G4
```

- b. In the `config_node` column, find the value `yes` and record the values in the `id` and `name` columns.
- c. Record the values in the `id` and the `name` columns for each node in the cluster.
- d. Record the values in the `IO_group_id` and the `IO_group_name` columns for each node in the cluster.
- e. Issue the following command from the CLI for each node in the cluster to determine the front panel ID:
 

```
svcinfolnodevpd node_name or node_id
```

 where *node\_name* or *node\_id* is the name or ID of the node for which you want to determine the front panel ID.
- f. Record the value in the `front_panel_id` column. The front panel ID is displayed on the front of each node. You can use this ID to determine the physical location of the node that matches the node ID or node name that you want to replace.
2. Perform the following steps to record the WWNN of the node that you want to replace:
  - a. Issue the following command from the CLI:
 

```
svcinfolnode -delim : node_name or node_id
```

 where *node\_name* or *node\_id* is the name or ID of the node for which you want to determine the WWNN.
  - b. Record the WWNN of the node that you want to replace.
3. Use the power button on the front panel to power off the node.

**Important:**

- a. Record and mark the order of the fibre-channel cables with the node port number (port 1 to 4) before you remove the cables from the back of the node. The fibre-channel ports on the back of the node are numbered 1 to 4 from left to right. You must



reconnect the cables in the exact order on the replacement node to avoid issues when the replacement node is added to the cluster. If the cables are not connected in the same order, the port IDs can change, which impacts your hosts ability to access VDisks. See the hardware documentation specific to your model to determine how the ports are numbered.

- b. Do not connect the replacement node to different ports on the switch or director. The SAN Volume Controller 2145-8G4 models have 4 Gbps HBAs; however, do not move them to 4 Gbps switch or director ports at this time to avoid issues when the replacement node is added to the cluster.
  - c. Do not move the node's fibre-channel cables to faster or different ports on the switch or director at this time. This is a separate task that must be planned independently of replacing nodes in a cluster.
4. Issue the following CLI command to delete this node from the cluster and I/O group:

```
svctask rmnode node_name or node_id
```

Where *node\_name* or *node\_id* is the name or ID of the node that you want to delete. You can use the CLI to verify that the deletion process has completed.

5. Issue the following CLI command to ensure that the node is no longer a member of the cluster:

```
svcinfo lsnode node_name or node_id
```

where *node\_name* or *node\_id* is the name or ID of the node that you have replaced. The node is not listed in the command output.

6. Perform the following steps to change the WWNN of the node that you just deleted from the cluster to FFFFF:

For SAN Volume Controller V4.3:

- a. Power on the node.
- b. With the Node WWNN: panel displayed, press and hold the down button, press and release the select button, and then release the down button. The display switches into edit mode. Edit WWNN is displayed on line 1. Line 2 of the display contains the last five numbers of the WWNN.
- c. Change the displayed number to FFFFF. To edit the highlighted number, use the up and down buttons to increase or decrease the numbers. The numbers wrap F to 0 or 0 to F. Use the left and right buttons to move between the numbers.
- d. Press the select button to save your changes and apply FFFFF as the new WWNN for the node.

For SAN Volume Controller versions prior to V4.3:

- a. Power on the node.
- b. Press and release the right button until the Status: panel is displayed.
- c. With the node status displayed on the front panel, press and hold the down button; press and release the select button; release the down button. WWNN is displayed on line 1 of the display. Line 2 of the display contains the last five numbers of the WWNN.
- d. With the WWNN displayed on the front panel; press and hold the down button; press and release the select button; release the down button. The display switches into edit mode.

- e. Change the displayed number to FFFF. To edit the highlighted number, use the up and down buttons to increase or decrease the numbers. The numbers wrap F to 0 or 0 to F. Use the left and right buttons to move between the numbers.
  - f. Press the select button to retain the numbers that you have updated and return to the WWNN panel.
  - g. Press the select button to apply the numbers as the new WWNN for the node.
7. Install the replacement node and the uninterruptible power supply in the rack and connect the uninterruptible power supply cables. See the *IBM System Storage SAN Volume Controller Hardware Installation Guide* to determine how to connect the node and the uninterruptible power supply.

**Important:** Do not connect the fibre-channel cables during this step.

- 8. Power-on the replacement node.
- 9. Record the WWNN of the replacement node. You can use this WWNN if you plan to reuse the node that you are replacing.
- 10. Perform the following steps to change the WWNN of the replacement node to match the WWNN that you recorded in step 2 on page 266:

For SAN Volume Controller V4.3:

- a. With the Node WWNN: panel displayed, press and hold the down button, press and release the select button, and then release the down button. The display switches into edit mode. Edit WWNN is displayed on line 1. Line 2 of the display contains the last five numbers of the WWNN.
- b. Change the WWNN that is displayed to match the last five numbers of the WWNN that you recorded in step 2 on page 266. To edit the highlighted number, use the up and down buttons to increase or decrease the numbers. The numbers wrap F to 0 or 0 to F. Use the left and right buttons to move between the numbers.
- c. Press the select button to apply the numbers as the new WWNN for the node.

For SAN Volume Controller versions prior to V4.3:

- a. Press and release the right button until the Status: panel is displayed.
- b. With the node status displayed on the front panel, press and hold the down button; press and release the select button; release the down button. WWNN is displayed on line 1 of the display. Line 2 of the display contains the last five numbers of the WWNN.
- c. With the WWNN displayed on the front panel; press and hold the down button; press and release the select button; release the down button. The display switches into edit mode. To edit the highlighted number, use the up and down buttons to increase or decrease the numbers. The numbers wrap F to 0 or 0 to F. Use the left and right buttons to move between the numbers.
- d. When the five numbers match the last five numbers of the WWNN that you recorded in step 2 on page 266, press the select button to retain the numbers that you have updated and return to the WWNN panel.
- e. Press the select button to apply the numbers as the new WWNN for the node.

Wait one minute. If Cluster: is displayed on the front panel, this indicates that the node is ready to be added to the cluster. If Cluster: does not display,

see the *IBM System Storage SAN Volume Controller Troubleshooting Guide* to determine how to address this problem or contact the IBM Support Center before you continue with the next step.

11. Connect the fibre-channel cables to the same port numbers that you recorded for the original node in 3 on page 266.
12. Issue the following CLI command to verify that the last five characters of the WWNN are correct:

```
svcinfo lsnodecandidate
```

**Important:** If the WWNN is not what you recorded in step 2 on page 266, you must repeat step 10 on page 268.

13. Issue the following CLI command to add the node to the cluster and ensure that the node has the same name as the original node and is in the same I/O group as the original node. See the **svctask addnode** CLI command in the *IBM System Storage SAN Volume Controller Command-Line Interface User's Guide* for more information.

```
svctask addnode -wwnodename WWNN -iogrp iogroupname/id -name nodename
```

where *WWNN*, *iogroupname/id*, and *nodename* are the values that you recorded for the original node. If the original node's name was automatically assigned by SAN Volume Controller, it is not possible to reuse the same name. It was automatically assigned if its name starts with **node**. In this case, either specify a different name that does not start with **node** or do not use the **-name** parameter so that SAN Volume Controller automatically assigns a new name to the node.

If necessary, the new node is updated to the same SAN Volume Controller version as the cluster. This update can take up to 20 minutes.

**Important:**

- a. Both nodes in the I/O group cache data; however, the cache sizes are asymmetric if the remaining partner node in the I/O group is a SAN Volume Controller 2145-4F2 node. The replacement node is limited by the cache size of the partner node in the I/O group. Therefore, the replacement node does not utilize the full 8 GB cache size until you replace the other SAN Volume Controller 2145-4F2 node in the I/O group.
  - b. You do not have to reconfigure the host multipathing device drivers because the replacement node uses the same WWNN and WWPN as the previous node. The multipathing device drivers should detect the recovery of paths that are available to the replacement node.
  - c. The host multipathing device drivers take approximately 30 minutes to recover the paths. Do not upgrade the other node in the I/O group until for at least 30 minutes after you have successfully upgraded the first node in the I/O group. If you have other nodes in different I/O groups to upgrade, you can perform those upgrades while you wait.
14. See the documentation that is provided with your multipathing device driver for information on how to query paths to ensure that all paths have been recovered before proceeding to the next step. If you are using the IBM System Storage Multipath Subsystem Device Driver (SDD), the command to query paths is **datapath query device**.
  15. Repeat steps 2 on page 266 to 14 for each node that you want to replace.

---

## Replacing nodes disruptively (re zoning the SAN)

You can replace SAN Volume Controller 2145-4F2, SAN Volume Controller 2145-8F2, or SAN Volume Controller 2145-8F4 nodes with SAN Volume Controller 2145-8G4 nodes. The following procedures are disruptive, because you do not use the same WWNN and WWPNS for the new node. You must rezone your SAN and the host multipathing device drivers must discover new paths. Access to virtual disks (VDisks) is lost during this task.

This task assumes that the following conditions exist:

- The cluster software is at 4.2.0 or higher
- All nodes that are configured in the cluster are present
- All errors in the cluster error log are fixed
- All managed disks (MDisks) are online
- You have a 2145 UPS-1U unit for each new SAN Volume Controller 2145-8G4 node.

Perform the following steps to replace nodes:

1. Quiesce all I/O from the hosts that access the I/O group of the node that you are replacing.
2. Delete the node that you want to replace from the cluster and I/O group.

**Notes:**

- a. The node is not deleted until the SAN Volume Controller cache is destaged to disk. During this time, the partner node in the I/O group transitions to write through mode.
  - b. You can use the command-line interface (CLI) or the SAN Volume Controller Console to verify that the deletion process has completed.
3. Ensure that the node is no longer a member of the cluster.
  4. Power-off the node and remove it from the rack.
  5. Install the replacement (new) node in the rack and connect the uninterruptible power supply cables and the fibre-channel cables.
  6. Power-on the node.
  7. Rezone your switch zones to remove the ports of the node that you are replacing from the host and storage zones. Replace these ports with the ports of the replacement node.
  8. Add the replacement node to the cluster and I/O group.

**Important:** Both nodes in the I/O group cache data; however, the cache sizes are asymmetric if the remaining partner node in the I/O group is a SAN Volume Controller 2145-4F2 node. The replacement node is limited by the cache size of the partner node in the I/O group. Therefore, the replacement node does not use the full 8 GB cache size until you replace the other SAN Volume Controller 2145-4F2 node in the I/O group.

9. From each host, issue a rescan of the multipathing software to discover the new paths to VDisks.

**Notes:**

- a. If your system is inactive, you can perform this step after you have replaced all nodes in the cluster.

- b. The host multipathing device drivers take approximately 30 minutes to recover the paths. Do not upgrade the other node in the I/O group until for at least 30 minutes after you have successfully upgraded the first node in the I/O group. If you have other nodes in different I/O groups to upgrade, you can perform those upgrades while you wait.
10. See the documentation that is provided with your multipathing device driver for information on how to query paths to ensure that all paths have been recovered before proceeding to the next step.
11. Repeat steps 1 on page 270 to 10 for the partner node in the I/O group.
12. Repeat steps 1 on page 270 to 11 for each node in the cluster that you want to replace.
13. Resume host I/O.

---

## Replacing nodes disruptively (moving VDisks to new I/O group)

You can replace SAN Volume Controller 2145-4F2, SAN Volume Controller 2145-8F2, or SAN Volume Controller 2145-8F4 nodes with SAN Volume Controller 2145-8G4 nodes. The following procedures are disruptive, because you move VDisks to a new I/O group.

This task assumes the following:

- The cluster software is at 4.2.0 or higher
- Your cluster contains six or less nodes
- All nodes that are configured in the cluster are present
- All errors in the cluster error log are fixed
- All managed disks (MDisks) are online
- You have a 2145 UPS-1U unit for each new SAN Volume Controller 2145-8G4 node.

Perform the following steps to replace nodes:

1. Quiesce all I/O from the hosts that access the I/O groups of the nodes that you are replacing.
2. Add two replacement nodes to the cluster to create a new I/O group.
3. Rezone your switch zones to add the ports of the new nodes to the host and storage zones.
4. Move all of the VDisks from the I/O group of the nodes that you are replacing to the new I/O group.
5. From each host, issue a rescan of the multipathing software to discover the new paths to VDisks. The host multipathing device drivers take approximately 30 minutes to recover the paths. Do not upgrade the other node in the I/O group until for at least 30 minutes after you have successfully upgraded the first node in the I/O group. If you have other nodes in different I/O groups to upgrade, you can perform those upgrades while you wait.
6. See the documentation that is provided with your multipathing device driver for information on how to query paths to ensure that all paths have been recovered before proceeding to the next step.
7. Delete the nodes that you are replacing from the cluster and remove the ports from the switch zones.
8. Repeat steps 1 to 7 for each node in the cluster that you want to replace.

---

## Adding SAN Volume Controller 2145-8A4 nodes to an existing cluster

You can add SAN Volume Controller 2145-8A4 nodes to your cluster.

This task requires that the following conditions are met:

- The cluster software version is 4.3.1 or higher
  - All nodes that are configured in the cluster are present
  - All errors in the cluster error log are fixed
  - All managed disks (MDisks) are online
1. Install the SAN Volume Controller 2145-8A4 nodes and the 2145 UPS-1U units in the rack.
  2. Connect the SAN Volume Controller 2145-8A4 nodes to the LAN.
  3. Connect the SAN Volume Controller 2145-8A4 nodes to the SAN fabric.
  4. Power on the SAN Volume Controller 2145-8A4 nodes and the 2145 UPS-1U units.
  5. Zone the SAN Volume Controller 2145-8A4 node ports in the existing SAN Volume Controller zone. The SAN Volume Controller zone exists in each fabric with only node ports.
  6. Zone the SAN Volume Controller 2145-8A4 node ports in the existing SAN Volume Controller and storage zone. A storage zone contains all of the SAN Volume Controller 2145-8A4 node ports and controller ports that are in the fabric and used to access the physical disks.
  7. For each system that is used with the SAN Volume Controller cluster, use the system management application to map the LUNs that are currently used by the cluster to all of the WWPNs of the SAN Volume Controller 2145-8A4 nodes that you want to add to the cluster. The SAN Volume Controller 2145-8A4 nodes must recognize the same LUNs that the existing nodes in the cluster can recognize before they can be added to the cluster. If the SAN Volume Controller 2145-8A4 nodes cannot recognize the same LUNs, the system is marked degraded.
  8. Add the SAN Volume Controller 2145-8A4 nodes to the cluster.
  9. Check the status of the systems and MDisks to ensure that status has not been marked degraded. If the status is degraded, there is a configuration problem that must be resolved before any further cluster configuration tasks can be performed. If the problem cannot be resolved, remove the newly added SAN Volume Controller 2145-8A4 nodes from the cluster and contact the IBM Support Center for assistance.

---

## Adding SAN Volume Controller 2145-8G4 nodes to an existing cluster

You can add SAN Volume Controller 2145-8G4 to increase the size of your cluster.

This task assumes that the following conditions exist:

- The cluster software version is 4.2.0 or higher
  - All nodes that are configured in the cluster are present
  - All errors in the cluster error log are fixed
  - All managed disks (MDisks) are online
1. Install the SAN Volume Controller 2145-8G4 nodes and the 2145 UPS-1U units in the rack.
  2. Connect the SAN Volume Controller 2145-8G4 nodes to the LAN.
  3. Connect the SAN Volume Controller 2145-8G4 nodes to the SAN fabric.

4. Power on the SAN Volume Controller 2145-8G4 nodes and the 2145 UPS-1U units.
5. Zone the SAN Volume Controller 2145-8G4 node ports in the existing SAN Volume Controller zone. A SAN Volume Controller zone should exist in each fabric with only node ports.
6. Zone the SAN Volume Controller 2145-8G4 node ports in the existing SAN Volume Controller and storage zone. A storage zone should contain all of the SAN Volume Controller 2145-8G4 node ports and controller ports that are in the fabric and used to access the physical disks.
7. For each system that is used with the SAN Volume Controller cluster, use the system management application to map the LUNs that are currently used by the cluster to all of the WWPNs of the SAN Volume Controller 2145-8G4 nodes that you want to add to the cluster. The SAN Volume Controller 2145-8G4 nodes must see the same LUNs that the existing nodes in the cluster can see before they can be added to the cluster. If the SAN Volume Controller 2145-8G4 nodes cannot see the same LUNs, the system is marked degraded.
8. Add the SAN Volume Controller 2145-8G4 nodes to the cluster.
9. Check the status of the systems and MDisks to ensure that status has not been marked degraded. If the status is degraded, there is a configuration problem that must be resolved before any further cluster configuration tasks can be performed. If the problem cannot be resolved, remove the newly added SAN Volume Controller 2145-8G4 nodes from the cluster and contact the IBM Support Center for assistance.

---

## Adding SAN Volume Controller 2145-8F4 nodes to an existing cluster

You can add SAN Volume Controller 2145-8F4 to increase the size of your cluster.

This task assumes that the following conditions exist:

- The cluster software version is 4.2.0 or higher
  - All nodes that are configured in the cluster are present
  - All errors in the cluster error log are fixed
  - All managed disks (MDisks) are online
1. Install the SAN Volume Controller 2145-8F4 nodes and the 2145 UPS-1U units in the rack.
  2. Connect the SAN Volume Controller 2145-8F4 nodes to the LAN.
  3. Connect the SAN Volume Controller 2145-8F4 nodes to the SAN fabric.
  4. Power on the SAN Volume Controller 2145-8F4 nodes and the 2145 UPS-1U units.
  5. Zone the SAN Volume Controller 2145-8F4 node ports in the existing SAN Volume Controller zone. A SAN Volume Controller zone should exist in each fabric with only node ports.
  6. Zone the SAN Volume Controller 2145-8F4 node ports in the existing SAN Volume Controller and storage zone. A storage zone should contain all of the SAN Volume Controller 2145-8F4 node ports and controller ports that are in the fabric and used to access the physical disks.
  7. For each system that is used with the SAN Volume Controller cluster, use the system management application to map the LUNs that are currently used by the cluster to all of the WWPNs of the SAN Volume Controller 2145-8F4 nodes that you want to add to the cluster. The SAN Volume Controller 2145-8F4 nodes must see the same LUNs that the existing nodes in the cluster can see

before they can be added to the cluster. If the SAN Volume Controller 2145-8F4 nodes cannot see the same LUNs, the system is marked degraded.

8. Add the SAN Volume Controller 2145-8F4 nodes to the cluster.
9. Check the status of the systems and MDisks to ensure that status has not been marked degraded. If the status is degraded, there is a configuration problem that must be resolved before any further cluster configuration tasks can be performed. If the problem cannot be resolved, remove the newly added SAN Volume Controller 2145-8F4 nodes from the cluster and contact the IBM Support Center for assistance.

---

## Adding SAN Volume Controller 2145-8F2 nodes to an existing cluster

You can add SAN Volume Controller 2145-8F2 nodes to increase the size of your cluster.

This task assumes that the following conditions exist:

- The cluster software version is 3.1.0 or higher
  - All nodes that are configured in the cluster are present
  - All errors in the cluster error log are fixed
  - All managed disks (MDisks) are online
1. Install the SAN Volume Controller 2145-8F2 nodes and the uninterruptible power supply units in the rack.
  2. Connect the SAN Volume Controller 2145-8F2 nodes to the LAN.
  3. Connect the SAN Volume Controller 2145-8F2 nodes to the SAN fabric.
  4. Power on the SAN Volume Controller 2145-8F2 nodes and the uninterruptible power supply units.
  5. Zone the SAN Volume Controller 2145-8F2 node ports in the existing SAN Volume Controller zone. A SAN Volume Controller zone should exist in each fabric with only node ports.
  6. Zone the SAN Volume Controller 2145-8F2 node ports in the existing SAN Volume Controller and storage zone. A storage zone should contain all of the SAN Volume Controller 2145-8F2 node ports and controller ports that are in the fabric and used to access the physical disks.
  7. For each system that is used with the SAN Volume Controller cluster, use the system management application to map the LUNs that are currently used by the cluster to all of the WWPNs of the SAN Volume Controller 2145-8F2 nodes that you want to add to the cluster. The SAN Volume Controller 2145-8F2 nodes must see the same LUNs that the existing nodes in the cluster can see before they can be added to the cluster. If the SAN Volume Controller 2145-8F2 nodes cannot see the same LUNs, the system is marked degraded.
  8. Add the SAN Volume Controller 2145-8F2 nodes to the cluster.
  9. Check the status of the systems and MDisks to ensure that status has not been marked degraded. If the status is degraded, there is a configuration problem that must be resolved before any further cluster configuration tasks can be performed. If the problem cannot be resolved, remove the newly added SAN Volume Controller 2145-8F2 nodes from the cluster and contact the IBM Support Center for assistance.



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## Adding SAN Volume Controller 2145-4F2 nodes to an existing cluster

You can add SAN Volume Controller 2145-4F2 nodes to increase the size of your cluster.

This task assumes that the following conditions exist:

- The cluster software version is 3.1.0 or higher
  - All nodes that are configured in the cluster are present
  - All errors in the cluster error log are fixed
  - All managed disks (MDisks) are online
1. Install the SAN Volume Controller 2145-4F2 nodes and the uninterruptible power supply units in the rack.
  2. Connect the SAN Volume Controller 2145-4F2 nodes to the LAN.
  3. Connect the SAN Volume Controller 2145-4F2 nodes to the SAN fabric.
  4. Power on the SAN Volume Controller 2145-4F2 nodes and the uninterruptible power supply units.
  5. Zone the SAN Volume Controller 2145-4F2 node ports in the existing SAN Volume Controller zone. A SAN Volume Controller zone should exist in each fabric with only node ports.
  6. Zone the SAN Volume Controller 2145-4F2 node ports in the existing SAN Volume Controller and storage zone. A storage zone should contain all of the SAN Volume Controller 2145-4F2 node ports and controller ports that are in the fabric and used to access the physical disks.
  7. For each system that is used with the SAN Volume Controller cluster, use the system management application to map the LUNs that are currently used by the cluster to all of the WWPNs of the SAN Volume Controller 2145-4F2 nodes that you want to add to the cluster. The SAN Volume Controller 2145-4F2 nodes must see the same LUNs that the existing nodes in the cluster can see before they can be added to the cluster. If the SAN Volume Controller 2145-4F2 nodes cannot see the same LUNs, the system is marked degraded.
  8. Add the SAN Volume Controller 2145-4F2 nodes to the cluster.
  9. Check the status of the systems and MDisks to ensure that status has not been marked degraded. If the status is degraded, there is a configuration problem that must be resolved before any further cluster configuration tasks can be performed. If the problem cannot be resolved, remove the newly added SAN Volume Controller 2145-4F2 nodes from the cluster and contact the IBM Support Center for assistance.

---

## Replacing a faulty node in the cluster using the CLI

You can use the command-line interface (CLI) to replace a faulty node in the cluster.

Before you attempt to replace a faulty node with a spare node you must ensure that you meet the following requirements:

- SAN Volume Controller version 3.1.0 or higher is installed on the cluster and on the spare node.
- You know the name of the cluster that contains the faulty node.
- A spare node is installed in the same rack as the cluster that contains the faulty node.

- You must make a record of the last five characters of the original worldwide node name (WWNN) of the spare node. You will need this information, if and when, you want to stop using this node as a spare node.

If a node fails, the cluster continues to operate with degraded performance until the faulty node is repaired. If the repair operation takes an unacceptable amount of time, it is useful to replace the faulty node with a spare node. However, the appropriate procedures must be followed and precautions must be taken so you do *not* interrupt I/O operations and compromise the integrity of your data.

The following table describes the changes that are made to your configuration when you replace a faulty node in the cluster:

| Node attributes               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |                  |                               |       |             |                  |             |                  |             |                  |             |                  |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------|-------------------------------|-------|-------------|------------------|-------------|------------------|-------------|------------------|-------------|------------------|
| Front panel ID                | This is the number that is printed on the front of the node and is used to select the node that is added to a cluster.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |                  |                               |       |             |                  |             |                  |             |                  |             |                  |
| Node ID                       | This is the ID that is assigned to the node. A new node ID is assigned each time a node is added to a cluster; the node name remains the same following service activity on the cluster. You can use the node ID or the node name to perform management tasks on the cluster. However, if you are using scripts to perform those tasks, use the node name rather than the node ID. This ID will change during this procedure.                                                                                                                                                                                                                                                                                                                          |      |                  |                               |       |             |                  |             |                  |             |                  |             |                  |
| Node name                     | This is the name that is assigned to the node. If you do not specify a name, the SAN Volume Controller assigns a default name. The SAN Volume Controller creates a new default name each time a node is added to a cluster. If you choose to assign your own names, you must type the node name on the Adding a node to a cluster panel. You cannot manually assign a name that matches the naming convention used for names assigned automatically by SAN Volume Controller. If you are using scripts to perform management tasks on the cluster and those scripts use the node name, you can avoid the need to make changes to the scripts by assigning the original name of the node to a spare node. This name might change during this procedure. |      |                  |                               |       |             |                  |             |                  |             |                  |             |                  |
| Worldwide node name           | This is the WWNN that is assigned to the node. The WWNN is used to uniquely identify the node and the fibre-channel ports. During this procedure, the WWNN of the spare node changes to that of the faulty node. The node replacement procedures must be followed exactly to avoid any duplication of WWNNs. This name does not change during this procedure.                                                                                                                                                                                                                                                                                                                                                                                          |      |                  |                               |       |             |                  |             |                  |             |                  |             |                  |
| Worldwide port names          | <p>These are the WWPNS that are assigned to the node. WWPNS are derived from the WWNN that is written to the spare node as part of this procedure. For example, if the WWNN for a node is 50050768010000F6, the four WWPNS for this node are derived as follows:</p> <table> <tbody> <tr> <td>WWNN</td> <td>50050768010000F6</td> </tr> <tr> <td>WWNN displayed on front panel</td> <td>000F6</td> </tr> <tr> <td>WWPN Port 1</td> <td>50050768014000F6</td> </tr> <tr> <td>WWPN Port 2</td> <td>50050768013000F6</td> </tr> <tr> <td>WWPN Port 3</td> <td>50050768011000F6</td> </tr> <tr> <td>WWPN Port 4</td> <td>50050768012000F6</td> </tr> </tbody> </table> <p>These names do not change during this procedure.</p>                             | WWNN | 50050768010000F6 | WWNN displayed on front panel | 000F6 | WWPN Port 1 | 50050768014000F6 | WWPN Port 2 | 50050768013000F6 | WWPN Port 3 | 50050768011000F6 | WWPN Port 4 | 50050768012000F6 |
| WWNN                          | 50050768010000F6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |                  |                               |       |             |                  |             |                  |             |                  |             |                  |
| WWNN displayed on front panel | 000F6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |                  |                               |       |             |                  |             |                  |             |                  |             |                  |
| WWPN Port 1                   | 50050768014000F6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |                  |                               |       |             |                  |             |                  |             |                  |             |                  |
| WWPN Port 2                   | 50050768013000F6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |                  |                               |       |             |                  |             |                  |             |                  |             |                  |
| WWPN Port 3                   | 50050768011000F6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |                  |                               |       |             |                  |             |                  |             |                  |             |                  |
| WWPN Port 4                   | 50050768012000F6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |                  |                               |       |             |                  |             |                  |             |                  |             |                  |

Perform the following steps to replace a faulty node in the cluster:

1. Verify the name and ID of the node that you want to replace.  
Perform the following step to verify the name and ID:
  - a. Issue the **svcinfo lsnode** CLI command to ensure that the partner node in the I/O group is online.
    - If the other node in the I/O group is offline, start Directed Maintenance Procedures (DMPs) to determine the fault.
    - If you have been directed here by the DMPs, and subsequently the partner node in the I/O group has failed, see the procedure for recovering from offline VDisks after a node or an I/O group failed.
    - If you are replacing the node for other reasons, determine the node you want to replace and ensure that the partner node in the I/O group is online.
    - If the partner node is offline, you will lose access to the VDisks that belong to this I/O group. Start the DMPs and fix the other node before proceeding to the next step.
2. Find and record the following information about the faulty node:
  - Node serial number
  - Worldwide node name
  - All of the worldwide port names
  - Name or ID of the I/O group that contains the node
  - Front panel ID
  - Uninterruptible power supply serial number
  - a. Issue the **svcinfo lsnode** CLI command to find and record the node name and I/O group name. The faulty node will be offline.
  - b. Record the following information about the faulty node:
    - Node name
    - I/O group name
  - c. Issue the following CLI command:
 

```
svcinfo lsnodevpd nodename
```

 Where *nodename* is the name that you recorded in step 1.
  - d. Find the WWNN field in the output.
  - e. Record the last five characters of the WWNN.
  - f. Find the `front_panel_id` field in the output.
  - g. Record the front panel ID.
  - h. Find the `UPS_serial_number` field in the output.
  - i. Record the uninterruptible power supply serial number.
3. Ensure that the faulty node has been powered off.
4. Issue the following CLI command to remove the faulty node from the cluster:
 

```
svctask rmnode nodename/id
```

 Where *nodename/id* is the name or ID of the faulty node.  
*Remember* to record the following information to avoid data corruption when this node is re-added to the cluster:
  - Node serial number
  - WWNN
  - All WWPNS
  - I/O group that contains the node
5. Disconnect all four fibre-channel cables from the node.

**Important:** Do not plug the fibre-channel cables into the spare node until the spare node is configured with the WWNN of the faulty node.

6. Connect the power and signal cables from the spare node to the uninterruptible power supply that has the serial number you recorded in step 2i on page 277.

**Note:** For 2145 UPS units, you can plug the signal cable into any vacant position on the top row of serial connectors on the 2145 UPS. If no spare serial connectors are available on the 2145 UPS, disconnect the cables from the faulty node. For 2145 UPS-1U units, you must disconnect the cables from the faulty node.

7. Power on the spare node.
8. Display the node status on the front-panel display.
9. You must change the WWNN of the spare node (with SAN Volume Controller V4.3 and above installed) to that of the faulty node. The procedure for doing this depends on the SAN Volume Controller version that is installed on the spare node. Press and release the down button until the Node: panel displays. Then press and release the right button until the WWNN: panel displays. If repeated pressing of the right button returns you to the Node: panel, without displaying a WWNN: panel, go to step 11; otherwise, continue with step 10.
10. Change the WWNN of the spare node (with SAN Volume Controller V4.3 and above installed) to match the WWNN of the faulty node by performing the following steps:
  - a. With the Node WWNN: panel displayed, press and hold the down button, press and release the select button, and then release the down button. The display switches into edit mode. Edit WWNN is displayed on line 1. Line 2 of the display contains the last five numbers of the WWNN.
  - b. Change the WWNN that is displayed to match the last five numbers of the WWNN that you recorded in step 2e on page 277. To edit the highlighted number, use the up and down buttons to increase or decrease the numbers. The numbers wrap F to 0 or 0 to F. Use the left and right buttons to move between the numbers.
  - c. When the five numbers match the last five numbers of the WWNN that you recorded in step 2e on page 277, press the select button to accept the numbers.
11. Change the WWNN of the spare node (with SAN Volume Controller versions prior to V4.3 installed) to match the WWNN of the faulty node by performing the following steps:
  - a. Press and release the right button until the Status: panel is displayed.
  - b. With the node status displayed on the front panel, press and hold the down button; press and release the select button; release the down button. WWNN is displayed on line 1 of the display. Line 2 of the display contains the last five numbers of the WWNN.
  - c. With the WWNN displayed on the front panel; press and hold the down button; press and release the select button; release the down button. The display switches into edit mode.
  - d. Change the WWNN that is displayed to match the last five numbers of the WWNN that you recorded in step 2e on page 277. To edit the highlighted number, use the up and down buttons to increase or decrease the numbers. The numbers wrap F to 0 or 0 to F. Use the left and right buttons to move between the numbers.

- e. When the five numbers match the last five numbers of the WWNN that you recorded in step 2e on page 277, press the select button to retain the numbers that you have updated and return to the WWNN panel.
  - f. Press the select button to apply the numbers as the new WWNN for the node.
12. Connect the four fibre-channel cables that you disconnected from the faulty node and connect them to the spare node.  
If an Ethernet cable has not been connected to the spare node, disconnect the Ethernet cable from the faulty node and connect it to the spare node.
  13. Issue the following command to add the spare node to the cluster:  

```
svctask addnode -wwnodename WWNN -iogrp iogroupname/id -name nodename
```

where *WWNN* is the WWNN of the node, *iogroupname/id* is the name or ID of the I/O group and *nodename* is the name of the node. If possible, use the same node name that was used for the faulty node. If necessary, the spare node is updated to the same SAN Volume Controller version as the cluster. This update can take up to 20 minutes.
  14. Use the tools that are provided with your multipathing device driver on the host systems to verify that all paths are now online. See the documentation that is provided with your multipathing device driver for more information. For example, if you are using the subsystem device driver (SDD), see the *IBM System Storage Multipath Subsystem Device Driver User's Guide* for instructions on how to use the SDD management tool on host systems. It might take up to 30 minutes for the paths to come online.
  15. Repair the faulty node.  
**Attention:** When the faulty node is repaired, do not connect the fibre-channel cables to it. Connecting the cables might cause data corruption because the spare node is using the same WWNN as the faulty node.  
If you want to use the repaired node as a spare node, perform the following steps.  
**For SAN Volume Controller V4.3 and above:**
    - a. With the Node WWNN: panel displayed, press and hold the down button, press and release the select button, and then release the down button.
    - b. The display switches into edit mode. Edit WWNN is displayed on line 1. Line 2 of the display contains the last five numbers of the WWNN.
    - c. Change the displayed number to 00000. To edit the highlighted number, use the up and down buttons to increase or decrease the numbers. The numbers wrap F to 0 or 0 to F. Use the left and right buttons to move between the numbers.
    - d. Press the select button to accept the numbers.  
This node can now be used as a spare node.**For SAN Volume Controller versions prior to V4.3:**
    - a. Press and release the right button until the Status: panel is displayed.
    - b. With the node status displayed on the front panel, press and hold the down button; press and release the select button; release the down button. WWNN is displayed on line 1 of the display. Line 2 of the display contains the last five numbers of the WWNN.
    - c. With the WWNN displayed on the front panel; press and hold the down button; press and release the select button; release the down button. The display switches into edit mode.

- d. Change the displayed number to 00000. To edit the highlighted number, use the up and down buttons to increase or decrease the numbers. The numbers wrap F to 0 or 0 to F. Use the left and right buttons to move between the numbers.
- e. Press the select button to accept the numbers.
- f. Press the select button to retain the numbers that you have updated and return to the WWNN panel.

This node can now be used as a spare node.

**Attention:** Never connect a node with a WWNN of 00000 to the cluster. If this node is no longer required as a spare and is to be used for normal attachment to a cluster, you must change the WWNN to the number you recorded when a spare was created. Using any other number might cause data corruption.

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## Chapter 11. Configuring and servicing storage systems

To avoid performance issues, you must ensure that your storage systems and switches are correctly configured to work with the SAN Volume Controller.

Virtualization provides many benefits over direct-attached or direct SAN-attached storage systems. However, virtualization is more susceptible to performance hot spots than direct-attached storage. Hot spots can cause I/O errors on your hosts and can potentially cause a loss of access to data.

---

### Identifying your storage system

The serial number that is presented by the command-line interface (CLI) and the SAN Volume Controller Console for the SAN Volume Controller is the serial number of the device.

The serial numbers can be viewed on your storage system. If the serial numbers are not displayed, the worldwide node name (WWNN) or worldwide port name (WWPN) is displayed. The WWNN or WWPN can be used to identify the different storage systems.

---

### Configuration guidelines for storage systems

You must follow the guidelines and procedures for your storage system to maximize performance and to avoid potential I/O problems.

#### General guidelines

You must follow these general guidelines when configuring your storage systems.

- Avoid splitting arrays into multiple logical disks at the storage system level. Where possible, create a single logical disk from the entire capacity of the array.
- Depending on the redundancy that is required, create RAID-5 arrays using between 5 and 8 plus parity components. That is 5 + P, 6 + P, 7 + P or 8 + P.
- Do not mix managed disks (MDisks) that greatly vary in performance in the same MDisk group. The overall MDisk group performance is limited by the slowest MDisk. Because some disk controllers can sustain much higher I/O bandwidths than others, do not mix MDisks that are provided by low-end storage systems with those that are provided by high-end storage systems. You must consider the following factors:
  - The underlying RAID type that the storage system is using to implement the MDisk.
  - The number of physical disks in the RAID array and the physical disk type. For example: 10K/15K rpm, FC/SATA.
- When possible, include similarly sized MDisks in an MDisk group. This makes it easier to balance the MDisks in the group. If the MDisks in an MDisk group are significantly different sizes, you can balance the proportion of space that is allocated on each MDisk by including the larger MDisk multiple times in the MDisk list. This is specified when you create a new VDisk. For example, if you have two 400 MB disks and one 800 MB disk that are identified as MDisk 0, 1, and 2, you can create the striped VDisk with the MDisk IDs of 0:1:2:2. This

doubles the number of extents on the 800 MB drive, which accommodates it being double the size of the other MDisks.

- Avoid leaving VDIs in image mode. Only use image mode to import existing data into the cluster. To optimize the benefits of virtualization, migrate this data across the other MDisks in the group as soon as possible.
- Follow the FlashCopy feature requirements before you set up the storage. Balance the spread of the FlashCopy VDIs across the MDisk groups and then across the storage systems. The I/O characteristics of the application that is writing to the source VDisk also affects the impact that FlashCopy operations have on your overall I/O throughput.
- Perform the appropriate calculations to ensure that your storage systems are configured correctly.
- If any controller that is associated with an MDisk has the **allowquorum** parameter set to **no**, the **setquorum** command will fail for that MDisk. Before setting the **allowquorum** parameter to **yes** on any controller, check the following Web site for controller configuration requirements.  
<http://www.ibm.com/storage/support/2145>

## Logical disk configuration guidelines for storage systems

Most storage systems provide some mechanism to create multiple logical disks from a single array. This is useful when the storage system presents storage directly to the hosts.

However, in a virtualized SAN, use a one-to-one mapping between arrays and logical disks so that the subsequent load calculations and the managed disk (MDisk) and MDisk group configuration tasks are simplified.

### Scenario: the logical disks are uneven

In this scenario, you have two RAID-5 arrays and both contain 5 + P components. Array A has a single logical disk that is presented to the SAN Volume Controller cluster. This logical disk is seen by the cluster as mdisk0. Array B has three logical disks that are presented to the cluster. These logical disks are seen by the cluster as mdisk1, mdisk2 and mdisk3. All four MDisks are assigned to the same MDisk group that is named mdisk\_grp0. When a virtual disk (VDisk) is created by striping across this group, array A presents the first extent and array B presents the next three extents. As a result, when the system reads and writes to the VDisk, the loading is split 25% on the disks in array A and 75% on the disks in array B. The performance of the VDisk is about one third of what array B can sustain.

The uneven logical disks cause performance degradation and complexity in a simple configuration. You can avoid uneven logical disks by creating a single logical disk from each array.

## RAID array configuration guidelines for storage systems

With virtualization, ensure that the storage devices are configured to provide some type of redundancy against hard disk failures.

A failure of a storage device can affect a larger amount of storage that is presented to the hosts. To provide redundancy, storage devices can be configured as RAID arrays that use either mirroring or parity to protect against single failures.

When creating RAID arrays with parity protection (for example, RAID-5 arrays) consider how many component disks you want to use in each array. If you use a



large amount of disks, you can reduce the number of disks that are required to provide availability for the same total capacity (1 per array). However, more disks mean that it takes a longer time to rebuild a replacement disk after a disk failure, and during this period a second disk failure causes a loss of all array data. More data is affected by a disk failure for a larger number of member disks because performance is reduced while you rebuild onto a hot spare (a redundant disk) and more data is exposed if a second disk fails before the rebuild operation is complete. The smaller the number of disks, the more likely it is that write operations span an entire stripe (stripe size, multiplied by the number of members, minus one). In this case, write performance is improved. The number of disk drives required to provide availability can be unacceptable if arrays are too small.

**Notes:**

1. For optimal performance, use arrays with between 6 and 8 member disks.
2. When creating RAID arrays with mirroring, the number of component disks in each array does not affect redundancy or performance.

## **Optimal MDisk group configuration guidelines for storage systems**

A managed disk (MDisk) group provides the pool of storage from which virtual disks (VDisks) are created. You must ensure that the entire pool of storage provides the same performance and reliability characteristics.

**Notes:**

1. The performance of an MDisk group is generally governed by the slowest MDisk in the group.
2. The reliability of an MDisk group is generally governed by the weakest MDisk in the group.
3. If a single MDisk in a group fails, access to the entire group is lost.

Use the following guidelines when you group similar disks:

- Group equally performing MDisks in a single group.
- Group similar arrays in a single group. For example, configure all 6 + P RAID-5 arrays in one group.
- Group MDisks from the same type of storage system in a single group.
- Group MDisks that use the same type of underlying physical disk in a single group. For example, group MDisks by fibre-channel or SATA.
- Do not use single disks. Single disks do not provide redundancy. Failure of a single disk results in total data loss of the MDisk group to which it is assigned.

### **Scenario: Similar disks are not grouped together**

Under one scenario, you could have two storage systems that are attached behind your SAN Volume Controller. One device is an IBM TotalStorage Enterprise Storage Server (ESS), which contains ten 6 + P RAID-5 arrays and MDisks 0 through 9. The other device is an IBM FASTT200, which contains a single RAID-1 array, MDisk10, one single JBOD, MDisk11, and a large 15 + P RAID-5 array, MDisk12.

If you assigned MDisks 0 through 9 and MDisk11 into a single MDisk group, and the JBOD MDisk11 fails, you lose access to all of the IBM ESS arrays, even though

they are online. The performance is limited to the performance of the JBOD in the IBM FAStT storage system, therefore slowing down the IBM ESS arrays.

To fix this problem, you can create three groups. The first group must contain the IBM ESS arrays, MDisks 0 through 9, the second group must contain the RAID-1 array, and the third group must contain the large RAID-5 array.

## FlashCopy mapping guidelines for storage systems

Ensure that you have considered the type of I/O and frequency of update before you create the virtual disks (VDisks) that you want to use in FlashCopy mappings.

FlashCopy operations perform in direct proportion to the performance of the source and target disks. If you have a fast source disk and slow target disk, the performance of the source disk is reduced because it has to wait for the write operation to occur at the target before it can write to the source.

The FlashCopy implementation that is provided by the SAN Volume Controller copies at least 256 K every time a write is made to the source. This means that *any* write involves at minimum a read of 256 K from the source, write of the same 256 K at the target, and a write of the original change at the target. Therefore, when an application performs small 4 K writes, this is translated into 256 K.

Because of this overhead, consider the type of I/O that your application performs during a FlashCopy operation. Ensure that you do not overload the storage. The calculations contain a heavy weighting when the FlashCopy feature is active. The weighting depends on the type of I/O that is performed. Random writes have a much higher overhead than sequential writes. For example, the sequential write would have copied the entire 256 K.

You can spread the FlashCopy source VDisks and the FlashCopy target VDisks between as many managed disk (MDisk) groups as possible. This limits the potential bottle-necking of a single storage system, (assuming that the MDisk groups contain MDisks from different storage systems). However, this can still result in potential bottle-necking if you want to maintain all your target VDisks on a single storage system. You must ensure that you add the appropriate weighting to your calculations.

## Image mode VDisks and data migration guidelines for storage systems

Image mode virtual disks (VDisks) enable you to import and then migrate existing data that is managed by the SAN Volume Controller cluster.

Ensure that you follow the guidelines for using image mode VDisks. This might be difficult because a configuration of logical disks and arrays that performs well in a direct SAN-attached environment can contain hot spots or hot component disks when they are connected through the cluster.

If the existing storage systems do not follow the configuration guidelines, consider stopping I/O operations on the host systems while you migrate the data into the cluster. If I/O operations are continued and the storage system does not follow the guidelines, I/O operations can fail at the hosts and ultimately loss of access to the data can occur.

| **Attention:** Migration commands fail if the target or source VDisk is offline, or if  
| there is insufficient quorum disk space to store the metadata. Correct the offline or  
| quorum disk condition and reissue the command.

The procedure for importing managed disks (MDisks) that contain existing data depends on the amount of free capacity you have in the cluster. You must have the same amount of free space in the cluster as the data that you want to migrate into the cluster. If you do not have this amount of available capacity, the migration causes the MDisk group to have an uneven distribution of data because some MDisks are more heavily loaded than others. Further migration operations are required to ensure an even distribution of data and subsequent I/O loading.

### **Migrating data with an equivalent amount of free capacity**

To prevent managed disks (MDisks) from having an uneven distribution of data, ensure that the cluster has the same amount of free space as the data that you want to migrate.

Perform the following steps to migrate data:

1. Stop all I/O operations from the hosts. Unmap the logical disks that contain the data from the hosts.
2. Create one or more MDisk groups with free capacity. Ensure that the MDisk groups have enough free capacity to contain all of the migrating data and that they have balanced data distribution.
3. Create an empty MDisk group. This temporarily contains the data that is imported.
4. Perform the following steps to create an image mode virtual disk (VDisk) from the first unmanaged-mode MDisk that contains the data to be imported:
  - a. Map one logical disk from the storage system to the SAN Volume Controller ports.
  - b. Issue the **svctask detectmdisk** command-line interface (CLI) command on the cluster or use the SAN Volume Controller Console to discover MDisks. The new unmanaged-mode MDisk that is found corresponds with the logical disk mapped in the previous step.
  - c. Create an image mode VDisk from this unmanaged-mode MDisk and assign it to the empty MDisk group that you just created.
  - d. Repeat steps 4a through 4c for all logical disks as required.
5. You can restart host applications by mapping the image mode VDIs to the hosts and restarting the hosts. Alternatively, you can wait until the migration is complete to map the VDIs to the hosts.
6. Perform the following steps to migrate the data to the MDisk groups that you created in step 2:
  - a. Select the first image mode VDisk to be migrated.
  - b. Using the **svctask migratevdisk** or **svctask migratetoimage** command, migrate this VDisk from its current MDisk group to one of the MDisk groups that you created in step 2. This migrates all of the data from the logical disk into the new free space.
  - c. Run the **svcinfolsmigrate** command to verify that the migration has completed.
  - d. Select the next image mode VDisk and repeat the previous step after the migration completes.

7. When all the VDIs have been migrated, the MDisk groups that you created in step 2 on page 285 contain the data that was on the image mode VDIs. The data is striped across the new groups and is virtualized.
8. Destroy the temporary MDisk group that contained the original image mode VDIs.
9. Go back to the storage system and reconfigure the old arrays and logical disks according to the guidelines.
10. Add this storage back under the SAN Volume Controller and use the old storage to create new VDIs.

### **Migrating data with a smaller amount of free capacity**

If the free capacity in the SAN Volume Controller cluster is smaller than the capacity of the data that is imported, you can still migrate data.

#### **Scenario**

Under one scenario, you could have one managed disk (MDisk) in the destination MDisk group. You add image mode logical units from an array on the storage system and migrate these logical units to the destination MDisk group. The logical units are then striped across the one managed-mode disk. Next, you add another logical unit to the destination MDisk group. The MDisk now contains two managed-mode disks, but all of the data is on the first managed-mode disk. As a result, some of the data must be migrated from the overloaded managed-mode disks to the underused managed-mode disks.

**Attention:** The migration causes an uneven distribution of data across the MDisks in the MDisk group. The impact of this depends on the number of MDisks that are initially in the MDisks group and how many of these have free capacity.

This task might require subsequent migration of data within the MDisk group in order to balance the distribution of data across the MDisks in the group.

Perform the following steps to migrate data:

1. Select an MDisk group that contains enough free capacity to migrate *all* of the logical disks on the first array that you want to migrate to the cluster.
2. Create an empty MDisk group that can temporarily contain the data that is imported.
3. Stop all I/O operations to the logical disks that you want to migrate first, and unmap these disks from their hosts.
4. Perform the following steps to create an image mode virtual disk (VDisk) from the first unmanaged-mode MDisk that contains the data that you want to import:
  - a. Map one logical disk from the storage system to the SAN Volume Controller ports.
  - b. Issue the **svctask detectmdisk** command-line interface (CLI) command on the cluster or use the SAN Volume Controller Console to discover MDisks. The new unmanaged-mode MDisk that is found corresponds with the logical disk that was mapped in the previous step.
  - c. Create an image mode VDisk from this unmanaged-mode MDisk and assign it to use the empty MDisk group just created.
  - d. Repeat steps 4a through 4c for all logical disks.

5. You can restart host applications by mapping the image mode VDisks to the hosts and restarting the hosts, using the SAN Volume Controller. Alternatively, you can wait until the migration is complete to map the VDisks to the hosts.
6. Perform the following steps to migrate the data into the MDisk groups that you created in step 1 on page 286:
  - a. Select the first image mode VDisk that you want to migrate.
  - b. Using the `svctask migratevdisk` or `svctask migratetoimage` command, migrate this VDisk from its current MDisk group to one of the MDisk groups that you created in step 2 on page 286. This migrates all of the data from the logical disk into the new free space.
  - c. Run the `svcinfolsmigrate` command to verify that the migration has completed.
  - d. Select the next image mode VDisk and repeat the previous step when the migration completes.
7. Perform the following steps to reconfigure the RAID array that contains the logical disks and add it to the MDisk group that you selected in step 1 on page 286:
  - a. Remove the MDisks from the temporary MDisk group.
  - b. At the storage system, unmap the logical disks that have been migrated from the SAN Volume Controller cluster and delete them from the array (if more than one existed).
  - c. Create a single logical disk that uses the entire array capacity.
  - d. Map this new logical disk to the SAN Volume Controller ports.
  - e. Issue the `svctask detectmdisk` CLI command on the cluster or use the SAN Volume Controller Console to discover MDisks. The new managed-mode MDisk that is found corresponds with the new logical disk that you created.
  - f. Add this managed-mode MDisk to the MDisk group that you selected in step 1 on page 286.
8. Repeat steps 3 on page 286 through 7 for the next array.

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## Configuring a balanced storage system

The attachment of a storage system to a SAN Volume Controller requires that specific settings are applied to the device.

There are two major steps to attaching a storage system to a SAN Volume Controller:

1. Setting the characteristics of the SAN Volume Controller to storage connections
2. Mapping logical units to these storage connections that allow the SAN Volume Controller to access the logical units

The virtualization features of the SAN Volume Controller enable you to choose how your storage is divided and presented to hosts. While virtualization provides you with a great deal of flexibility, it also offers the potential to set up an overloaded storage system. A storage system is overloaded if the quantity of I/O transactions that are issued by the host systems exceeds the capability of the storage to process those transactions. If a storage system is overloaded, it causes delays in the host systems and might cause I/O transactions to time out in the host. If I/O transactions time out, the host logs errors and I/Os fail to the applications.

### Scenario: You have an overloaded storage system

Under one scenario, you have used the SAN Volume Controller to virtualize a single RAID array and to divide the storage across 64 host systems. If all host systems attempt to access the storage at the same time, the single RAID array is overloaded.

Perform the following steps to configure a balanced storage system:

1. Use Table 14 to calculate the I/O rate for each RAID array in the storage system.

**Note:** The actual number of I/O operations per second that can be processed depends on the location and length of each I/O, whether the I/O is a read or a write operation and on the specifications of the component disks of the RAID array. For example, a RAID-5 array with eight component disks has an approximate I/O rate of  $150 \times 7 = 1050$ .

Table 14. Calculate the I/O rate

| Type of RAID array                                      | Number of component disks in the RAID array | Approximate I/O rate per second |
|---------------------------------------------------------|---------------------------------------------|---------------------------------|
| RAID-1 (mirrored) arrays                                | 2                                           | 300                             |
| RAID-3, RAID-4, RAID-5 (striped + parity) arrays        | N+1 parity                                  | $150 \times N$                  |
| RAID-10, RAID 0+1, RAID 1+0 (striped + mirrored) arrays | N                                           | $150 \times N$                  |

2. Calculate the I/O rate for a managed disk (MDisk).
  - If there is a one-to-one relationship between backend arrays and MDisks, the I/O rate for an MDisk is the same as the I/O rate of the corresponding array.
  - If an array is divided into multiple MDisks, the I/O rate per MDisk is the I/O rate of the array divided by the number of MDisks that are using the array.
3. Calculate the I/O rate for an MDisk group. The I/O rate for an MDisk group is the sum of the I/O rates of the MDisk that is in the MDisk group. For example, an MDisk group contains eight MDisks and each MDisk corresponds to a RAID-1 array. Using Table 14, the I/O rate for each MDisk is calculated as 300. The I/O rate for the MDisk group is  $300 \times 8 = 2400$ .
4. Use Table 15 to calculate the impact of FlashCopy mappings. If you are using the FlashCopy feature that is provided by the SAN Volume Controller, you must consider the additional amount of I/O that FlashCopy operations generate because it reduces the rate at which I/O from host systems can be processed. When a FlashCopy mapping copies write I/Os from the host systems to areas of the source or target virtual disk (VDisk) that are not yet copied, the SAN Volume Controller generates extra I/Os to copy the data before the write I/O is performed. The effect of using the FlashCopy feature depends on the type of I/O workload that is generated by an application.

Table 15. Calculate the impact of FlashCopy mappings

| Type of application               | Impact to I/O rate   | Additional weighting for FlashCopy |
|-----------------------------------|----------------------|------------------------------------|
| Application is not performing I/O | Insignificant impact | 0                                  |
| Application is only reading data  | Insignificant impact | 0                                  |

Table 15. Calculate the impact of FlashCopy mappings (continued)

| Type of application                               | Impact to I/O rate         | Additional weighting for FlashCopy |
|---------------------------------------------------|----------------------------|------------------------------------|
| Application is only issuing random writes         | Up to 50 times as much I/O | 49                                 |
| Application is issuing random reads and writes    | Up to 15 times as much I/O | 14                                 |
| Application is issuing sequential reads or writes | Up to 2 times as much I/O  | 1                                  |

For each VDisk that is the source or target of an active FlashCopy mapping, consider the type of application that you want to use the VDisk and record the additional weighting for the VDisk.

**Example**

For example, a FlashCopy mapping is used to provide point-in-time backups. During the FlashCopy process, a host application generates an I/O workload of random read and write operations to the source VDisk. A second host application reads the target VDisk and writes the data to tape to create a backup. The additional weighting for the source VDisk is 14. The additional weighting for the target VDisk is 0.

5. Calculate the I/O rate for VDIsks in an MDisk group by performing the following steps:
  - a. Calculate the number of VDIsks in the MDisk group.
  - b. Add the additional weighting for each VDisk that is the source or target of an active FlashCopy mapping.
  - c. Divide the I/O rate of the MDisk group by this number to calculate the I/O rate per VDisk.

**Example 1**

An MDisk group has an I/O rate of 2400 and contains 20 VDIsks. There are no FlashCopy mappings. The I/O rate per VDisk is  $2400 / 20 = 120$ .

**Example 2**

An MDisk group has an I/O rate of 5000 and contains 20 VDIsks. There are two active FlashCopy mappings that have source VDIsks in the MDisk group. Both source VDIsks are accessed by applications that issue random read and write operations. As a result, the additional weighting for each VDisk is 14. The I/O rate per VDisk is  $5000 / ( 20 + 14 + 14 ) = 104$ .

6. Determine if the storage system is overloaded. The figure that was determined in step 4 on page 288 provides some indication of how many I/O operations per second can be processed by each VDisk in the MDisk group.
  - If you know how many I/O operations per second that your host applications generate, you can compare these figures to determine if the system is overloaded.
  - If you do not know how many I/O operations per second that your host applications generate, you can use the I/O statistics facilities that are provided by the SAN Volume Controller to measure the I/O rate of your virtual disks, or you can use Table 16 as a guideline.

Table 16. Determine if the storage system is overloaded

| Type of Application                            | I/O rate per VDisk |
|------------------------------------------------|--------------------|
| Applications that generate a high I/O workload | 200                |

Table 16. Determine if the storage system is overloaded (continued)

| Type of Application                              | I/O rate per VDisk |
|--------------------------------------------------|--------------------|
| Applications that generate a medium I/O workload | 80                 |
| Applications that generate a low I/O workload    | 10                 |

- Interpret the result. If the I/O rate that is generated by the application exceeds the I/O rate per VDisk that you calculated, you might be overloading your storage system. You must carefully monitor the storage system to determine if the backend storage limits the overall performance of the storage system. It is also possible that the previous calculation is too simplistic to model your storage use after. For example, the calculation assumes that your applications generate the same I/O workload to all VDIs, which might not be the case. You can use the I/O statistics facilities that are provided by the SAN Volume Controller to measure the I/O rate of your MDIs. You can also use the performance and I/O statistics facilities that are provided by your storage systems.

If your storage system is overloaded there are several actions that you can take to resolve the problem:

- Add more backend storage to the system to increase the quantity of I/O that can be processed by the storage system. The SAN Volume Controller provides virtualization and data migration facilities to redistribute the I/O workload of VDIs across a greater number of MDIs without having to take the storage offline.
- Stop unnecessary FlashCopy mappings to reduce the amount of I/O operations that are submitted to the backend storage. If you perform FlashCopy operations in parallel, consider reducing the amount of FlashCopy mappings that start in parallel.
- Adjust the queue depth to limit the I/O workload that is generated by a host. Depending on the type of host and type of host bus adapters (HBAs), it might be possible to limit the queue depth per VDisk or limit the queue depth per HBA, or both. The SAN Volume Controller also provides I/O governing features that can limit the I/O workload that is generated by hosts.

**Note:** Although these actions can be used to avoid I/O time-outs, performance of your storage system is still limited by the amount of storage that you have.

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## Back-end storage controller requirements

The performance of applications at the local cluster can be limited by the performance of the back-end storage controllers at the remote cluster.

Your set up must meet the following requirements to maximize the amount of I/O operations that applications can run on Global Mirror VDIs:

- The Global Mirror VDIs at the remote cluster must be in dedicated MDI groups that only contain other Global Mirror VDIs.
- Configure storage controllers to support the Global Mirror workload that is required of them. The following guidelines can be used to fulfill this requirement:
  - Dedicate storage controllers to only Global Mirror VDIs



- Configure the storage controller to guarantee sufficient quality of service for the disks that are being used by Global Mirror operations
- Ensure that physical disks are not shared between Global Mirror VDisks and other I/O operations. For example, do not split an individual RAID array.
- For Global Mirror MDisk groups, use MDisks with the same characteristics. For example, use MDisks that have the same RAID level, physical disk count, and disk speed. This requirement is important to maintain performance when you use the Global Mirror feature.

You must provision the storage controllers that are attached to the remote cluster to accommodate the following:

- The peak application workload to the Global Mirror VDisks
- The specified background copy level
- All I/O operations that run on the remote cluster

## Back-end storage requirements for FlashCopy, VDisk mirroring, and space-efficient VDisks

Application performance on a local cluster can be affected by the use of FlashCopy, VDisk mirroring, and space-efficient VDisks for back-end storage.

The FlashCopy, VDisk mirroring, and space-efficient VDisk features can all have a negative impact on cluster performance. The impact depends on the type of I/O taking place, and is estimated using a weighting factor from Table 17.

A FlashCopy mapping effectively adds a number of loaded VDisks to the MDisk group. The effect of mirrored and space-efficient VDisks is also estimated in Table 17. The estimates assume that space-efficient VDisks are running at approximately 80% capacity of a fully allocated VDisk, and that mirrored VDisks read from one copy and write to all copies.

*Table 17. Performance impact estimates for FlashCopy, VDisk mirroring, and space-efficient VDisks*

| Type of I/O (to VDisk)    | Impact on I/O weighting | FlashCopy weighting | VDisk mirroring weighting | Space-efficient weighting |
|---------------------------|-------------------------|---------------------|---------------------------|---------------------------|
| None or minimal           | Insignificant           | 0                   | 0                         | 0                         |
| Read Only                 | Insignificant           | 0                   | 0                         | 0.25 * Sv                 |
| Sequential read and write | Up to 2 x I/O           | 2 * F               | C-V                       | 0.25 * Sc                 |
| Random read and write     | Up to 15 x I/O          | 14 * F              | C-V                       | 0.25 * Sc                 |
| Random write              | Up to 50 x I/O          | 49 * F              | C-V                       | 0.25 * Sc                 |

Table 17. Performance impact estimates for FlashCopy, VDisk mirroring, and space-efficient VDIsks (continued)

| Type of I/O (to VDisk)                                                                                                                                                                                                                                                                                                                                                                                                                              | Impact on I/O weighting                                                                         | FlashCopy weighting | VDisk mirroring weighting | Space-efficient weighting |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------|---------------------------|---------------------------|
| <b>Notes:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                 |                     |                           |                           |
| <ul style="list-style-type: none"> <li>In an MDisk group with two FlashCopy mappings and random read/write to those VDIsks, the weighting factor is <math>14 * 2 = 28</math>.</li> <li>In an MDisk group with ten copies, five of which are primary copies of a VDisk, a weighting factor of <math>10 - 5 = 5</math> applies. If the copies are space-efficient, an additional weighting factor of <math>0.25 * 10 = 2.5</math> applies.</li> </ul> |                                                                                                 |                     |                           |                           |
| <b>Key:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                 |                     |                           |                           |
| <b>C</b>                                                                                                                                                                                                                                                                                                                                                                                                                                            | Number of VDisk Copies in this MDisk Group                                                      |                     |                           |                           |
| <b>V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                            | Number of VDIsks with their primary copy in this MDisk Group                                    |                     |                           |                           |
| <b>F</b>                                                                                                                                                                                                                                                                                                                                                                                                                                            | Number of FlashCopy mappings affecting VDIsks that have copies in this MDisk Group              |                     |                           |                           |
| <b>Sv</b>                                                                                                                                                                                                                                                                                                                                                                                                                                           | Number of space-efficient VDisk Copies in this MDisk Group that are the primary copy of a VDisk |                     |                           |                           |
| <b>Sc</b>                                                                                                                                                                                                                                                                                                                                                                                                                                           | Number of space-efficient VDisk Copies in this MDisk Group                                      |                     |                           |                           |

To calculate the average I/O rate per VDisk, use the following equation:

$$\text{I/O rate} = (\text{I/O capacity}) / (\text{V} + \text{weighting factor for FlashCopy} + \text{weighting factor for VDisk mirroring} + \text{weighting factor for space-efficient})$$

For example, consider 20 VDIsks with an I/O capacity of 5250, a FlashCopy weighting of 28, a mirroring weighting of 5, and a space-efficient weighting of 0.25. The I/O rate per VDisk is  $5250 / (20 + 28 + 5 + 2.5) = 94.6$ . This estimate is an average I/O rate per VDisk; for example, half of the VDIsks could be running at 200 IOPs, and the other half could be running at 20 IOPs. This would not overload the system however, because the average load is 94.6.

If the average I/O rate to the VDIsks in the example exceeds 94.6, the system would be overloaded. As approximate guidelines, a heavy I/O rate is 200, a medium I/O rate is 80, and a low I/O rate is 10.

With VDisk mirroring, a single VDisk can have multiple copies in different MDisk groups. The I/O rate for such a VDisk is the minimum I/O rate calculated from each of its MDisk Groups.

If back-end storage is overloaded, you can migrate some of the VDIsks to MDisk groups with available capacity.

## Discovering logical units

The SAN Volume Controller initialization includes a process called discovery.

The discovery process systematically recognizes all visible ports on the SAN for devices that identify themselves as storage systems and the number of logical units (LUs) that they export. The LUs can contain new storage or a new path for previously discovered storage. The set of LUs forms the SAN Volume Controller managed disk (MDisk) view.

The discovery process runs when ports are added to or deleted from the SAN and when certain error conditions occur. You can also manually run the discovery process using the **svctask detectmdisk** command-line interface (CLI) command or the **Discover MDisks** function from the SAN Volume Controller Console. The **svctask detectmdisk** CLI command and the **Discover MDisks** function have the cluster rescan the fibre-channel network. The rescan discovers any new MDisks that might have been added to the cluster and rebalances MDisk access across the available controller device ports.

**Note:** Some storage systems do not automatically export LUs to the SAN Volume Controller.

## Guidelines for exporting LUs

Ensure that you are familiar with the following guidelines for exporting LUs to the SAN Volume Controller:

- When you define the SAN Volume Controller as a host object to the storage systems, you must include *all* ports on *all* nodes and candidate nodes.
- When you first create an LU, you *must* wait until it is initialized before you export it to the SAN Volume Controller.  
**Attention:** Failure to wait for the LUs to initialize can result in excessive discovery times and an unstable view of the SAN.
- Do not present new LUs to the SAN Volume Controller until the array initialization and format is complete. If you add a LUN to an MDisk group before the array initialization format is complete, the MDisk group goes offline. While the MDisk group is offline, you cannot access the VDIs that are in the MDisk group.
- When you export an LU to the SAN Volume Controller, the LU *must* be accessible through all ports on the storage system that are visible to the SAN Volume Controller.

**Important:** The LU *must* be identified by the same logical unit number (LUN) on all ports.

---

## Expanding a logical unit using the CLI

You can use the command-line interface (CLI) to expand a logical unit.

Some storage systems enable you to expand the size of a logical unit (LU) using vendor-specific disk-configuration software that is provided. However, the SAN Volume Controller cannot use extra capacity that is provided in this way.

The LU has increased in size and this additional space must be made available for use.

Perform the following steps to ensure that this additional capacity is available to the SAN Volume Controller:

1. Issue the **svctask rmmdisk** CLI command to remove the MDisk from the MDisk group.
2. Issue the **svctask includemdisk** CLI command.
3. Issue the **svctask detectmdisk** CLI command to rescan the fibre-channel network. The rescan discovers any new MDisks that have been added to the cluster and rebalances MDisk access across the available controller device ports. This can take a few minutes.

4. Issue the `svcinfolsmdisk` CLI command to display the additional capacity that has been expanded.

The extra capacity is available for use by the SAN Volume Controller.

---

## Modifying a logical unit mapping using the CLI

You can modify a logical unit (LU) mapping using the command-line interface (CLI).

Perform the following steps to modify an LU mapping:

1. Migrate all of the data from the managed disk (MDisk) by performing the following steps:

- a. If the MDisk is in managed mode or image mode and the virtual disk (VDisk) must be kept online, issue the following CLI command and then proceed to step 2:

```
svctask rmmdisk -mdisk MDisk number -force MDisk group number
```

Where *MDisk number* is the number of the MDisk that you want to modify and *MDisk group number* is the number of the MDisk group for which you want to remove the MDisk.

**Note:**

- The VDisk becomes a striped MDisk *not* an image-mode VDisk.
- All data that is stored on this MDisk is migrated to the other MDisks in the MDisk group.
- This CLI command can fail if there are not enough free extents in the MDisk group.

- b. If the MDisk is in image mode and you do not want to convert the VDisk to a striped VDisk, stop all I/O to the image mode VDisk.

- c. Issue the following CLI command to remove the host mapping and any SCSI reservation that the host has on the VDisk:

```
svctask rmvdiskhostmap -host host name VDisk name
```

Where *host name* is the name of the host for which you want to remove the VDisk mapping and *VDisk name* is the name of the VDisk for which you want to remove mapping.

- d. Issue the following command to delete the VDisk:

```
svctask rmdisk VDisk name
```

Where *VDisk name* is the name of the VDisk that you want to delete.

2. Remove the LU mapping on the storage system so that the LUN is not visible to the SAN Volume Controller.

3. Issue the following CLI command to clear all error counters on the MDisk:

```
svctask includemdisk MDisk number
```

Where *MDisk number* is the number of the MDisk that you want to modify.

4. Issue the following CLI command to rescan the fibre-channel network and detect that the LU is no longer there.

```
svctask detectmdisk MDisk number
```

Where *MDisk number* is the number of the MDisk that you want to modify. The MDisk is removed from the configuration.

5. Issue the following CLI command to verify that the MDisk is removed:

```
svcinfolsmdisk MDisk number
```

Where *MDisk number* is the number of the MDisk that you want to modify.

- If the MDisk is still displayed, repeat steps 3 on page 294 and 4 on page 294.
6. Configure the mapping of the LU to the new LUN on the storage system.
  7. Issue the following CLI command:  

```
svctask detectmdisk
```
  8. Issue the following CLI command to check that the MDisk now has the correct LUN:  

```
svcinfolsmdisk
```

The MDisk has the correct LUN.

---

## Accessing controller devices with multiple remote ports

If a managed disk (MDisk) logical unit (LU) is accessible through multiple controller device ports, the SAN Volume Controller ensures that all nodes that access this LU coordinate their activity and access the LU through the same controller device port.

### Monitoring LU access through multiple controller device ports

When the SAN Volume Controller can access an LU through multiple controller device ports, the SAN Volume Controller uses the following criteria to determine the accessibility of these controller device ports:

- The SAN Volume Controller node is a member of a cluster.
- The SAN Volume Controller node has fibre-channel connections to the controller device port.
- The SAN Volume Controller node has successfully discovered the LU.
- Slandering has not caused the SAN Volume Controller node to exclude access to the MDisk through the controller device port.

An MDisk path is presented to the cluster for all SAN Volume Controller nodes that meet these criteria.

### Controller device port selection

When an MDisk is created, the SAN Volume Controller selects one of the controller device ports to access the MDisk.

Table 18 describes the algorithm that the SAN Volume Controller uses to select the controller device port.

*Table 18. Controller device port selection algorithm*

| Criteria      | Description                                                                                                                                                                     |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accessibility | Creates an initial set of candidate controller device ports. The set of candidate controller device ports include the ports that are accessible by the highest number of nodes. |
| Slandering    | Reduces the set of candidate controller device ports to those with the lowest number of nodes.                                                                                  |
| Preference    | Reduces the set of candidate controller device ports to those that the controller device uses as preferred ports.                                                               |

Table 18. Controller device port selection algorithm (continued)

| Criteria     | Description                                                                                                |
|--------------|------------------------------------------------------------------------------------------------------------|
| Load balance | Selects the port from the set of candidate controller device ports that has the lowest MDisk access count. |

After the initial device port selection is made for an MDisk, the following events can cause the selection algorithm to rerun:

- A new node joins the cluster and has a different view of the controller device than the other nodes in the cluster.
- The **svctask detectmdisk** command-line interface (CLI) command is run or the **Discover MDisks** SAN Volume Controller Console function is used. The **svctask detectmdisk** CLI command and the **Discover MDisks** function have the cluster rescan the fibre-channel network. The rescan discovers any new MDisks that might have been added to the cluster and rebalances MDisk access across the available controller device ports.
- Error recovery procedures (ERPs) are started because a controller device has changed its preferred port.
- New controller device ports are discovered for the controller device that is associated with the MDisk.
- The controller device port that is currently selected becomes inaccessible.
- Slandering has caused the SAN Volume Controller to exclude access to the MDisk through the controller device port.

---

## Determining a storage system name from its SAN Volume Controller name

You can determine a storage system name from its SAN Volume Controller name.

This task assumes that you have already launched the SAN Volume Controller application.

Perform the following steps to determine the name of the storage system:

1. Click **Work with Managed Disks** → **Disk Controller Systems**. The Viewing Disk Controller Systems panel is displayed.
2. Select the link for the name of the storage system for which you want to determine the name.
3. Record the worldwide node name (WWNN). You can launch the native user interface for the storage system, or use the command-line tools to verify the name of the storage system that uses this WWNN.

---

## Determining a storage system name from its SAN Volume Controller name using the CLI

You can determine a storage system name from its SAN Volume Controller name using the command-line interface (CLI).

1. Issue the following CLI command to list the storage system:

```
svcinfolsccontroller
```

2. Record the name or ID for the storage system that you want to determine.

3. Issue the following CLI command:

```
svcinfo lscontroller controllername/id
```

where *controllername/id* is the name or ID that you recorded in step 2 on page 296.

4. Record the worldwide node name (WWNN) for the device. The WWNN can be used to determine the actual storage system by launching the native user interface or using the command-line tools it provides to verify the actual storage system that has this WWNN.

---

## Renaming a storage system

You can rename a storage system from the Renaming a Disk Controller System panel.

This task assumes that you have already launched the SAN Volume Controller application.

Perform the following steps to rename a storage system:

1. Click **Work with Managed Disks** → **Disk Controller Systems** in the portfolio. The Viewing Disk Controller Systems panel is displayed.
2. Select the storage system to rename and select **Rename a Disk Controller System** from the list. Click **Go**. The Renaming Disk Controller System panel is displayed.

---

## Renaming a storage system using the CLI

You can use the command-line interface (CLI) to rename a storage system.

Perform the following step to rename a storage system:

Issue the `svctask chcontroller -name new_name controller_id` command.

---

## Changing the configuration of an existing storage system using the CLI

You can use the command-line interface (CLI) to change the configuration of an existing storage system. You must change the configuration for a storage system when you want to delete and replace logical units (LUs).

Perform the following steps to delete existing LUs and replace them with new LUs:

1. Issue the following CLI command to delete the managed disks (MDisks) that are associated with the LUs from their MDisk groups:

```
svctask rmmdisk -mdisk MDisk name1:MDisk name2 -force MDisk group name
```

Where *MDisk name1:MDisk name2* are the names of the MDisks to delete.
2. Delete the existing LUs using the configuration software of the storage system.
3. Issue the following command to delete the associated MDisks from the cluster:

```
svctask detectmdisk
```
4. Configure the new LUs using the configuration software of the storage system.
5. Issue the following command to add the new LUs to the cluster:

```
svctask detectmdisk
```

---

## Adding a new storage controller to a running configuration

You can add a new storage controller to your SAN at any time.

You must follow the zoning guidelines for your switch and also ensure that the controller is setup correctly for use with the SAN Volume Controller.

You must create one or more arrays on the new controller.

If your controller provides array partitioning, create a single partition from the entire capacity available in the array. You must record the LUN number that you assign to each partition. You must also follow the mapping guidelines (if your storage controller requires LUN mapping) to map the partitions or arrays to the SAN Volume Controller ports. You can determine the SAN Volume Controller ports by following the procedure for determining WWPNS.

Perform the following steps to add a new storage controller:

1. Ensure that the cluster has detected the new storage (MDisks).
  - a. Click **Work with Managed Disks** → **Managed Disks**. The Viewing Managed Disks panel is displayed.
  - b. Select **Discover MDisks** from the task list and click **Go**.
2. Determine the storage controller name to validate that this is the correct controller. The controller will have automatically been assigned a default name.
  - If you are unsure which controller is presenting the MDisks perform the following steps:
    - a. Click **Work with Managed Disks** → **Disk Controller Systems**. The Viewing Disk Controller Systems panel is displayed.
    - b. Find the new controller in the list. The new controller has the highest numbered default name.
3. Record the field controller LUN number. The controller LUN number corresponds with the LUN number that you assigned to each of the arrays or partitions.
  - a. Click **Work with Managed Disks** → **Managed Disks**. The Viewing Managed Disks panel is displayed.
  - b. Find the MDisks that are not in managed mode. These MDisks should correspond with the RAID arrays or partitions that you created.
4. Create a new MDisk group and add only the RAID arrays that belong to the new controller to this MDisk group. To avoid mixing RAID types, create a new MDisk group for each set of RAID array types (for example, RAID-5, RAID-1).
  - a. Click **Work with Managed Disks** → **Managed Disk Groups**.
  - b. Select **Create an MDisk Group** from the task list and click **Go**. The Create Managed Disk Group wizard begins.
  - c. Complete the wizard to create a new MDisk group.

**Tip:** Give each MDisk group that you create a descriptive name. For example, if your controller is named FAST650-fred, and the MDisk group contains RAID-5 arrays, name the MDisk Group F600-fred-R5.



---

## Adding a new storage controller to a running configuration using the CLI

You can add a new disk controller system to your SAN at any time using the command-line interface (CLI).

You must follow the zoning guidelines for your switch and also ensure that the controller is setup correctly for use with the SAN Volume Controller.

You must create one or more arrays on the new controller.

If your controller provides array partitioning, create a single partition from the entire capacity available in the array. You must record the LUN number that you assign to each partition. You must also follow the mapping guidelines (if your storage controller requires LUN mapping) to map the partitions or arrays to the SAN Volume Controller ports. You can determine the SAN Volume Controller ports by following the procedure for determining WWPNS.

Perform the following steps to add a new storage controller:

1. Issue the following CLI command to ensure that the cluster has detected the new storage (MDisks):

```
svctask detectmdisk
```

2. Determine the storage controller name to validate that this is the correct controller. The controller is automatically assigned a default name.

- If you are unsure which controller is presenting the MDisks, issue the following command to list the controllers:

```
svcinfolsccontroller
```

3. Find the new controller in the list. The new controller has the highest numbered default name.
4. Record the name of the controller and follow the instructions in the section about determining a disk controller system name.
5. Issue the following command to change the controller name to something that you can easily use to identify it:

```
svctask chcontroller -name newname oldname
```

Where *newname* is the name that you want to change the controller to and *oldname* is the name that you are changing.

6. Issue the following command to list the unmanaged MDisks:

```
svcinfolsmdisk -filtervalue mode=unmanaged:controller_name=new_name
```

These MDisks should correspond with the RAID arrays or partitions that you have created.

7. Record the field controller LUN number. This number corresponds with the LUN number that you assigned to each of the arrays or partitions.
8. Create a new MDisk group and add only the RAID arrays that belong to the new controller to this MDisk group. To avoid mixing RAID types, create a new MDisk group for each set of RAID array types (for example, RAID-5, RAID-1). Give each MDisk group that you create a descriptive name. For example, if your controller is named FAST650-fred, and the MDisk group contains RAID-5 arrays, name the MDisk Group F600-fred-R5.

```
svctask mkmdiskgrp -ext 16 -name mdisk_grp_name
-mdisk colon separated list of RAID-x mdisks returned
in step 4
```

This creates a new MDisk group with an extent size of 16MB.

---

## Removing a storage system

You can replace or decommission a storage system.

This task assumes that you have already launched the SAN Volume Controller Console.

During this procedure, you will add a new device, migrate data off of the storage system and remove the old MDisks.

An alternative to following this procedure is to migrate all of the virtual disks (VDisks) that are using storage in this MDisk group to another MDisk group. This allows you to consolidate the VDIs in a single or new group. However, you can only migrate one VDisk at a time. The procedure outlined below migrates all the data through a single command.

You can also use this procedure to remove or replace a single MDisk in a group. If an MDisk experiences a partial failure, such as a degraded array, and you can still read the data from the disk but cannot write to it, you can replace just that MDisk. Steps 1 and 3 detail how you can add or remove a single MDisk rather than a list of MDisks.

Perform the following steps to remove a storage system:

1. Add the new MDisks to the MDisk group by performing the following steps:
  - a. Click **Work with Managed Disks** → **Managed Disks**. The Viewing Managed Disk Groups panel is displayed.
  - b. Select the MDisk group that you want to add the new MDisks to and select **Add MDisks** from the task list. Click **Go**. The Adding Managed Disks to Managed Disk Group panel is displayed.
  - c. Select the new MDisks and click **OK**. The MDisk group should now contain both the old and new MDisks.
2. Ensure that the capacity of the new MDisks is the same or exceeds that of the old MDisks before proceeding to step 3.
3. Force the deletion of the old MDisks from the MDisk group to migrate all the data from the old MDisks to the new MDisks.
  - a. Click **Work with Managed Disks** → **Managed Disks**. The Viewing Managed Disk Groups panel is displayed.
  - b. Select the MDisk group that you want to add the new MDisks to and select **Remove MDisks** from the task list. Click **Go**. The Deleting Managed Disks from Managed Disk Group panel is displayed.
  - c. Select the old MDisks and click **OK**. The migration process begins.

**Note:** The amount of time this process runs depends on the number and size of MDisks and the number and size of the VDIs that are using the MDisks.

4. Check the progress of the migration process by issuing the following command from the command-line interface (CLI): `svcinfo lsmigrate`

5. When all the migration tasks are complete, for example, the command in step 4 on page 300 returns no output, verify that the MDisks are unmanaged.
6. Access the storage system and unmap the LUNs from the SAN Volume Controller ports.

**Note:** You can delete the LUNs if you no longer want to preserve the data that is on the LUNs.

7. Perform the following steps to have the cluster rescan the fibre-channel network:
  - a. Click **Work with Managed Disks** → **Managed Disks**.
  - b. Select **Discover MDisks** from the task list and click **Go**. The Discovering Managed Disks panel is displayed. The rescan discovers that the MDisks have been removed from the cluster and also rebalances MDisk access across the available controller device ports.
8. Verify that there are no MDisks for the storage system that you want to decommission.
9. Remove the storage system from the SAN so that the SAN Volume Controller ports can no longer access the storage system.

---

## Removing a storage system using the CLI

You can replace or decommission a storage system using the command-line interface (CLI).

During this procedure, you will add a new device, migrate data off of the storage system and remove the old MDisks.

An alternative to following this procedure is to migrate all of the virtual disks (VDisks) that are using storage in this MDisk group to another MDisk group. This allows you to consolidate the VDisks in a single or new group. However, you can only migrate one VDisk at a time. The procedure outlined below migrates all the data through a single command.

You can also use this procedure to remove or replace a single MDisk in a group. If an MDisk experiences a partial failure, such as a degraded array, and you can still read the data from the disk but cannot write to it, you can replace just that MDisk.

Perform the following steps to remove a storage system:

1. Add the new storage system to your cluster configuration.
2. Issue the following command:

```
svctask addmdisk -mdisk mdiskx:mdisky:mdiskz... mdisk_grp_name
```

Where *mdiskx:mdisky:mdiskz...* are the names of new MDisks that have a total capacity that is larger than the decommissioned MDisks and *mdisk\_grp\_name* is the name of the MDisk group that contains the MDisks that you want to decommission.

You should now have an MDisk group that you want to decommission and the new MDisks.

3. Ensure that the capacity of the new MDisks is the same or exceeds that of the old MDisks before you proceed to step 4.
4. Issue the following command to force delete the old MDisks from the group:

```
svctask rmmdisk -force -mdisk mdiskx:mdisky:mdiskz... mdisk_grp_name
```

Where *mdiskx:mdisky:mdiskz...* are the old MDisks that you want to delete and *mdisk\_grp\_name* is the name of the MDisk group that contains the MDisks that you want to delete. Depending upon the number and size of the MDisks, and the number and size of the VDIs that are using these MDisks, this operation takes some time to complete, even though the command returns immediately.

5. Check the progress of the migration process by issuing the following command:  

```
svcinfo lsmigrate
```
6. When all the migration tasks are complete, for example, the command in step 5 returns no output, verify that the MDisks are unmanaged.
7. Access the storage system and unmap the LUNs from the SAN Volume Controller ports.  
  
**Note:** You can delete the LUNs if you no longer want to preserve the data that is on the LUNs.
8. Issue the following CLI command:  

```
svctask detectmdisk
```
9. Verify that there are no MDisks for the storage system that you want decommission.
10. Remove the storage system from the SAN so that the SAN Volume Controller ports can no longer access the storage system.

---

## Removing MDisks that represent unconfigured LUs using the CLI

You can use the command-line interface (CLI) to remove MDisks from the cluster.

When you remove LUs from your storage system, the managed disks (MDisks) that represent those LUs might still exist in the cluster. However, the cluster cannot access these MDisks because the LUs that these MDisks represent have been unconfigured or removed from the storage system. You must remove these MDisks.

Perform the following steps to remove MDisks:

1. Run the **svctask includemdisk** CLI command on all the affected MDisks.
2. Run the **svctask rmmdisk** CLI command on all affected MDisks. This puts the MDisks into the unmanaged mode.
3. Run the **svctask detectmdisk** CLI command. The cluster detects that the MDisks no longer exist in the storage system.

All of the MDisks that represent unconfigured LUs are removed from the cluster.

---

## Creating a quorum disk

A quorum disk is used to resolve tie-break situations when the voting set of nodes disagree on the current state of the cluster.

### Quorum disk creation and extent allocation

The use of a quorum disk allows the cluster to manage a SAN fault that splits the cluster exactly in half. One half of the cluster continues to operate and the other half stops until the SAN connectivity is restored.

During quorum disk discovery, the system assesses each logical unit (LU) to determine its potential use as a quorum disk. From the set of eligible LUs, the system nominates three quorum candidate disks.

An LU must meet the following criteria to be considered a candidate for a quorum disk:

- It must be in managed space mode.
- It must be visible to all nodes in the cluster.
- It must be presented by a storage system that is an approved host for quorum disks.
- It must have sufficient free extents to hold the cluster state and the configuration metadata.

If possible, the quorum disk candidates are presented by different devices. After the quorum candidate disks are selected, the cluster selects one of the candidate quorum disks to become the quorum disk. After the quorum disk is selected, the cluster does not attempt to ensure that the candidate quorum disks are presented by different devices. The quorum disk candidates can be updated by configuration activity if other eligible LUs are available.

If no quorum disk candidates are found after the discovery, one of the following situations has occurred:

- No LUs exist in managed space mode. An error is logged when this situation occurs.
- LUs exist in managed space mode, but they do not meet the eligibility criteria. An error is logged when this situation occurs.

---

## Manual discovery

When you create or remove LUNs on a storage system, the managed disk (MDisk) view is not automatically updated.

You must issue the `svctask detectmdisk` command-line interface (CLI) command or use the **Discover MDisks** function from the SAN Volume Controller Console to have the cluster rescan the fibre-channel network. The rescan discovers any new MDisks that might have been added to the cluster and rebalances MDisk access across the available controller device ports.

---

## Servicing storage systems

Storage systems that are supported for attachment to the SAN Volume Controller are designed with redundant components and access paths to enable concurrent maintenance. Hosts have continuous access to their data during component failure and replacement.

The following guidelines apply to all storage systems that are attached to the SAN Volume Controller:

- Always follow the service instructions that are provided in the documentation for your storage system.
- Ensure that there are no unfixed errors in the SAN Volume Controller error log before you perform any maintenance procedures.
- After you perform a maintenance procedure, check the SAN Volume Controller error log and fix any errors. Expect to see the following types of errors:

- MDisk error recovery procedures (ERPs)
- Reduced paths

The following categories represent the types of service actions for storage systems:

- Controller code upgrade
- Field replaceable unit (FRU) replacement

### **Controller code upgrade**

Ensure that you are familiar with the following guidelines for upgrading controller code:

- Check to see if the SAN Volume Controller supports concurrent maintenance for your storage system.
- Allow the storage system to coordinate the entire upgrade process.
- If it is not possible to allow the storage system to coordinate the entire upgrade process, perform the following steps:
  1. Reduce the storage system workload by 50%.
  2. Use the configuration tools for the storage system to manually failover all logical units (LUs) from the controller that you want to upgrade.
  3. Upgrade the controller code.
  4. Restart the controller.
  5. Manually failback the LUs to their original controller.
  6. Repeat for all controllers.

### **FRU replacement**

Ensure that you are familiar with the following guidelines for replacing FRUs:

- If the component that you want to replace is directly in the host-side data path (for example, cable, fibre-channel port, or controller), disable the external data paths to prepare for upgrade. To disable external data paths, disconnect or disable the appropriate ports on the fabric switch. The SAN Volume Controller ERPs reroute access over the alternate path.
- If the component that you want to replace is in the internal data path (for example, cache, or disk drive) and did not completely fail, ensure that the data is backed up before you attempt to replace the component.
- If the component that you want to replace is not in the data path, (for example, uninterruptible power supply units, fans, or batteries) the component is generally dual-redundant and can be replaced without additional steps.

---

## **Configuring Bull FDA systems**

This section provides information about configuring Bull StoreWay FDA systems for attachment to a SAN Volume Controller.

### **Supported firmware levels for the Bull FDA**

The Bull FDA system must use a firmware level that is supported by the SAN Volume Controller.

See the following Web site for specific firmware levels and the latest supported hardware: [www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Logical unit creation and deletion for Bull FDA

You can create or delete logical units for the Bull FDA. See the storage configuration guidelines that are specified in the Bull FDA documentation that is provided for this system.

## Platform type for Bull FDA

You must set all logical units that the SAN Volume Controller accesses to platform type AX (AIX).

## Access control methods for Bull FDA

You can use access control to restrict access from hosts and SAN Volume Controller clusters. You do not need to use access control to allow a SAN Volume Controller cluster to use all of the defined logical units on the system.

The following table lists the access control methods that are available:

| Method    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Port Mode | Allows access to logical units that you want to define on a per storage controller port basis. SAN Volume Controller visibility (through switch zoning, physical cabling, etc.) must allow the SAN Volume Controller cluster to have the same access from all nodes and the accessible controller ports have been assigned the same set of logical units with the same logical unit number. This method of access control is not recommended for SAN Volume Controller connection. |
| WWN Mode  | Allows access to logical units using the WWPN of each of the ports of an accessing host device. All WWPNs of all the SAN Volume Controller nodes in the same cluster must be added to the list of linked paths in the controller configuration. This becomes the list of host (SAN Volume Controller) ports for an LD Set or group of logical units. This method of access control allows sharing because different logical units can be accessed by other hosts.                  |

## Setting cache allocations for Bull FDA

Cache allocations can be set manually; however, changes to the default settings can adversely effect performance and cause you to lose access to the system.

## Snapshot Volume and Link Volume for Bull FDA

You cannot use Copy Services logical volumes with logical units that are assigned to the SAN Volume Controller.

---

## Configuring the EMC CLARiiON system

This section provides information about configuring the EMC CLARiiON storage system for attachment to a SAN Volume Controller.

### Access Logix

Access Logix is an optional feature of the firmware code that provides the functionality that is known as LUN Mapping or LUN Virtualization.

You can use the software tab in the storage systems properties page of the EMC Navisphere GUI to determine if Access Logix is installed.

After Access Logix is installed it can be disabled but not removed. The following are the two modes of operation for Access Logix:

- **Access Logix not installed:** In this mode of operation, all LUNs are accessible from all target ports by any host. Therefore, the SAN fabric must be zoned to ensure that only the SAN Volume Controller can access the target ports.
- **Access Logix enabled:** In this mode of operation, a storage group can be formed from a set of LUNs. Only the hosts that are assigned to the storage group are allowed to access these LUNs.

## Configuring the EMC CLARiiON controller with Access Logix installed

The SAN Volume Controller does not have access to the storage controller logical units (LUs) if Access Logix is installed on the EMC CLARiiON controller. You must use the EMC CLARiiON configuration tools to associate the SAN Volume Controller and LU.

The following prerequisites must be met before you can configure an EMC CLARiiON controller with Access Logix installed:

- The EMC CLARiiON controller is not connected to the SAN Volume Controller
- You have a RAID controller with LUs and you have identified which LUs you want to present to the SAN Volume Controller

You must complete the following tasks to configure an EMC CLARiiON controller with Access Logix installed:

- Register the SAN Volume Controller ports with the EMC CLARiiON
- Configure storage groups

The association between the SAN Volume Controller and the LU is formed when you create a storage group that contains both the LU and the SAN Volume Controller.

### Registering the SAN Volume Controller ports with the EMC CLARiiON

You must register the SAN Volume Controller ports with an EMC CLARiiON controller if Access Logix is installed.

The following prerequisites must be met before you can register the SAN Volume Controller ports with an EMC CLARiiON controller that has Access Logix installed:

- The EMC CLARiiON controller is not connected to the SAN Volume Controller
- You have a RAID controller with LUs and you have identified which LUs you want to present to the SAN Volume Controller

Each initiator port [worldwide port name (WWPN)] must be registered against a host name and against a target port to which access is granted. If a host has multiple initiator ports, multiple table entries with the same host name are listed. If a host is allowed access using multiple target ports, multiple table entries are listed. For SAN Volume Controller hosts, all WWPN entries should carry the same host name.



The following table lists the associations:

| Option             | EMC CLARiiON default setting | SAN Volume Controller required setting |
|--------------------|------------------------------|----------------------------------------|
| WWPN               | N/A                          | Any                                    |
| WWN                | N/A                          | Any                                    |
| Host name          | N/A                          | Any                                    |
| SP™ port           | N/A                          | Any                                    |
| Initiator type     | 3                            | 3                                      |
| ArrayCommPath      | Enable                       | Disable                                |
| Failover mode      | 0                            | 2                                      |
| Unit Serial Number | Array                        | Array                                  |

1. Connect the fibre channel and zone the fabric as required.
2. Issue the **svctask detectmdisk** command-line interface (CLI) command.
3. Right-click on the storage system from the Enterprise Storage window.
4. Select **Connectivity Status**. The Connectivity Status window is displayed.
5. Click **New**. The Create Initiator Record window is displayed.
6. Wait for the list of SAN Volume Controller ports to appear in the dialog box. Use the WWPN to Identify them. This can take several minutes.
7. Click **Group Edit**.
8. Select all instances of all the SAN Volume Controller ports in the Available dialog box.
9. Click the right arrow to move them to the selected box.
10. Fill in the **HBA WWN** field. You must know the following information:
  - WWNN of each SAN Volume Controller in the cluster
  - WWPN of each port ID for each node on the cluster

The HBA WWN field is made up of the WWNN and the WWPN for the SAN Volume Controller port. The following is an example of the output:  
50:05:07:68:01:00:8B:D8:50:05:07:68:01:20:8B:D8
11. Select **A** in the field marked SP and **0** in the SP Port field.
12. Select **CLARiiON Open** in the drop down list of the **Initiator Type** field.
13. Deselect the ArrayCommPath checkbox if it has been selected.
14. Select **2** in the drop down list of the **Failover Mode** field.
 

**Attention:** Failure to select failover mode 2 prevents the SAN Volume Controller from being able to failover I/O. Your data might become unavailable in the event of a single failure.

  - a. If this is the first time that a port has been registered, ensure that you select the New Host option. Otherwise, select Existing Host.
  - b. Ensure that the same host name is entered for each port that is registered.
15. Select **Array** in the drop down list of the **Unit Serial Number** field.
16. Assign a host name in the Host Name field.
17. Click **OK**.
18. Specify the IP address of your switch. The EMC CLARiiON does not use this IP address. However it must be unique (within the EMC CLARiiON) to prevent errant behavior by Navisphere.

19. Repeat step 11 on page 307 for all possible combinations. The following example shows the different combinations of a system with four ports:
  - SP: A SP Port: 0
  - SP: A SP Port: 1
  - SP: B SP Port: 0
  - SP: B SP Port: 1
20. Repeat steps 1 on page 307 to 19 to register the rest of your SAN Volume Controller WWPNs.

All your WWPNs are registered against the host name that you specified.

## Configuring your storage groups

Storage groups can only be configured if Access Logix is installed and enabled.

Access Logix provides the following LUN mapping:

### Notes:

1. A subset of logical units (LUs) can form a storage group.
  2. An LU can be in multiple storage groups.
  3. A host can be added to a storage group. This host has access to all LUs in the storage group.
  4. A host *cannot* be added to a second storage group.
1. Right-click on the storage system from the Enterprise Storage window.
  2. Select **Create Storage Group**. The Create Storage Group window is displayed.
  3. Enter a name for your storage group in the **Storage Group Name** field.
  4. If available, select **Dedicated** in the **Sharing State** field.
  5. Click **OK**. The storage group is created.
  6. Right-click the storage group in the Enterprise Storage window.
  7. Select **Properties**. The Storage Group Properties window is displayed.
  8. Perform the following steps from the Storage Group Properties window:
    - a. Select the **LUNs** tab.
    - b. Select the LUNs that you want the SAN Volume Controller to manage in the Available LUNs table.
 

**Attention:** Ensure that the LUs that you have selected are not used by another storage group.
    - c. Click the forward arrow button.
    - d. Click **Apply**. A Confirmation window is displayed.
    - e. Click **Yes** to continue. A Success window is displayed.
    - f. Click **OK**.
    - g. Select the **Hosts** tab.
    - h. Select the host that you created when you registered the SAN Volume Controller ports with the EMC CLARiiON.
 

**Attention:** Ensure that only SAN Volume Controller hosts (initiator ports) are in the storage group.
    - i. Click the forward arrow button.
    - j. Click **OK**. The Confirmation window is displayed.
    - k. Click **Yes** to continue. A Success window is displayed.
    - l. Click **OK**.

## Configuring the EMC CLARiiON controller without Access Logix installed

If Access Logix is not installed on an EMC CLARiiON controller, all logical units (LUs) that were created on the controller can be used by the SAN Volume Controller.

No further configuration of the EMC CLARiiON controller is necessary.

Configure the switch zoning such that no hosts can access these LUs.

## Supported models of the EMC CLARiiON

The SAN Volume Controller supports models of the EMC CLARiiON.

See the following Web site for the latest supported models:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Supported firmware levels for the EMC CLARiiON

The EMC CLARiiON must use a firmware level that is supported by the SAN Volume Controller.

See the following Web site for specific firmware levels and the latest supported hardware:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Concurrent maintenance on EMC CLARiiON systems

Concurrent maintenance is the ability to perform I/O operations to a controller while simultaneously performing maintenance on it.

**Important:** An EMC Field Engineer must perform all maintenance procedures.

The EMC CLARiiON FC series and the SAN Volume Controller cluster allow concurrent replacement of the following components:

- Disk drives
- Controller fans (fans must be replaced within 2 minutes or controllers are shut down.)
- Disk enclosure fans (fans must be replaced within 2 minutes or controllers are shut down.)
- Controller (service processor: you must first disable cache)
- Fibre Channel Bypass cards (LCC)
- Power supplies (you must first remove fans.)
- Uninterruptible power supply battery (SPS)

EMC CLARiiON FC devices require that the I/O is quiesced during code upgrade. Consequently, the SAN Volume Controller cluster does not support concurrent upgrade of the FC controller code.

The EMC CLARiiON CX series and the SAN Volume Controller cluster allow concurrent replacement of the following components:

- Disk drives

- Controller (service processor or drawer controller)
- Power/cooling modules (modules must be replaced within 2 minutes or controllers are shut down.)
- Uninterruptible power supply battery (SPS)

The SAN Volume Controller cluster and EMC CLARiiON CX devices support concurrent code upgrade of the CX controllers.

**Note:**

- EMC CLARiiON procedures for concurrent upgrade must be followed in all cases.
- The CX Series also has a feature called Data In Place Upgrade which allows you to upgrade from one model to another (for example, from the CX200 to the CX600) with no data loss or migration required. This is *not* a concurrent operation.

## EMC CLARiiON user interfaces

Ensure that you are familiar with the user interface applications that EMC CLARiiON systems use.

### Navisphere or Navicli

The following user interface applications are available with EMC CLARiiON systems:

- Navisphere is the Web-based application that can be accessed from any Web browser.
- Navicli is the command-line interface (CLI) that is installed as part of the Navisphere Agent software (the host software).

**Note:** Some options and features are only accessible through the CLI. Communication with the EMC CLARiiON in both cases is out-of-band. Therefore, the host does not need to be connected to the storage over fibre-channel and cannot be connected without Access Logix.

## Sharing the EMC CLARiiON between a host and the SAN Volume Controller

The EMC CLARiiON can be shared between a host and a SAN Volume Controller.

- Split controller access is only supported when Access Logix is installed and enabled.
- A host cannot be connected to both the SAN Volume Controller and EMC CLARiiON at the same time.
- LUs must not be shared between a host and a SAN Volume Controller.
- Partitions in a RAID group must not be shared between a host and a SAN Volume Controller.

## Switch zoning limitations for the EMC CLARiiON systems

There are limitations in switch zoning for SAN Volume Controller clusters and EMC CLARiiON systems.

## FC4500 and CX200 models

The EMC CLARiiON FC4500 and CX200 systems limit the number of initiator HBAs to only allow 15 connections for each controller port. This limit is less than the 16 initiator ports that are required to connect to an 8-node cluster in a dual fabric configuration. To use EMC CLARiiON FC4500 and CX200 systems with an 8-node cluster, you must zone the system to use one SAN Volume Controller port for each node in each fabric. This reduces the initiator HBA count to eight.

## FC4700 and CX400 models

EMC CLARiiON FC4700 and CX400 systems provide 4 target ports and allow 64 connections. Using a single SAN fabric, a 4-node cluster requires 64 connections ( $4 \times 4 \times 4$ ), which is equal to the number of connections that are allowed. If split support with other hosts is required, this can cause issues. You can reduce either the number of initiator ports or target ports so that only 32 of the available 64 connections are used.

## CX600 models

EMC CLARiiON CX600 systems provide 8 target ports and allow 128 connections. A 4-node cluster consumes all 128 connections ( $4 \times 4 \times 8$ ). An 8-node cluster exceeds the connection limit and no reduction methods can be used.

## Quorum disks on the EMC CLARiiON

The EMC CLARiiON supports quorum disks.

A SAN Volume Controller configuration that only includes the EMC CLARiiON is permitted.

## Advanced functions for the EMC CLARiiON

Some advanced functions of the EMC CLARiiON are not supported by the SAN Volume Controller.

### Advanced copy functions

Advanced copy functions for EMC CLARiiON (for example, SnapView, MirrorView and SANcopy) are not supported for disks that are managed by the SAN Volume Controller because the copy function does *not* extend to the SAN Volume Controller cache.

### MetaLUN

MetaLUN allows a logical unit (LU) to be expanded using LUs in other RAID groups. The SAN Volume Controller only supports MetaLUN for the migration of image mode virtual disks.

## Logical unit creation and deletion on the EMC CLARiiON

Binding a logical unit (LU) to a RAID group can take a significant amount of time on EMC CLARiiON systems.

Do not add the LU to a storage group until binding is complete. If the LU is mapped to a SAN Volume Controller cluster during the binding process, the LU

might be identified with the wrong capacity. If this occurs, run the following procedure to rediscover the LU with the correct capacity:

1. Unmap the LU from the SAN Volume Controller cluster.
2. Run `detectmdisk` and wait for the managed disk to be deconfigured.
3. Wait for any binding activity to complete.
4. Remap the LU to the SAN Volume Controller cluster.
5. Run `detectmdisk`.

## Configuring settings for the EMC CLARiiON

A number of settings and options are available through the EMC CLARiiON configuration interface.

The following settings and options are supported by the SAN Volume Controller:

- System
- Port
- Logical unit

### Global settings for the EMC CLARiiON

Global settings apply across an EMC CLARiiON system. Not all options are available on all EMC CLARiiON models.

Table 19 lists the global settings that are supported by the SAN Volume Controller.

*Table 19. EMC CLARiiON global settings supported by the SAN Volume Controller*

| Option                                   | EMC CLARiiON default setting                    | SAN Volume Controller required setting          |
|------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Access Controls (Access Logix installed) | Not installed                                   | Either Installed or Not Installed               |
| Subsystem Package Type                   | 3                                               | 3                                               |
| Queue Full Status                        | Disable                                         | Disable                                         |
| Recovered Errors                         | Disable                                         | Disable                                         |
| Target Negotiate                         | Displays the state of the target negotiate bit. | Displays the state of the target negotiate bit. |
| Mode Page 8 Info                         | Disable                                         | Disable                                         |
| Base UUID                                | 0                                               | 0                                               |
| Write Cache Enabled                      | Enabled                                         | Enabled                                         |
| Mirrored Write Cache                     | Enabled                                         | Enabled                                         |
| Write Cache Size                         | 600 MB                                          | Default recommended                             |
| Enable Watermarks                        | Enabled                                         | Enabled                                         |
| Cache High Watermark                     | 96%                                             | Default                                         |
| Cache Low Watermark                      | 80%                                             | Default                                         |
| Cache Page Size                          | 4 Kb                                            | 4 Kb                                            |
| RAID3 Write Buffer Enable                | Enable                                          | Default recommended                             |
| RAID3 Write Buffer                       | 0 MB                                            | Default recommended                             |

### Controller settings for the EMC CLARiiON

The controller settings for the EMC CLARiiON are the settings that apply across one EMC CLARiiON system.

Table 20 lists the options that can be set by the EMC CLARiiON.

*Table 20. EMC CLARiiON controller settings supported by the SAN Volume Controller*

| Option             | EMC CLARiiON default setting | SAN Volume Controller required setting |
|--------------------|------------------------------|----------------------------------------|
| Read Cache Enabled | Enable                       | Enable                                 |
| Read Cache Size    | 200 MB                       | Default recommended                    |
| Statistics Logging | Disable                      | Either Enable or Disable               |

**Note:** The SAN Volume Controller cannot obtain or change the configuration options that are listed above. You must configure the options that are listed above.

### Port settings for the EMC CLARiiON

Port settings are configurable at the port level.

Table 21 lists port settings, the EMC CLARiiON defaults, and the required settings for SAN Volume Controller clusters.

*Table 21. EMC CLARiiON port settings*

| Option     | EMC CLARiiON default setting | SAN Volume Controller required setting |
|------------|------------------------------|----------------------------------------|
| Port speed | Depends on the model         | Any                                    |

**Note:** The SAN Volume Controller cluster cannot obtain or change the configuration options that are listed above. You must configure the options that are listed above.

### Logical unit settings for the EMC CLARiiON

Logical unit (LU) settings are configurable at the LU level.

Table 22 lists the options that must be set for each LU that is accessed by the SAN Volume Controller. LUs that are accessed by hosts can be configured differently.

*Table 22. EMC CLARiiON LU settings supported by the SAN Volume Controller*

| Option           | EMC CLARiiON default setting | SAN Volume Controller required setting |
|------------------|------------------------------|----------------------------------------|
| LU ID            | Auto                         | N/A                                    |
| RAID Type        | 5                            | Any RAID Group                         |
| RAID Group       | Any available RAID Group     | Any available RAID Group               |
| Offset           | 0                            | Any setting                            |
| LU Size          | ALL LBAs in RAID Group       | Any setting                            |
| Placement        | Best Fit                     | Either Best Fit or First Fit           |
| UID              | N/A                          | N/A                                    |
| Default Owner    | Auto                         | N/A                                    |
| Auto Assignment  | Disabled                     | Disabled                               |
| Verify Priority  | ASAP                         | N/A                                    |
| Rebuild Priority | ASAP                         | N/A                                    |

Table 22. EMC CLARiiON LU settings supported by the SAN Volume Controller (continued)

| Option                | EMC CLARiiON default setting | SAN Volume Controller required setting |
|-----------------------|------------------------------|----------------------------------------|
| Strip Element Size    | 128                          | N/A                                    |
| Read Cache Enabled    | Enabled                      | Enabled                                |
| Write Cache Enabled   | Enabled                      | Enabled                                |
| Idle Threshold        | 0–254                        | 0–254                                  |
| Max Prefetch Blocks   | 0–2048                       | 0–2048                                 |
| Maximum Prefetch IO   | 0–100                        | 0–100                                  |
| Minimum Prefetch Size | 0–65534                      | 0–65534                                |
| Prefetch Type         | 0, 1, or 2                   | 0, 1, or 2                             |
| Prefetch Multiplier   | 0 to 2048 or 0 to 324        | 0 to 2048 or 0 to 324                  |
| Retain prefetch       | Enabled or Disabled          | Enabled or Disabled                    |
| Prefetch Segment Size | 0 to 2048 or 0 to 32         | 0 to 2048 or 0 to 32                   |
| Idle Delay Time       | 0 to 254                     | 0 to 254                               |
| Verify Priority       | ASAP, High, Medium, or Low   | Low                                    |
| Write Aside           | 16 to 65534                  | 16 to 65534                            |

**Note:** The SAN Volume Controller cannot obtain or change the configuration options that are listed above. You must configure the options that are listed above.

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## Configuring the EMC Symmetrix and Symmetrix DMX systems

This section provides information about configuring the EMC Symmetrix and Symmetrix DMX for attachment to a SAN Volume Controller.

### Supported models of the EMC Symmetrix and Symmetrix DMX controllers

The SAN Volume Controller supports models of the EMC Symmetrix and Symmetrix DMX controllers.

See the following Web site for the latest supported models:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

### Supported firmware levels for the EMC Symmetrix and Symmetrix DMX

The EMC Symmetrix and Symmetrix DMX must use a firmware level that is supported by the SAN Volume Controller.

See the following Web site for specific firmware levels and the latest supported hardware:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)



## Concurrent maintenance on the EMC Symmetrix and Symmetrix DMX

Concurrent maintenance is the capability to perform I/O operations to the EMC Symmetrix or Symmetrix DMX while simultaneously performing maintenance operations on it.

**Important:** Service actions and upgrade procedures can only be performed by an EMC Field Engineer.

The EMC Symmetrix and Symmetrix DMX are Enterprise class devices that support nondisruptive replacement of the following components:

- Channel Director
- Disk Director
- Cache card
- Disk drive
- Cooling fan
- Comms card
- EPO card
- Operator panel
- PSU
- Service Processor
- Batteries
- Ethernet hub

The SAN Volume Controller and EMC Symmetrix/Symmetrix DMX support concurrent upgrade of the EMC Symmetrix/Symmetrix DMX firmware.

## User interfaces on EMC Symmetrix and Symmetrix DMX

Ensure that you are familiar with the user interface applications that support the EMC Symmetrix and Symmetrix DMX systems.

### EMC Control Center

A basic EMC Symmetrix or Symmetrix DMX configuration is performed by an EMC Field Engineer (FE) using the EMC Symmetrix service processor. After the initial configuration, you can configure and control the exported storage. The FE defines the storage device types and sets the configurable options.

You can configure and control the exported storage as described below.

You can use the EMC Control Center to manage and monitor the EMC Symmetrix and Symmetrix DMX systems.

You can use Volume Logix for volume configuration management. Volume Logix allows you to control access rights to the storage when multiple hosts share target ports.

### SYMCLI

The EMC Symmetrix Command Line Interface (SYMCLI) allows the server to monitor and control the EMC Symmetrix and Symmetrix DMX.

## Sharing the EMC Symmetrix or Symmetrix DMX system between a host and a SAN Volume Controller cluster

There are restrictions for sharing EMC Symmetrix and Symmetrix DMX systems between a host and a SAN Volume Controller cluster.

An EMC Symmetrix or Symmetrix DMX system can be shared between a host and a SAN Volume Controller under the following conditions:

- When possible, avoid sharing target ports between the SAN Volume Controller cluster and other hosts. If this cannot be avoided, you must regularly check the combined I/O workload that is generated by the SAN Volume Controller cluster and the other hosts. The performance of either the SAN Volume Controller cluster or the hosts is impacted if the workload exceeds the target port capabilities.
- A single host must not be connected to a SAN Volume Controller and an EMC Symmetrix or Symmetrix DMX because the multipathing drivers (for example, subsystem device driver (SDD) and PowerPath) cannot coexist.
- Other hosts can be directly connected to an EMC Symmetrix or Symmetrix DMX system at the same time as a SAN Volume Controller cluster, under the following conditions:
  - The fabric must be zoned such that other hosts cannot access the target ports that are used by the SAN Volume Controller cluster.
  - The EMC Symmetrix or Symmetrix DMX must be configured such that other hosts cannot access the LUs that are managed by the SAN Volume Controller cluster.

## Switch zoning limitations for the EMC Symmetrix and Symmetrix DMX

There are limitations in switch zoning for the SAN Volume Controller and the EMC Symmetrix and Symmetrix DMX systems.

### Switch zoning

The SAN Volume Controller switch zone must include at least one target port on two or more fibre-channel adapters to avoid a single point of failure.

The EMC Symmetrix and Symmetrix DMX must be configured to present logical units (LUs) to all SAN Volume Controller initiator ports that are in the fabric zone.

Only SAN Volume Controller initiator ports that are LUN masked on the EMC Symmetrix or Symmetrix DMX controller should be present in the fabric zone.

### Connecting to the SAN

You can connect a maximum of 16 EMC Symmetrix or Symmetrix DMX ports to the SAN Volume Controller cluster. There are no further special zoning requirements. Configurations that are setup to adhere to the requirements that are described in previous SAN Volume Controller releases are also supported, but should not be followed for new installations.

## Quorum disks on EMC Symmetrix and Symmetrix DMX

The SAN Volume Controller chooses managed disks (MDisks) that are presented by the EMC Symmetrix or Symmetrix DMX as quorum disks.

The SAN Volume Controller uses a logical unit (LU) that is presented by an EMC Symmetrix or Symmetrix DMX as a quorum disk. The SAN Volume Controller provides a quorum disk even if the connection is through a single port.

## Advanced functions for EMC Symmetrix and Symmetrix DMX

SAN Volume Controller cache-disabled virtual disks (VDisks) can be used as the source or target in Symmetrix advanced copy functions (for example, SRDF and TimeFinder).

## LU creation and deletion on EMC Symmetrix and Symmetrix DMX

A logical unit (LU) that is exported by an EMC Symmetrix or Symmetrix DMX, meaning it is visible to a host, is either a *Symmetrix device* or a *Meta device*.

### Symmetrix device

**Restriction:** An LU with a capacity of 32 MB or less is ignored by the SAN Volume Controller.

*Symmetrix device* is an EMC term for an LU that is hosted by an EMC Symmetrix. These are all emulated devices and have exactly the same characteristics. The following are the characteristics of a Symmetrix device:

- N cylinders
- 15 tracks per cylinder
- 64 logical blocks per track
- 512 bytes per logical block

Symmetrix devices can be created using the **create dev** command from the EMC Symmetrix Command Line Interface (SYMCLI). The configuration of an LU can be changed using the **convert dev** command from the SYMCLI. Each physical storage device in an EMC Symmetrix is partitioned into 1 to 128 hyper-volumes (hypers). Each hyper can be up to 16 GB. A Symmetrix device maps to one or more hypers, depending on how it is configured. The following are examples of hyper configurations:

- Hypers can be mirrored (2-way, 3-way, 4-way)
- Hypers can be formed into RAID-S groups

### Meta device

*Meta device* is an EMC term for a concatenated chain of EMC Symmetrix devices. This enables the EMC Symmetrix to provide LUs that are larger than a hyper. Up to 255 hypers can be concatenated to form a single meta device. Meta devices can be created using the **form meta** and **add dev** commands from the SYMCLI. This allows an extremely large LU to be created, however, if exported to the SAN Volume Controller, only the first 2 TB is used.

Do not extend or reduce meta devices that are used for managed disks (MDisks). Reconfiguration of a meta device that is used for an MDisk causes unrecoverable data-corruption.

## Configuring settings for the EMC Symmetrix and Symmetrix DMX

A number of settings and options are available through the EMC Symmetrix configuration interface.

The settings and options can have a scope of the following:

- System
- Port
- Logical unit (LU)

### Global settings for the EMC Symmetrix and Symmetrix DMX

Global settings apply across the EMC Symmetrix and Symmetrix DMX systems.

You can specify EMC Symmetrix and Symmetrix DMX settings with the **set Symmetrix** command from the Symmetrix Command Line Interface (SYMCLI). The settings can be viewed using the **symconfigure** command from the SYMCLI.

Table 23 lists the EMC Symmetrix global settings that can be used with SAN Volume Controller clusters.

Table 23. EMC Symmetrix and Symmetrix DMX global settings

| Option                 | EMC Symmetrix and Symmetrix DMX default setting | SAN Volume Controller required setting |
|------------------------|-------------------------------------------------|----------------------------------------|
| max_hypers_per_disk    | -                                               | Any                                    |
| dynamic_rdf            | Disable                                         | Any                                    |
| fba_multi_access_cache | Disable                                         | N/A                                    |
| Raid_s_support         | Disable                                         | Enable or Disable                      |

### Port settings for the EMC Symmetrix and Symmetrix DMX

Target port characteristics can be set using the **set port** command from the Symmetrix Command Line Interface (SYMCLI).

The target port characteristics can be viewed using the **symcfg** command from the SYMCLI.

Table 24 lists the EMC Symmetrix and Symmetrix DMX port settings that can be used with the SAN Volume Controller cluster.

Table 24. EMC Symmetrix and Symmetrix DMX port settings that can be used with the SAN Volume Controller

| Option                 | EMC Symmetrix and Symmetrix DMX default setting | SAN Volume Controller required setting |
|------------------------|-------------------------------------------------|----------------------------------------|
| Disk_Array             | Enabled                                         | Disabled                               |
| Volume_Set_Addresssing | Enabled                                         | Disabled                               |
| Hard_Addresssing       | Enabled                                         | Enabled                                |
| Non_Participating      | Disabled                                        | Disabled                               |
| Global_3rdParty_Logout | Enabled                                         | Enabled                                |
| Tagged_Commands        | Enabled                                         | Enabled                                |

Table 24. EMC Symmetrix and Symmetrix DMX port settings that can be used with the SAN Volume Controller (continued)

| Option                | EMC Symmetrix and Symmetrix DMX default setting | SAN Volume Controller required setting |
|-----------------------|-------------------------------------------------|----------------------------------------|
| Common_Serial_Number  | -                                               | Enabled                                |
| Disable_Q_Reset_on_UA | Disabled                                        | Disabled                               |
| Return_busy_for_abort | Disabled                                        | Disabled                               |
| SCSI-3                | Disabled                                        | Disabled or Enabled                    |
| Environ_Set           | Disabled                                        | Disabled                               |
| Unique_WWN            | Enabled                                         | Enabled                                |
| Point_to_Point        | Disabled                                        | Enabled                                |
| VCM_State             | Disabled                                        | Disabled or Enabled                    |
| OpenVMS               | Disabled                                        | Disabled                               |

## Logical unit settings for the EMC Symmetrix and Symmetrix DMX

Logical unit (LU) settings are configurable at the LU level.

LU characteristics can be set using the **set device** command from the Symmetrix Command Line Interface (SYMCLI).

Table 25 lists the options that must be set for each LU that is accessed by the SAN Volume Controller.

Table 25. EMC Symmetrix and Symmetrix DMX LU settings supported by the SAN Volume Controller

| Option    | EMC Symmetrix and Symmetrix DMX default setting | SAN Volume Controller required setting |
|-----------|-------------------------------------------------|----------------------------------------|
| emulation | -                                               | FBA                                    |
| attribute | -                                               | Set all attributes to disabled.        |

## Mapping and virtualization settings for the EMC Symmetrix and Symmetrix DMX

Mapping a logical unit (LU) to a host is a function of the EMC Control Center.

LUs can be mapped to a particular director or target port using the **map dev** command from the Symmetrix Command Line Interface (SYMCLI). LUs can be unmapped using the **unmap dev** command from the SYMCLI.

### Volume Logix and masking

Volume Logix allows you to restrict access to particular WWPNs on the fabric for Symmetrix Volumes.

This function can be switched on and off by changing the VMC\_State port setting. The SAN Volume Controller requires that you do not share target ports between a host and a SAN Volume Controller. However, you can still use Volume Logix to protect the system from errors that can occur if the SAN is not correctly configured.

To mask a volume to the SAN Volume Controller, you must first identify the SAN Volume Controller ports that are connected to each system. This can be done using the EMC Symmetrix `symmask` command.

The SAN Volume Controller automatically logs into any EMC Symmetrix system it sees on the fabric. You can use the SAN Volume Controller `svcinfo lsnode` CLI command to find the correct port identifiers.

After you have identified the ports, you can map each volume on each port to each WWPN. The EMC Symmetrix stores the LUN masking in a database, so you must apply the changes you have made to refresh the contents of the database to view the changes.

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## Configuring the Fujitsu ETERNUS systems

This section provides information about configuring the Fujitsu ETERNUS systems for attachment to a SAN Volume Controller.

### Supported models of the Fujitsu ETERNUS

The SAN Volume Controller supports models of the Fujitsu ETERNUS series of systems.

See the following Web site for the latest supported models:[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

### Supported firmware levels for the Fujitsu ETERNUS

The Fujitsu ETERNUS must use a firmware level that is supported by the SAN Volume Controller.

See the following Web site for specific firmware levels and the latest supported hardware:[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

### User interfaces on the Fujitsu ETERNUS

Ensure that you are familiar with the user interface application that is used by the Fujitsu ETERNUS.

You can use the ETERNUSmgr web-based configuration utility. See the documentation that is provided with the Fujitsu ETERNUS system for more information.

## Configuring the Fujitsu ETERNUS to use with the SAN Volume Controller

Ensure that you use the settings that are required to use the Fujitsu ETERNUS with the SAN Volume Controller. It is important that you use the correct settings to avoid data access problems.

Use the following sequence of steps to configure the Fujitsu ETERNUS system:

1. Configure the SAN Volume Controller host response pattern.
2. Register the host world wide names (WWNs) and associate them with the host response pattern.
3. Setup the affinity group for SAN Volume Controller volumes or setup LUN mapping.
4. Create or reassign storage to the SAN Volume Controller.

For all other settings and procedures, consider the SAN Volume Controller a host. See the documentation that is provided with the Fujitsu ETERNUS system.

## CA parameters

The following table lists the port settings that are required. See the documentation that is provided with your Fujitsu ETERNUS system for more information because some options are only available on certain models.

| Option                                     | Fujitsu ETERNUS default setting | SAN Volume Controller required setting                                              |
|--------------------------------------------|---------------------------------|-------------------------------------------------------------------------------------|
| Connection Topology/FC Connection Settings | FC-AL Connection                | Fabric Connection                                                                   |
| Service Class                              | Class 3                         | Class 3                                                                             |
| FC Transfer Rate                           | Auto Setting                    | Any                                                                                 |
| Reset Scope/Scope of LUR Actions           | T_L                             | T_L<br><b>Note:</b> If this option is not set correctly, data corruption can occur. |
| Release Reservation upon Chip Reset        | Enable/valid                    | Enable/valid                                                                        |
| HP-UX Connection Setting                   | Disable                         | Disable                                                                             |
| Frame Size Setting                         | 2048                            | Any                                                                                 |
| Affinity/Addressing Mode                   | Off                             | Any                                                                                 |

## Host response pattern

The SAN Volume Controller requires that a new host response pattern is created. If the Host Affinity/Host Table Settings Mode is used, this host response pattern must be associated with each WWN. If the Host Affinity/Host Table Settings Mode is not used, this host response pattern must be associated with the target port.

The following table lists the settings that are required. See the documentation that is provided with your Fujitsu ETERNUS system for more information because some options are only available on certain models.

| Option                                                  | Fujitsu ETERNUS default setting      | SAN Volume Controller required setting |
|---------------------------------------------------------|--------------------------------------|----------------------------------------|
| Command timeout interval                                | Depends on the Fujitsu ETERNUS model | Default                                |
| Response status in overload                             | Unit Attention                       | Unit Attention                         |
| Byte 0 of Inquiry response/Response to inquiry commands | Default                              | Default                                |
| Inquiry Standard Data NACA Function                     | Disable                              | Disable                                |
| Inquiry Standard Data Version                           | Depends on the Fujitsu ETERNUS model | Default                                |
| Inquiry Command Page 83/Inquiry VPD ID Type             | Depends on the Fujitsu ETERNUS model | Type 01                                |

| Option                                                    | Fujitsu ETERNUS default setting | SAN Volume Controller required setting |
|-----------------------------------------------------------|---------------------------------|----------------------------------------|
| Reservation Conflict Response to Test Unit Ready Commands | Disable/Normal Response         | Enable/Conflict Response               |
| Target Port Group Access Support                          | Disable                         | Enable                                 |
| Host Specific Mode                                        | Normal Mode                     | Normal Mode                            |
| Response Sense at Firmware Hot Switching                  | Enable                          | Enable                                 |
| Change LUN mapping                                        | No Report                       | Report                                 |
| LUN Capacity Expansion                                    | No Report                       | Report                                 |
| Aymmetric / Symmetric Logical Unit Access                 | Active/Active                   | Active/Active                          |
| Pattern of Sense Code Conversion                          | No Conversion                   | No Conversion                          |

**Notes:**

1. If you set Inquiry VPD ID Type option to Type 3 on E4000 or E8000 range, the MDisks go offline.
2. If you set the Target Port Group Access Support option to Disabled on E3000 range, a 1370 error is shown in the error log.

**Host WWNs**

After the SAN Volume Controller is zoned on the fabric to see the Fujitsu ETERNUS, the system might not initially appear in the list of controllers when you issue the **Iscontroller** CLI command. This is normal and expected behavior.

See the documentation that is provided with the Fujitsu ETERNUS system to add all SAN Volume Controller WWPNs as host WWNs. The following restrictions apply:

- The SAN Volume Controller WWNs must be associated with a host response pattern. The host response pattern must be defined prior to registration. If you use an incorrect or default host response pattern, you can lose access to data.
- All SAN Volume Controller WWNs must be registered on all Fujitsu ETERNUS ports on the same fabric. If the WWNs are not registered, you can lose access to data.

**Affinity groups/zones**

Use the affinity groups/zones mode to protect the SAN Volume Controller LUs if the SAN is incorrectly configured. The affinity group mode is setup in the CA configuration. See the documentation that is provided with your Fujitsu ETERNUS system for more information about using the affinity groups/zones mode. The following restrictions apply:

- Each SAN Volume Controller must have exactly one affinity group/zone.
- The SAN Volume Controller affinity group/zone must be associated with all SAN Volume Controller WWNs.



## LUN mapping

You can use the LUN mapping mode (also called the zone settings mode for some models) with the following restrictions:

- The SAN zoning must only allow a single SAN Volume Controller access to this target port.
- The host response pattern must be set in CA configuration using the required SAN Volume Controller settings.

**Note:** If you use the LUN mapping mode, you cannot use the host affinity mode. The host affinity mode is set to OFF.

## Assigning storage to the SAN Volume Controller

Ensure that you understand all SAN Volume Controller and Fujitsu ETERNUS restrictions before you assign storage to the SAN Volume Controller. See the documentation that is provided with the Fujitsu ETERNUS system for more information.

## Zoning configuration for the Fujitsu ETERNUS

If LUN mapping mode is used for a Fujitsu ETERNUS port, you must exclusively zone the SAN Volume Controller with this target port.

## Migrating logical units from the Fujitsu ETERNUS to the SAN Volume Controller

You can use the standard migration procedure with the following restrictions:

- The SAN Volume Controller must have software level 4.2.0 or higher installed before you start migration. Upgrades from previous SAN Volume Controller software levels to software level 4.2.0 or higher causes all Fujitsu ETERNUS systems that are attached to be excluded.
- You must configure the Fujitsu ETERNUS system to work with the SAN Volume Controller before you start migration.
- The subsystem device driver (SDD) and Fujitsu Multipath driver cannot coexist.
- The SAN Volume Controller must support all host code levels.

## Concurrent maintenance on the Fujitsu ETERNUS

Concurrent maintenance is the capability to perform I/O operations to a Fujitsu ETERNUS while simultaneously performing maintenance operations on it.

You can perform nondisruptive maintenance procedures concurrently on the following components:

- Fujitsu ETERNUS controller module
- Fujitsu ETERNUS controller cache
- Fujitsu ETERNUS cache battery pack
- Fan
- Power supply
- Disk drive
- SFP transceiver

See the documentation that is provided with the Fujitsu ETERNUS system for more information.

## Advanced functions for the Fujitsu ETERNUS

The Fujitsu ETERNUS system provides several Advanced Copy functions. Do not use these Advanced Copy functions for storage that is managed by the SAN Volume Controller, even if the VDisk cache is disabled.

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### Configuring the IBM TotalStorage ESS system

This section provides information about configuring the IBM TotalStorage Enterprise Storage Server (ESS) for attachment to a SAN Volume Controller.

#### Configuring the IBM ESS

The IBM Enterprise Storage Server (ESS) provides functionality that is compatible with the SAN Volume Controller.

Perform the following steps to configure the IBM ESS:

1. Enter the IP address of the IBM ESS in a Web browser to access the ESS Specialist.
2. Login with your user name and password.
3. Click **ESS Specialist**.
4. Click **Storage Allocation**.
5. Click **Open System Storage**.
6. Click **Modify Host Systems**.
7. Create a host entry for each initiator port on each SAN Volume Controller node in your cluster. Complete the following fields:
  - a. Enter a unique name for each port in the **Nickname** field. For example, enter `knode` or `lnode`.
  - b. Select **IBM SAN Volume Controller** in the **Host Type** field. If this option is not available, select **RS/6000**.
  - c. Select **Fibre Channel attached** in the **Host Attachment** field.
  - d. Leave the **Hostname/IP address** field blank.
  - e. Select the WWPN from the list or enter it manually into the **WWPN** field. A configuration command fails if you use WWPN 0 in the command string.
8. Click **Perform Configuration Update** after you are finished adding all of the ports.
9. Click **Add Volumes** to add the volumes that you want the SAN Volume Controller to use. The Add Volumes panel is displayed.
10. Perform the following steps in the Add Volumes panel:
  - a. Select any of the SAN Volume Controller host ports that you created earlier.
  - b. Select the necessary ESS adapter to create the volumes.
  - c. Click **Next**.
  - d. Create volumes using your desired size, placement, and RAID level.
  - e. Click **Perform Configuration Update** after you have created all the volumes.
11. Perform the following steps to map the volumes to all of your SAN Volume Controller ports:
  - a. Click **Modify Volume Assignments**.
  - b. Select all of the volumes that you created earlier.

- c. Click **Assigning selected volumes to target hosts**.
- d. Select all of the remaining SAN Volume Controller host ports that you created earlier.
- e. Click **Perform Configuration Update**.

**Important:** If you are adding SAN Volume Controller ports to a volume that is already assigned to other SAN Volume Controller ports, you must select the **Use same ID/LUN in source and target** check box.

## Supported models of the IBM ESS

The SAN Volume Controller supports models of the IBM Enterprise Storage Server (ESS).

See the following Web site for the latest supported models:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Supported firmware levels for the IBM ESS

The SAN Volume Controller supports the IBM Enterprise Storage Server (ESS).

See the following Web site for specific firmware levels and the latest supported hardware:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Concurrent maintenance on the IBM ESS

Concurrent maintenance is the capability to perform I/O operations to an IBM Enterprise Storage Server (ESS) while simultaneously performing maintenance operations on it.

All IBM ESS concurrent maintenance procedures are supported.

## User interface on the IBM ESS

Ensure that you are familiar with the user interface application that supports the IBM Enterprise Storage Server (ESS) system.

### Web Server

A Web server runs on each of the controllers on the system. During normal operation, the user interface application allows only basic monitoring of the system and displays an error log. If you press the reset button on the controller to put the controller into diagnostic mode, the user interface application allows firmware upgrades and system configuration resets.

## Sharing the IBM ESS between a host and the SAN Volume Controller

The IBM Enterprise Storage Server (ESS) can be shared between a host and a SAN Volume Controller.

The following restrictions apply when you share the IBM ESS between a host and a SAN Volume Controller:

- If an IBM ESS port is in the same zone as a SAN Volume Controller port, that same IBM ESS port should not be in the same zone as another host.
- A single host can have both IBM ESS direct-attached and SAN Volume Controller virtualized disks configured to it.
- If a LUN is managed by the SAN Volume Controller, it *cannot* be mapped to another host.

See the following Web site for the latest supported configurations:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Switch zoning limitations for the IBM ESS

Consider the following limitations when you zone the IBM Enterprise Storage Server (ESS) to the SAN Volume Controller.

To avoid a single point of failure on the IBM ESS, you must have a minimum of two SAN connections from two separate adapter bays. The maximum number of IBM ESS SAN connections in the SAN Volume Controller switch zone is 16.

**Note:** The IBM ESS provides ESCON<sup>®</sup>, FICON<sup>®</sup> and Ultra SCSI connectivity; however, only a 1 or 2 Gb fibre-channel SAN attachment is supported by the SAN Volume Controller.

## Quorum disks on the IBM ESS

The SAN Volume Controller can choose managed disks (MDisks) that are presented by the IBM Enterprise Storage Server (ESS) controller as quorum disks.

## Advanced functions for the IBM ESS

SAN Volume Controller cache-disabled virtual disk (VDisks) can be used as the source or target for IBM Enterprise Storage Server (ESS) advanced copy functions (for example, FlashCopy, MetroMirror, GlobalCopy).

## Logical unit creation and deletion on the IBM ESS

Certain IBM Enterprise Storage Server (ESS) types are supported for use with the SAN Volume Controller.

Before you delete or unmap a logical unit (LU) from the SAN Volume Controller, remove the LU from the managed disk (MDisk) group. The following is supported:

- LU size of 1 GB to 2 TB.
- RAID 5 and RAID 10 LUs.
- LUs can be added dynamically.

**Attention:** When adding additional SAN Volume Controller ports to an existing LU, you must select the **Use same ID/LUN in source and target** checkbox. Failure to select the **Use same ID/LUN in source and target** checkbox can cause loss in redundancy or a loss of data. If this checkbox is not available, the option is not required. The detect MDisks task in the SAN Volume Controller Console or the `svctask detectmdisk` command-line interface (CLI) command must be run for the SAN Volume Controller to detect the new disks.

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## Configuring IBM System Storage DS5000, IBM DS4000 and IBM DS3000 systems

This section provides information about configuring IBM System Storage DS5000, IBM DS4000 and IBM DS3000 systems for attachment to a SAN Volume Controller cluster. Some IBM System Storage DS4000 controllers are equivalent to StorageTek models; SAN Volume Controller also supports certain StorageTek FlexLine series and StorageTek D series. The information in this section also applies to the supported models of the StorageTek FlexLine series and StorageTek D series.

IBM System Storage DS5000, IBM DS4000, and IBM DS3000 are similar systems. The concepts in this section apply generally to all three systems; however, some options may not be available. See the documentation that is provided with your system for specific information.

### Configuring IBM System Storage DS5000 and IBM DS4000 systems for the storage server

IBM System Storage DS5000 and IBM DS4000 disk controllers are supported with the SAN Volume Controller cluster.

The following steps provide the supported options and impact on the SAN Volume Controller cluster:

1. Perform the following steps for the host type option:
  - a. Depending on your IBM System Storage DS5000 or IBM DS4000 model, you must set either the default host type of the system, or the host type of the chosen partition to one of the following:
    - IBM TS SAN VCE
    - SAN Volume Contr
    - 1) Click **Storage Subsystem** → **Change** → **Default Host Type**, or
    - 2) For each host port, you can specify the host type of that port or modify existing ports.
2. Perform the following steps for the worldwide node name (WWNN) option:
  - a. Set the system so that both controllers have the same WWNN.
  - b. See the following Web site for the scripts that are available to change the setup of the IBM System Storage DS5000 or IBM DS4000 system:  
[www.ibm.com/storage/support/](http://www.ibm.com/storage/support/)
3. Perform the following steps for the auto volume transfer (AVT) option:
  - a. Ensure that the AVT option is enabled. The host type selection should have already enabled the AVT option.
  - b. View the storage system profile data to confirm that you have the AVT option enabled. This storage profile is presented as a text view in a separate window.
  - c. See the following Web site for the scripts that are available to enable the AVT option:  
[www.ibm.com/storage/support/](http://www.ibm.com/storage/support/)

The following limitations apply to partitions:

- Only one IBM System Storage DS5000 or IBM DS4000 system storage partition that contains any of the ports of any of the nodes in a single SAN Volume Controller cluster can be created.

- Only map one partition to any of the ports on any of the nodes that are in the SAN Volume Controller cluster to avoid unexpected behavior. For example, you can lose access to your storage or you might not receive warning messages, even if there are errors logged in the SAN Volume Controller error log.

The following limitation applies to IBM System Storage DS5000 and IBM DS4000 Copy Services:

- Do not use IBM System Storage DS5000 or IBM DS4000 Copy Services when the SAN Volume Controller cluster is attached to an IBM System Storage DS5000 or IBM DS4000 system.
- You can use partitioning to allow IBM System Storage DS5000 or IBM DS4000 Copy Services usage for other hosts.

The following information applies to the access LUN (also known as the Universal Transport Mechanism (UTM) LUN):

- The access/UTM LUN is a special LUN that allows a IBM System Storage DS5000 or IBM DS4000 system to be configured through software over the fibre-channel connection. The access/UTM LUN does not have to be in the partition that contains the SAN Volume Controller ports because the access/UTM LUN is not required by the SAN Volume Controller cluster. No errors are generated if the access/UTM LUN is not in the partition.

The following information applies to the logical unit (LU):

- The SAN Volume Controller cluster attempts to follow the preferred ownership that is specified by the IBM System Storage DS5000 or IBM DS4000 system. You can specify which controller (A or B) is used for I/O operations to an LU.
- If the SAN Volume Controller cluster can see the ports of the preferred controller and error conditions do not exist, the SAN Volume Controller cluster accesses the LU through one of the ports on the preferred controller.
- If error conditions exist, the SAN Volume Controller cluster ignores the preferred ownership of the IBM System Storage DS5000 or IBM DS4000 system.

## Supported options for IBM System Storage DS5000 and IBM DS4000 controllers

IBM System Storage DS5000 and IBM DS4000 series disk controllers provide functions that can be used with the SAN Volume Controller.

The storage manager for IBM System Storage DS5000 and IBM DS4000 systems has several options and actions that you can perform.

### Controller run diagnostics

Diagnostics are automatically recovered by the SAN Volume Controller software. After the controller run diagnostics option is used, check your managed disks (MDisks) to ensure that they have not been set to degraded mode.

### Controller disable data transfer

The controller disable data transfer option is not supported when a SAN Volume Controller is attached to IBM System Storage DS5000 or IBM DS4000 systems.

## Setting an array Offline

Do not set an array offline because you can lose access to the MDisk group.

## Array increase capacity

The array increase capacity option is supported but the new capacity is not usable until the MDisk is removed from the MDisk group and re-added to the MDisk group. You might have to migrate data to increase the capacity.

## Redistribute logical drives or change ownership of the preferred path

You can redistribute logical drives or change ownership of the preferred path; however, these options might not take effect until a discovery is started on the SAN Volume Controller cluster. You can use the **svctask detectmdisk** command-line interface (CLI) command to restart a cluster discovery process. The discovery process rescans the fibre-channel network to discover any new MDisks that might have been added to the cluster and to rebalance MDisk access across the available controller device ports.

## Controller reset

You must only use the controller reset option if you are directed to do so by IBM Service and the alternate controller is functional and available to the SAN. The SAN Volume Controller reset is automatically recovered by the SAN Volume Controller software.

Check your MDisks to ensure that they have not been set to the degraded state during the controller reset process. You can issue the **svctask includemdisk** CLI command to repair degraded MDisks.

## Supported models of IBM System Storage DS5000, IBM DS4000 and IBM DS3000 systems

The SAN Volume Controller supports models of the IBM System Storage DS5000, IBM DS4000 and IBM DS3000 systems. Some IBM System Storage DS4000 series controllers are equivalent to Sun StorageTek and StorageTek models; SAN Volume Controller also supports some Sun StorageTek, StorageTek FlexLine and D series models.

See the following Web site for the latest supported models:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

**Note:** Some levels of FAStT microcode support a maximum of 32 LUNs per host partition, newer versions allow up to 256 LUNs per host partition.

## Supported firmware levels for IBM System Storage DS5000, IBM DS4000 and IBM DS3000 systems

You must ensure that the firmware level of the system can be used with the SAN Volume Controller cluster.

See the following Web site for specific firmware levels and the latest supported hardware:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

The Web site includes the maximum number of LUNs per partition that are supported by the firmware level.

## Concurrent maintenance on IBM System Storage DS5000 and IBM DS4000 systems

Concurrent maintenance is the capability to perform I/O operations to an IBM System Storage DS5000 or IBM DS4000 series controller while simultaneously performing maintenance operations on the system.

See your IBM System Storage DS5000 or IBM DS4000 series documentation for information about concurrent maintenance.

## IBM System Storage DS5000, IBM DS4000 and IBM DS3000 systems user interface

Ensure that you are familiar with the user interface that supports the IBM System Storage DS5000, IBM DS4000 and IBM DS3000 systems.

### Web Server

A Web server is running on each of the controllers in the system. During normal operation, the user interface only allows basic monitoring of the system and displays an error log. If you press the reset button to put a controller in diagnostic mode, the user interface allows firmware upgrades and system configuration resets.

## Sharing an IBM System Storage DS5000, IBM DS4000 or IBM DS3000 system between a host and the SAN Volume Controller

You can share an IBM System Storage DS5000, IBM DS4000 or IBM DS3000 system between a host and a SAN Volume Controller cluster.

The IBM System Storage DS5000 and IBM DS4000 function known as *partitioning* must be used to separate groups of logical units that are directly attached to hosts or groups of hosts from the logical units that are accessed by the SAN Volume Controller cluster.

**Note:** The SAN Volume Controller partition must either contain all the ports of the SAN Volume Controller cluster that are connected to the SAN or are zoned to have access to the controller ports. At least one port from each controller must be visible by the SAN Volume Controller cluster.



## Quorum disks on IBM System Storage DS5000, IBM DS4000 and IBM DS3000 systems

The SAN Volume Controller can choose managed disks (MDisks) that are presented by a IBM System Storage DS5000, IBM DS4000 or IBM DS3000 system as quorum disks.

**Note:** The FASsT series 200 does not support quorum disks.

## Advanced functions for IBM System Storage DS5000, IBM DS4000 and IBM DS3000 systems

SAN Volume Controller cache-disabled virtual disks (VDisks) can be used as the source or target for IBM System Storage DS5000, IBM DS4000 and IBM DS3000 advanced copy functions: for example, FlashCopy and Metro Mirror.

### Data migration on partitioned IBM System Storage DS5000 and IBM DS4000 systems

You can migrate data on partitioned IBM System Storage DS5000 and IBM DS4000 systems.

You can enable the SAN Volume Controller to be introduced to an existing SAN environment, so that you have the option of using image mode LUNs to import the existing data into the virtualization environment without requiring a backup and restore cycle. Each partition can only access a unique set of HBA ports, as defined by the worldwide port names (WWPNs). For a single host to access multiple partitions, unique host fibre ports (WWPNs) must be assigned to each partition. All LUNs within a partition are identified to the assigned host fibre ports (no subpartition LUN mapping).

Host A is mapped to LUN 0, 1, 2 in Partition 0.

Host B is mapped to LUN 0, 1, 2, 3, 4, 5 in Partition 1.

Host C is mapped to LUN 0, 1, 2 in Partition 2.

To allow Host A to access the LUNs in partition B, you must remove one of the HBAs (for example, A1) from the access list for partition 0 and add it to partition 1. A1 cannot be on the access list for more than one partition.

To add a SAN Volume Controller into this configuration without backup and restore cycles requires a set of unique SAN Volume Controller HBA port WWPNs for each partition. This allows the IBM System Storage DS5000 or IBM DS4000 system to make the LUNs known to the SAN Volume Controller, which then configures these LUNs as image-mode LUNs and identifies them to the required hosts. This violates a requirement that all SAN Volume Controller nodes must be able to see all back-end storage. For example, to fix this problem for an IBM DS4000 system, change the configuration to allow more than 32 LUNs in one storage partition, so that you can move all the LUNs from all the other partitions into one partition and map to the SAN Volume Controller cluster.

### Scenario: the SAN Volume Controller nodes cannot see all back-end storage

The IBM DS4000 series has eight partitions with 30 LUNs in each.

Perform the following steps to allow the SAN Volume Controller nodes to see all back-end storage:

1. Change the mappings for the first four partitions on the IBM DS4000 system such that each partition is mapped to one port on each node. This maintains redundancy across the cluster.
2. Create a new partition on the system that is mapped to all four ports on all the nodes.
3. Gradually migrate the data into the managed disks (MDisks) in the target partition. As storage is freed from the source partitions, it can be reused as new storage in the target partition. As partitions are deleted, new partitions that must be migrated can be mapped and migrated in the same way. The host side data access and integrity is maintained throughout this process.

## Logical unit creation and deletion on IBM System Storage DS5000 and IBM DS4000 systems

You can create or delete logical units on IBM System Storage DS5000 and IBM DS4000 systems.

Some IBM System Storage DS5000 and IBM DS4000 controllers are supported for use with SAN Volume Controller clusters.

To create a logical disk, you must set either the default host type of the IBM System Storage DS5000 or IBM DS4000 system, or the host type of the chosen partition to one of the following settings, depending on the model:

IBM TS SAN VCE  
SAN Volume Contr

Perform one of the following tasks to set the host type:

- Click **Storage Subsystem** → **Change** → **Default Host Type**
- For each host port, specify the host type of that port or modify existing ports.

## Configuration interface for IBM System Storage DS5000 and IBM DS4000 systems

IBM System Storage DS5000 and IBM DS4000 systems include a configuration application.

The access LUN, also known as the Universal Transport Mechanism (UTM) LUN, is the configuration interface for IBM System Storage DS5000 and IBM DS4000 systems.

The access LUN might not be in a partition that contains the SAN Volume Controller ports because it is not required by the SAN Volume Controller cluster. The UTM LUN is a special LUN that allows IBM System Storage DS5000 and IBM DS4000 systems to be configured through suitable software over the fibre-channel connection. Because the SAN Volume Controller does not require the UTM LUN, it does not generate errors either way. IBM System Storage DS5000 and IBM DS4000 systems *must not* have the Access UTM LUN that is presented as LUN 0 (zero).

It is possible to use in-band (over fibre channel) and out-of-band (over Ethernet) to allow the configuration software to communicate with more than one IBM System Storage DS5000 or IBM DS4000 system. If using in-band configuration, the Access

UTM LUN must be configured in a partition that does not include any logical units that are accessed by the SAN Volume Controller cluster.

**Note:** In-band is not supported for access to the LUN while in the SAN Volume Controller partition.

## Controller settings for IBM System Storage DS5000 and IBM DS4000 systems

Controller settings are the settings that apply across one IBM System Storage DS5000 or IBM DS4000 system.

You must configure the following settings for IBM System Storage DS5000 and IBM DS4000 systems:

- Depending on your model, you must set either the default host type of your IBM System Storage DS5000 or IBM DS4000 system, or the host type of the chosen partition, to one of the following:

IBM TS SAN VCE  
SAN Volume Contr

Perform one of the following tasks to set the host type:

- Click **Storage Subsystem** → **Change** → **Default Host Type**
- For each host port, specify the host type of that port or modify existing ports.
- Set the system so that both controllers have the same worldwide node name (WWNN). See the following Web site for the scripts that are available to change the setup for IBM System Storage DS5000 and IBM DS4000 systems:  
[www.ibm.com/storage/support/](http://www.ibm.com/storage/support/)
- Ensure that the AVT option is enabled. The host type selection should have already enabled the AVT option. View the storage system profile data to confirm that you have the AVT option enabled. This storage profile is presented as a text view in a separate window. See the following Web site for the scripts that are available to enable the AVT option:  
[www.ibm.com/storage/support/](http://www.ibm.com/storage/support/)
- You must have the following options enabled on any logical units that are mapped to IBM System Storage DS5000 and IBM DS4000 systems:
  - read caching
  - write caching
  - write cache mirroring
- You must *not* have caching without batteries enabled.

## Configuration settings for IBM System Storage DS5000, IBM DS4000 and IBM DS3000 systems

The system configuration interface provides configuration settings and options that can be used with the SAN Volume Controller cluster.

These settings and options can have the following scope:

- System
- Logical unit (LU)
  - The SAN Volume Controller cluster attempts to follow preferred ownership that is specified by the system. You can specify which controller (A or B) is used to perform I/O operations to a given LU. If the SAN Volume Controller cluster can see the ports of the preferred controller and no error conditions

- exist, the SAN Volume Controller cluster accesses that LU through one of the ports on that controller. Under error conditions, the ownership is ignored.
- You must have the following options enabled on any LUs that are mapped to the SAN Volume Controller cluster:
    - read caching
    - write caching
    - write cache mirroring
  - You must *not* have caching without batteries enabled.

## Global settings for IBM System Storage DS5000 or IBM DS4000 systems

Global settings apply across IBM System Storage DS5000 or IBM DS4000 systems.

Table 26 lists the global settings that can be used with SAN Volume Controller clusters.

*Table 26. IBM System Storage DS5000 and DS4000 system global options and required settings*

| Option           | IBM DS5000 or IBM DS4000 system default setting |
|------------------|-------------------------------------------------|
| Start flushing   | 80%                                             |
| Stop flushing    | 80%                                             |
| Cache block size | 4 Kb                                            |

**Attention:** Do not modify these settings unless you are directed by the IBM Support Center

Depending on the IBM DS5000 or IBM DS4000 model, use a host type of IBM TS SAN VCE or SAN Volume Contr to establish the correct global settings for the SAN Volume Controller cluster. Either set this as the system default host type or, if partitioning is enabled, associate each SAN Volume Controller port with this host type.

## Logical unit settings for IBM System Storage DS5000, IBM DS4000 and IBM DS3000 systems

Logical unit (LU) settings are configurable at the LU level.

LUs that are accessed by hosts can be configured differently.

The read ahead cache multiplier is typically set to 0 or 1. Do not modify this setting unless you are directed to do so by the IBM Support Center.

The following options must be enabled on any LUs that are mapped to the SAN Volume Controller cluster:

- read caching
- write caching
- write cache mirroring

You must not have caching without batteries enabled.

Depending on your system model, set the host type to the one of following when you create a new LU:

## Miscellaneous settings for IBM System Storage DS5000, IBM DS4000 or IBM DS3000 systems

The SAN Volume Controller cluster supports all media scan settings that are provided by the system. Set the background media scan to enabled and set the frequency to 30 days. These settings are enabled at both the system level and the individual logical drive level.

See the documentation that is provided with your system for information about other settings.

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## Configuring the IBM System Storage DS6000 system

This section provides information about configuring the IBM System Storage DS6000™ system for attachment to a SAN Volume Controller.

### Configuring the IBM DS6000

The IBM DS6000 provides functions that are compatible with the SAN Volume Controller.

After you have defined at least one storage complex, storage unit, and I/O port, you can define the SAN Volume Controller as a host and create host connections. If you have not defined all of these required storage elements, use the IBM System Storage DS6000 Storage Manager or the IBM DS6000 command-line interface (CLI) to define these elements and return to this topic after they are configured.

This task assumes that you have already launched the IBM System Storage DS6000 Storage Manager.

Perform the following steps to configure the IBM DS6000:

1. Click **Real-time manager** → **Manage hardware** → **Host systems**.
2. Select **Create** from the **Select Action** list. The Create Host System wizard is displayed.
3. Perform the following steps to select a host type:
  - a. Select **IBM SAN Volume Controller (SVC)** from the **Host Type** list.
  - b. Enter a unique name of up to 16 characters for each port in the **Nickname** field. The value that you enter in this field appears in other panels when you select defined hosts. This is a required field.
  - c. Optionally, enter a detailed description of up to 256 characters in the **Description** field.
  - d. Click **Next**. The Define host wizard panel is displayed.
4. Perform the following steps in the Define host panel:
  - a. Enter the number of ports that you are defining for the SAN Volume Controller node in the **Quantity** field.

**Note:** You must add all of the SAN Volume Controller node ports.
  - b. Select **FC Switch fabric (P-P)** from the **Attachment Port Type** list.
  - c. Click **Add**.
  - d. Select **Group ports to share a common set of volumes**.
  - e. Click **Next**. The Define host WWPN panel is displayed.

5. Specify a WWPN for each SAN Volume Controller node port that you are configuring. After you have defined all SAN Volume Controller node port WWPNs, click **Next**.
6. Perform the following steps in the Specify storage units panel:
  - a. Select all the available storage units that use the ports that you defined in step 5.
  - b. Click **Add** to move the selected storage units to the **Selected storage units** field.
  - c. Click **Next**. The Specify storage units parameters panel is displayed
7. Perform the following steps in the Specify storage units parameters panel:
  - a. Select a host attachment identifier from the table.
  - b. Click **the following specific storage unit I/O ports** in the **This host attachment can login to** field. The available ports are displayed in the Available storage unit I/O ports table.
  - c. Select each port in the Available storage unit I/O ports table.
 

**Note:** The **Type** for each port should be **FcSf**. If the listed type is not FcSf, click **Configure I/O Ports**. The Configure I/O Ports panel is displayed. Click the port that you want to configure and select **Change to FcSf** from the **Select Action** list.
  - d. Click **Apply assignment**.
  - e. Click **OK**. The Verification panel is displayed.
8. Verify that the attributes and values that are displayed in the table are correct.
9. Click **Finish** if the values that are displayed in the table are correct. Otherwise, click **Back** to return to the previous panels and change the values that are not correct.

## Supported firmware levels for the IBM DS6000

The IBM DS6000 must use a firmware level that is supported by the SAN Volume Controller.

See the following Web site for specific firmware levels and the latest supported hardware:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Supported models of the IBM DS6000 series

The SAN Volume Controller supports models of the IBM DS6000 series of controllers.

See the following Web site for the latest supported models:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## User interfaces on the IBM DS6000

Ensure that you are familiar with the user interfaces that support the IBM DS6000.

### Web server

You can manage, configure, and monitor the IBM DS6000 through the IBM System Storage DS6000 Storage Manager.

## CLI

You can also manage, configure, and monitor the IBM DS6000 through the IBM System Storage DS command-line interface.

## Concurrent maintenance on the IBM DS6000

Concurrent maintenance is the capability to perform I/O operations to an IBM DS6000 while simultaneously performing maintenance operations on it.

All IBM DS6000 concurrent maintenance procedures are supported.

## Target port groups on the IBM DS6000

The IBM DS6000 uses the SCSI Target Port Groups feature to indicate a preferred path for each logical unit (LU).

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## Configuring the IBM System Storage DS8000 system

This section provides information about configuring the IBM System Storage DS8000™ system for attachment to a SAN Volume Controller.

### Configuring the IBM DS8000

The IBM DS8000 provides functions that are compatible with the SAN Volume Controller.

After you have defined at least one storage complex, storage unit, and I/O port, you can define the SAN Volume Controller as a host and create host connections. If you have not defined all of these required storage elements, use the IBM System Storage DS8000 Storage Manager or the IBM System Storage DS command-line interface to define these elements and return to this topic after they are configured.

This task assumes that you have already launched the IBM System Storage DS8000 Storage Manager.

Perform the following steps to configure the IBM DS8000:

1. Click **Real-time manager** → **Manage hardware** → **Host systems**.
2. Select **Create** from the **Select Action** list. The Create Host System wizard begins.
3. Perform the following steps to select a host type:
  - a. Select **IBM SAN Volume Controller (SVC)** from the **Host Type** list.
  - b. Enter a unique name of up to 16 characters for each port in the **Nickname** field. The value that you enter in this field is displayed in other panels when you select defined hosts. This is a required field.
  - c. Optionally, enter a detailed description of up to 256 characters in the **Description** field.
  - d. Click **Next**. The Define host wizard panel is displayed.
4. Perform the following steps in the Define host panel:
  - a. Enter the number of ports that you are defining for the SAN Volume Controller node in the **Quantity** field.

**Note:** You must add all of the SAN Volume Controller node ports.

- b. Select **FC Switch fabric (P-P)** from the **Attachment Port Type** list.
- c. Click **Add**.

- d. Select **Group ports to share a common set of volumes**.
- e. Click **Next**. The Define host WWPN panel is displayed.
5. Specify a WWPN for each SAN Volume Controller node port that you are configuring. When you have defined all SAN Volume Controller node port WWPNs, click **Next**.
6. Perform the following steps in the Select storage images panel:
  - a. Select all the available storage units that use the ports that you defined in the previous step.
  - b. Click **Add** to move the selected storage units to the **Select storage images** field.
  - c. Click **Next**. The Specify storage image parameters panel is displayed
7. Perform the following steps in the Specify storage image parameters panel:
  - a. Select a host attachment identifier from the table.
  - b. Click **the following specific storage image I/O ports** in the **This host attachment can login to** field. The available ports are displayed in the Available storage unit I/O ports table.
  - c. Select each port in the Available storage unit I/O ports table.
 

**Note:** The **Type** for each port should be **FcSf**. If the listed type is not FcSf, click **Configure I/O Ports**. The Configure I/O Ports panel is displayed. Click the port that you want to configure and select **Change to FcSf** from the **Select Action** list.
  - d. Click **Apply assignment**.
  - e. Click **OK**. The Verification panel is displayed.
8. Verify that the attributes and values that are displayed in the table are correct.
9. Click **Finish** if the values that are displayed in the table are correct. Otherwise, click **Back** to return to the previous panels and change the incorrect values.

## Supported firmware levels for the IBM DS8000

The SAN Volume Controller supports the IBM DS8000 series.

See the following Web site for specific firmware levels and the latest supported hardware: [www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Supported models of the IBM DS8000

The SAN Volume Controller supports models of the IBM DS8000 series of controllers.

See the following Web site for the latest supported models:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## User interfaces on the IBM DS8000

Ensure that you are familiar with the user interfaces that support the IBM DS8000.

### Web server

You can manage, configure, and monitor the IBM DS8000 through the IBM System Storage DS8000 Storage Manager.



## CLI

You can also manage, configure, and monitor the IBM DS8000 through the IBM System Storage DS command-line interface.

## Concurrent maintenance for the IBM DS8000

Concurrent maintenance is the capability to perform I/O operations to an IBM DS8000 while simultaneously performing maintenance operations on it.

All IBM DS8000 concurrent maintenance procedures are supported.

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## Configuring the HDS Lightning series system

This section provides information about configuring the Hitachi Data Systems (HDS) Lightning series system for attachment to a SAN Volume Controller.

The information in this section also applies to the supported models of the Sun StorEdge series and the HP XP series.

## Supported models of the HDS Lightning

The SAN Volume Controller supports models of the HDS Lightning. Certain models of the HDS Lightning are equivalent to Sun StorEdge and HP XP models; therefore, the SAN Volume Controller also supports models of the Sun StorEdge and the HP XP.

See the following Web site for the latest supported models:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Supported firmware levels for HDS Lightning

The SAN Volume Controller supports the HDS Lightning.

See the following Web site for specific HDS Lightning firmware levels and the latest supported hardware:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

**Note:** Concurrent upgrade of the controller firmware is supported with the SAN Volume Controller.

## Concurrent maintenance on the HDS Lightning

Concurrent maintenance is the capability to perform I/O operations to an HDS Lightning while simultaneously performing maintenance operations on it.

**Important:** An HDS Field Engineer must perform all maintenance procedures.

## User interface on HDS Lightning

Ensure that you are familiar with the user interface application that supports the HDS Lightning system.

## Service Processor (SVP)

HDS Lightning has a laptop in the controller frame. The laptop runs the Service Processor (SVP) as the primary configuration user interface. You can use SVP to perform most configuration tasks and to monitor the controller.

## HiCommand

The HiCommand is a graphical user interface that allows basic creation of storage and system monitoring. The HiCommand communicates with HDS Lightning through Ethernet.

## Sharing the HDS Lightning 99xxV between a host and the SAN Volume Controller

There are restrictions for sharing an HDS Lightning 99xxV between a host and a SAN Volume Controller cluster.

### Sharing ports

The HDS Lightning 99xxV can be shared between a host and a SAN Volume Controller cluster under the following conditions:

- The same host cannot be connected to both a SAN Volume Controller cluster and an HDS Lightning at the same time because the Hitachi HiCommand Dynamic Link Manager (HDLM) and the subsystem device driver (SDD) cannot coexist.
- A controller port cannot be shared between a host and a SAN Volume Controller cluster. If a controller port is used by a SAN Volume Controller cluster, it must not be present in a switch zone that allows a host to access the port.
- Logical units (LUs) cannot be shared between a host and a SAN Volume Controller cluster.

### Supported Topologies

You can connect the SAN Volume Controller cluster to the HDS Lightning under the following conditions:

- For SAN Volume Controller software version 4.2.1 and later, you can connect a maximum of 16 HDS Lightning ports to the SAN Volume Controller cluster without any special zoning requirements.
- For SAN Volume Controller software version 4.2.0, the following applies:
  - Logical Unit Size Expansion (LUSE) and Virtual LVI/LUN operations cannot be run on a disk that is managed by the SAN Volume Controller cluster. LUNs that are created using LUSE and Virtual LVI/LUN can be mapped to the cluster after they are created.
  - Only disks with open emulation can be mapped to the SAN Volume Controller cluster.
  - S/390® disks cannot be used with the SAN Volume Controller cluster.
  - Only fibre-channel connections can connect the SAN Volume Controller cluster to the HDS Lightning.

## Quorum disks on HDS Lightning 99xxV

HDS Lightning 99xxV is not an approved host for quorum disks. Therefore, configurations with only HDS Lightning are not possible.

## Advanced functions for HDS Lightning

Some advanced functions of the HDS Lightning are not supported by the SAN Volume Controller.

### Advanced copy functions

Advanced copy functions for HDS Lightning (for example, ShadowImage, Remote Copy, and Data Migration) are not supported for disks that are managed by the SAN Volume Controller, because the copy function does not extend to the SAN Volume Controller cache.

### Logical Unit Size Expansion

The HDS Lightning 99xxV supports Logical Unit Expansion (LUSE). LUSE is *not* a concurrent operation. LUSE is accomplished by concatenating between 2 and 26 existing logical units (LUs) together. Before LUSE can be performed on an LU, the LU must be removed from the managed disk (MDisk) group and unmapped from the SAN Volume Controller.

**Attention:** LUSE destroys all data that exists on the LU, except on a Windows system.

### TrueCopy

TrueCopy operations are functionally similar to Metro Mirror. TrueCopy processing is not supported when the disk controller system is used with the SAN Volume Controller. Even when an HDS Lightning 99xxV is shared between a host and a SAN Volume Controller, TrueCopy processing is not supported on the ports that are zoned directly with the host.

### Virtual LVI/LUNs

The HDS Lightning 99xxV supports Virtual LVI/LUNs. Virtual LVI/LUNs is *not* a concurrent operation. Virtual LVI/LUNs allows you to divide LUNs into several smaller virtual LUNs for use by the HDS Lightning. You must first create existing LUNs into free space and then define their own LUNs using that free space. Virtual LVI/LUNs must *not* be managed or mapped to a SAN Volume Controller.

LUNs that are set up using either LUSE or Virtual LVI/LUNs appear as normal LUNs after they are created. Therefore, LUNs that are set up using LUSE or Virtual LVI/LUNs can be used by the SAN Volume Controller after they are created.

### Write protect

LUs cannot be explicitly set to write-protected. However, some of the advanced features, such as Metro Mirror, can be used to write-protect an LU as part of the function. Metro Mirror must not be used for LUs that are in use by a SAN Volume Controller.

## Logical unit configuration for HDS Lightning

Logical unit (LU) configuration for HDS Lightning supports both RAID 1 and RAID 5 arrays.

The HDS Lightning system can have up to 8192 LUs defined; however, only 256 LUs can be mapped to a single port. Report LUNs is supported by LUN 0, so the SAN Volume Controller can detect all LUNs.

In the event that a LUN 0 is not configured, the HDS Lightning system presents a pseudo-LUN at LUN 0. The inquiry data for this pseudo-LUN slightly differs from the inquiry data of normal LUNs. The difference allows the SAN Volume Controller to recognize the pseudo-LUN and exclude it from I/O. The pseudo LUN can accept the report LUNs command.

The HDS Lightning system supports both open-mode attachment and S/390 attachment. The emulation mode is set when the LU is defined. All LUNs that are presented to a SAN Volume Controller must use open emulation. All LUNs with open emulation use a standard 512 byte block size.

The HDS Lightning system can only have certain sized LUs that are defined. These LUs can be expanded by merging 2 - 36 of these LUs using the Logical Unit Size Expansion (LUSE) feature. They can also be made into several, smaller virtual LUNs by using the Virtual LVI/LUN feature.

## Special LUs

When an LU is mapped to a host, you have the option to make it a *command LUN*. Command LUNs support in-band configuration commands, but not I/O. Therefore, you cannot map command LUNs to the SAN Volume Controller.

## Logical unit creation and deletion on HDS Lightning

The SAN Volume Controller supports Logical Unit Size Expansion (LUSE) with certain restrictions.

The following restrictions apply:

- Before LUSE can be performed on an LU, the LU must be unmounted from a host and have no available paths. The LUSE function destroys all data that exists on the LU, except for LUs on a Windows operating system.
- LUSE must not be performed on any disk that is managed by the SAN Volume Controller.
- If data exists on a disk and you want to use image mode to import the data, do not use LUSE on the disk before you import the data.

## Configuring settings for HDS Lightning

The Lightning configuration interface provides functions for configuration.

These options and settings can have the following scope:

- Subsystem
- Port
- Logical unit (LU)

## Global settings for HDS Lightning

Global settings apply across an HDS Lightning disk controller system.

Table 27 lists the global settings for HDS Lightning.

*Table 27. HDS Lightning global settings supported by the SAN Volume Controller*

| Option                       | Lightning default setting           | SAN Volume Controller Required setting |
|------------------------------|-------------------------------------|----------------------------------------|
| Spare disk recover           | Interleave                          | Interleave                             |
| Disk copy place              | Medium                              | Medium                                 |
| Copy operation               | Correction copy and dynamic sparing | Correction copy and dynamic sparing    |
| Read configuration data mode | Selected                            | Selected                               |
| PS off timer                 | Not selected                        | Not selected                           |

### Controller settings for HDS Lightning

Controller settings are settings that apply across the entire HDS Lightning controller.

Table 28 lists the HDS Lightning controller settings that are supported by the SAN Volume Controller.

*Table 28. HDS Lightning controller settings that are supported by the SAN Volume Controller*

| Option   | HDS Lightning default setting | SAN Volume Controller required setting |
|----------|-------------------------------|----------------------------------------|
| PCB mode | Standard                      | Standard                               |

### Port settings for HDS Lightning

Port settings are configurable at the port level.

There are no available options with the scope of a single controller.

- The ports are included in switch zones.
- The switch zones only present the ports directly to the hosts and not to a SAN Volume Controller.

Table 29 lists the HDS Lightning port settings that are supported by the SAN Volume Controller.

*Table 29. HDS Lightning port settings supported by the SAN Volume Controller*

| Option          | HDS Lightning default setting | SAN Volume Controller required setting |
|-----------------|-------------------------------|----------------------------------------|
| Address         | AL/PA                         | AL/PA                                  |
| Fabric          | On                            | On                                     |
| Connection      | Point-to-Point                | Point-to-Point                         |
| Security switch | On                            | On or off                              |
| Host type       | Default                       | Windows                                |

### Logical unit settings for HDS Lightning

Logical unit (LU) settings apply to individual LUs that are configured in the HDS Lightning controller.

HDS Lightning LUs must be configured as described in Table 30 if the LUN is associated with ports in a switch zone that is accessible to the SAN Volume Controller.

Table 30. HDS Lightning LU settings for the SAN Volume Controller

| Option           | HDS Lightning default setting | SAN Volume Controller required setting |
|------------------|-------------------------------|----------------------------------------|
| Command device   | Off                           | Off                                    |
| Command security | Off                           | Off                                    |

**Note:** These settings only apply to LUs that are accessible by the SAN Volume Controller.

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## Configuring HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems

You can attach Hitachi Data Systems (HDS) Thunder, HDS TagmaStore Adaptable Modular Storage (AMS), and HDS TagmaStore Workgroup Modular Storage (WMS) systems to a SAN Volume Controller cluster.

**Note:** In Japan, the HDS Thunder 9200 is referred to as the HDS SANrise 1200. Therefore, the information in this section that refers to the HDS Thunder 9200 also applies to the HDS SANrise 1200.

### Supported HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS models

You can attach certain HDS Thunder, HDS TagmaStore Adaptable Modular Storage (AMS), and HDS TagmaStore Workgroup Modular Storage (WMS) models to SAN Volume Controller clusters.

See the following Web site for the latest supported models:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

### Supported firmware levels for HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS

The SAN Volume Controller supports certain HDS Thunder, HDS TagmaStore Adaptable Modular Storage (AMS), and HDS TagmaStore Workgroup Modular Storage (WMS) models.

See the following Web site for specific firmware levels and the latest supported hardware:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

### Concurrent maintenance on HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems

Concurrent maintenance is the capability to perform I/O operations to a system while simultaneously performing maintenance operations on it.

**Important:** An HDS Field Engineer must perform all maintenance operations.

The SAN Volume Controller supports concurrent hardware maintenance and firmware upgrade operations on these systems.

## **User interface on HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems**

Ensure that you are familiar with the user interface applications that support the Hitachi Data Systems (HDS) Thunder, HDS TagmaStore Adaptable Modular Storage (AMS), and HDS TagmaStore Workgroup Modular Storage (WMS) systems.

### **In-band configuration**

Disable the system command LUN when you use the user interface applications.

### **Storage Navigator Modular GUI**

The Storage Navigator Modular (SNM) is the primary user interface application for configuring HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems. Use SNM to upgrade firmware, change settings, and to create and monitor storage.

SNM supports an Ethernet connection to the system. An out-of-band command-line interface is available with SNM that supports the majority of the functions that are provided in SNM.

### **HiCommand**

HiCommand is another configuration user interface that is available for the HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems. You must have access to SNM to use HiCommand to configure settings. HiCommand only allows basic creation of storage and provides some monitoring features.

HiCommand uses Ethernet to connect to the system.

### **Web Server**

A Web server runs on each of the controllers on the system. During normal operation, the user interface only allows basic monitoring of the system and displays an error log. If you put a controller into diagnostic mode by pressing the reset button on the controller, the user interface allows firmware upgrades and system configuration resets.

## **Sharing the HDS Thunder, HDS TagmaStore AMS, or HDS TagmaStore WMS between a host and the SAN Volume Controller**

You can share the HDS Thunder, HDS TagmaStore Adaptable Modular Storage (AMS), and HDS TagmaStore Workgroup Modular Storage (WMS) systems between a host and a SAN Volume Controller cluster, with certain restrictions.

The following restrictions apply:

- The same host cannot be connected to both a SAN Volume Controller cluster and an HDS Thunder, HDS TagmaStore AMS, or HDS TagmaStore WMS at the same time because Hitachi Dynamic Link Manager (HDLM) and the subsystem device driver (SDD) cannot coexist.

- For the HDS Thunder 9200, a target port cannot be shared between a host and a SAN Volume Controller cluster. If a target port is used by a SAN Volume Controller cluster, it cannot be present in a switch zone that allows a host to access the port.
- Logical units (LUs) cannot be shared between a host and a SAN Volume Controller cluster. The Thunder 9200 must be set into M-TID M-LUN mode and Mapping Mode must be enabled on Thunder 95xx. No LU can have a LUN number that is associated with a port that is zoned for host use while also having a LUN number that is associated with a port that is zoned for a SAN Volume Controller cluster.

## Supported topologies

You can connect the SAN Volume Controller cluster to the HDS Thunder under the following conditions:

- For SAN Volume Controller software version 4.2.1 and later, you can connect a maximum of 16 HDS Thunder ports to the SAN Volume Controller cluster without any special zoning requirements.
- For SAN Volume Controller software version 4.2.0, the following applies:
  - Logical Unit Size Expansion (LUSE) and Virtual LVI/LUN operations cannot be run on a disk that is managed by the SAN Volume Controller cluster. LUNs that are created using LUSE and Virtual LVI/LUN can be mapped to the cluster after they are created.
  - Only disks with open emulation can be mapped to the SAN Volume Controller cluster.
  - S/390 disks cannot be used with the SAN Volume Controller cluster.
  - Only fibre-channel connections can connect the SAN Volume Controller cluster to the HDS Thunder.

## Quorum disks on HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems

When a SAN Volume Controller cluster initializes, the cluster can choose managed disks (MDisks) that are presented by HDS Thunder, HDS TagmaStore Adaptable Modular Storage (AMS), and HDS TagmaStore Workgroup Modular Storage (WMS) systems as quorum disks.

You can use the set quorum disk CLI command or the SAN Volume Controller Console to select quorum disks.

## Advanced functions for HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS

Some advanced functions of the HDS Thunder, HDS TagmaStore Adaptable Modular Storage (AMS) and HDS TagmaStore Workgroup Modular Storage (WMS), systems are not supported by the SAN Volume Controller clusters.

### Advanced copy functions

Advanced copy functions for HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems are not supported for disks that are managed by the SAN Volume Controller clusters because the copy function does not extend to the SAN Volume Controller cache. For example, ShadowImage, TrueCopy, and HiCopy are not supported.



## LUN Security

LUN Security enables LUN masking by the worldwide node name (WWNN) of the initiator port. This function is not supported for logical units (LUs) that are used by SAN Volume Controller clusters.

## Partitioning

Partitioning splits a RAID array into up to 128 smaller LUs, each of which serves as an independent disk like entity. The SAN Volume Controller cluster and HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems support the partitioning function.

## Dynamic array expansion

The HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems allow the last LU that is defined in a RAID group to be expanded. This function is not supported when these storage systems are attached to a SAN Volume Controller cluster. Do *not* perform dynamic array expansion on LUs that are in use by a SAN Volume Controller cluster.

**Note:** Use in this context means that the LU has a LUN number that is associated with a fibre-channel port, and this fibre-channel port is contained in a switch zone that also contains SAN Volume Controller fibre-channel ports.

## Host storage domains and virtual fibre-channel ports

The HDS Thunder 95xxV, HDS TagmaStore AMS, and HDS TagmaStore WMS systems support host storage domains (HSD) and virtual fibre-channel ports. Each fibre-channel port can support multiple HSDs. Each host in a given HSD is presented with a virtual target port and a unique set of LUNs.

The Thunder 9200 does not support HSD and virtual fibre-channel the ports.

## Logical unit creation and deletion on HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems

The HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems Storage Navigator Modular Graphical User Interface (GUI) enables you to create and delete LUNs. You must avoid certain creation and deletion scenarios to prevent data corruption.

### Creation and deletion scenarios

For example, the Storage Navigator Modular GUI enables you to create LUN A, delete LUN A, and then create LUN B with the same unique ID as LUN A. If a SAN Volume Controller cluster is attached, data corruption can occur because the cluster might not realize that LUN B is different than LUN A.

**Attention:** Before you use the Storage Navigator Modular GUI to delete a LUN, remove the LUN from the managed disk group that contains it.

### Adding LUNs dynamically

To prevent the existing LUNs from rejecting I/O operations during the dynamic addition of LUNs, perform the following procedure to add LUNs:

1. Create the new LUNs using the Storage Navigator Modular GUI.
2. Quiesce all I/O operations.
3. Perform either an offline format or an online format of all new LUNs on the controller using the Storage Navigator Modular GUI. Wait for the format to complete.
4. Go into the LUN mapping function of the Storage Navigator Modular GUI. Add mapping for the new LUN to all of the controller ports that are available to the SAN Volume Controller cluster on the fabric.
5. Restart the controller. (Model 9200 only)
6. After the controller has restarted, restart I/O operations.

### LUN mapping considerations

If LUN mapping is used as described in the LUN mapping topic, you must restart the controller to pick up the new LUN mapping configuration. For each managed disk group that contains an MDisk that is supported by an LU on the system, all virtual disks in those managed disk groups go offline.

## Configuring settings for HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems

The Storage Navigator Modular GUI configuration interface provides functions for configuration.

These options and settings can have the following scope:

- System
- Port
- Logical unit

### Global settings for the HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems

Global settings apply across HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems.

Table 31 lists the global settings for these disk systems.

*Table 31. HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems global settings supported by the SAN Volume Controller*

| Option                                   | Default setting  | SAN Volume Controller required setting |
|------------------------------------------|------------------|----------------------------------------|
| Start attribute                          | Dual active mode | Dual active mode                       |
| SCSI ID/Port takeover mode               | Not applicable   | Not applicable                         |
| Default controller                       | Not applicable   | Not applicable                         |
| Data-share mode                          | Used             | Used                                   |
| Serial number                            |                  | Same as the system default setting     |
| Delay planned shutdown                   | 0                | 0                                      |
| Drive detach mode                        | False            | False                                  |
| Multipath controller (Thunder 9200 only) | False            | False                                  |
| PROCOM mode                              | False            | False                                  |

Table 31. HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems global settings supported by the SAN Volume Controller (continued)

| Option                                                     | Default setting | SAN Volume Controller required setting                       |
|------------------------------------------------------------|-----------------|--------------------------------------------------------------|
| Report status                                              | False           | False                                                        |
| Multipath (Array unit)                                     | False           | False                                                        |
| Turbo LU warning                                           | False           | False                                                        |
| NX mode                                                    | False           | False                                                        |
| Auto reconstruction mode                                   | False           | False                                                        |
| Forced write-through mode                                  | False           | False                                                        |
| Changing logical unit mode 1                               | False           | False                                                        |
| Multiple stream mode (Thunder 9200 only)                   | False           | False                                                        |
| Multiple stream mode (write) (Thunder 95xxV only)          | False           | False                                                        |
| Multiple stream mode (read) (Thunder 95xxV only)           | False           | False                                                        |
| RAID 3 mode (Thunder 9200 only)                            | False           | False                                                        |
| Target ID (9200 only)<br>Mapping mode on 95xx              | S-TID, M-LUN    | M-TID, M-LUN (if sharing controller, otherwise S-TID, M-LUN) |
| Data striping size                                         | 16K; 32K; 64K   | Any (Thunder 9200)<br>64K (Thunder 95xxV)                    |
| Operation if processor failure occurs                      | Reset the fault | Reset the fault                                              |
| Command queuing                                            | True            | True                                                         |
| ANSI Version                                               | Not applicable  | Not applicable                                               |
| Vendor ID                                                  | HITACHI         | HITACHI                                                      |
| Product ID (Thunder 9200)                                  | DF500F          | DF500F                                                       |
| Product ID (Thunder 95xxV)                                 | DF500F          | DF600F                                                       |
| ROM microprogram version                                   | <Empty>         | <Empty>                                                      |
| RAM microprogram version                                   | <Empty>         | <Empty>                                                      |
| Web title                                                  | <Empty>         | Any setting supported                                        |
| Cache mode (Thunder 9200 only)                             | All off         | All off                                                      |
| Link separation (Thunder 9200 only)                        | False           | False                                                        |
| ROM Pseudo-response command processing (Thunder 9200 only) | Not applicable  | Not applicable                                               |
| Save data pointer response (Thunder 9200 only)             | Not applicable  | Not applicable                                               |
| Controller identifier                                      | False           | False                                                        |

Table 31. HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS systems global settings supported by the SAN Volume Controller (continued)

| Option                                | Default setting | SAN Volume Controller required setting |
|---------------------------------------|-----------------|----------------------------------------|
| RS232C error information outflow mode | Off             | Any                                    |
| Execute write and verify mode         | True            | True                                   |

### Controller settings for HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS subsystems

Controller settings apply across the entire HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS subsystems. Options are not available within the scope of a single controller.

### Port settings for the HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS subsystems

Port settings are configurable at the port level.

The settings listed in Table 32 apply to disk controllers that are in a switch zone that contains SAN Volume Controller nodes. If the subsystem is shared between a SAN Volume Controller cluster and another host, you can configure with different settings than shown if both of the following conditions are true:

- The ports are included in switch zones
- The switch zones only present the ports directly to the hosts and not to a SAN Volume Controller cluster

There are no available options with the scope of a single controller.

Table 32. HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS subsystem port settings supported by the SAN Volume Controller

| Option                                               | Default setting | SAN Volume Controller required setting |
|------------------------------------------------------|-----------------|----------------------------------------|
| Host connection mode 1                               | Standard        | Standard                               |
| VxVM DMP mode (HDS Thunder 9200 only)                | False           | False                                  |
| HP connection mode                                   | False           | False                                  |
| Report inquiry page 83H (HDS Thunder 9200 only)      | False           | True                                   |
| UA (06/2A00) suppress mode                           | False           | False                                  |
| HISUP mode                                           | False           | False                                  |
| CCHS mode                                            | False           | False                                  |
| Standard inquiry data expand (HDS Thunder 9200 only) | False           | False                                  |
| Host connection mode 2                               | False           | False                                  |
| Product ID DF400 mode                                | False           | False                                  |
| HBA WWN report mode (HDS Thunder 9200 only)          | False           | False                                  |

Table 32. HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS subsystem port settings supported by the SAN Volume Controller (continued)

| Option                                                     | Default setting | SAN Volume Controller required setting |
|------------------------------------------------------------|-----------------|----------------------------------------|
| NACA mode                                                  | False           | False                                  |
| SUN cluster connection mode                                | False           | False                                  |
| Persistent RSV cluster mode                                | False           | False                                  |
| ftServer connection mode 1 (HDS Thunder 9200 only)         | False           | False                                  |
| ftServer connection mode 2                                 | False           | False                                  |
| SRC Read Command reject                                    | False           | False                                  |
| Reset/LIP mode (signal)                                    | False           | False                                  |
| Reset/LIP mode (progress)                                  | False           | False                                  |
| Reset ALL LIP port mode                                    | False           | False                                  |
| Reset target (reset bus device mode)                       | False           | True                                   |
| Reserve mode                                               | False           | True                                   |
| Reset logical unit mode                                    | False           | True                                   |
| Reset logout of third party process mode                   | False           | False                                  |
| Read Frame minimum 128 byte mode (HDS Thunder 950xxV only) | False           | False                                  |
| Topology                                                   | Point-to-point  | Point-to-point                         |

### Logical unit settings for the HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS subsystems

Logical unit (LU) settings apply to individual LUs that are configured in the HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS subsystems.

You must configure the subsystems LUs as described in Table 33 if the logical unit number (LUN) is associated with ports in a switch zone that is accessible to the SAN Volume Controller cluster.

Table 33. HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS subsystems LU settings for the SAN Volume Controller

| Option                 | Required values              | Default setting |
|------------------------|------------------------------|-----------------|
| LUN default controller | Controller 0 or Controller 1 | Any             |

**Note:** These settings only apply to LUs that are accessible by the SAN Volume Controller cluster.

### Data corruption scenarios to avoid

**Scenario 1:** The configuration application enables you to change the serial number for an LU. Changing the serial number also changes the unique user identifier (UID) for the LU. Because the serial number is also used to determine the WWPN

of the controller ports, two LUNs cannot have the same unique ID on the same SAN because two controllers cannot have the same WWPN on the same SAN.

**Scenario 2:** The serial number is also used to determine the WWPN of the controller ports. Therefore, two LUNs must not have the same ID on the same SAN because this results in two controllers having the same WWPN on the same SAN. This is not a valid configuration.

**Attention:** Do not change the serial number for an LU that is managed by a SAN Volume Controller cluster because this can result in data loss or undetected data corruption.

**Scenario 3:** The configuration application enables you to create LUN A, delete LUN A, and create LUN B with the same unique ID as LUN A. If the LUN is managed by a SAN Volume Controller cluster, this scenario can cause data corruption because the cluster might not recognize that LUN B is different than LUN A.

### **Mapping and virtualization settings for HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS subsystems**

The HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS subsystems support different modes of operation. These modes affect LUN mapping or masking and virtualization.

The SAN Volume Controller supports the S-TID M-LUN and M-TID M-LUN modes on Thunder 9200, and Mapping Mode enabled or disabled on Thunder 95xx. You must restart the controllers for changes to LUN mapping to take effect.

**Attention:** The HDS Thunder, HDS TagmaStore AMS, and HDS TagmaStore WMS subsystems do not provide an interface that enables a SAN Volume Controller cluster to detect and ensure that the mapping or masking and virtualization options are set properly. Therefore, you must ensure that these options are set as described in this topic.

#### **S-TID M-LUN modes**

In S-TID M-LUN mode all LUs are accessible through all ports on the subsystem with the same LUN number on each port. You can use this mode in environments where the subsystem is not being shared between a host and a SAN Volume Controller cluster.

#### **M-TID M-LUN modes**

If a subsystem is shared between a host and a SAN Volume Controller cluster, you must use M-TID M-LUN mode. Configure the subsystem so that each LU that is exported to the SAN Volume Controller cluster can be identified by a unique LUN. The LUN must be the same on all ports through which the LU can be accessed.

#### **Example**

A SAN Volume Controller cluster can access controller ports x and y. The cluster also sees an LU on port x that has LUN number p. In this situation the following conditions must be met:

- The cluster must see either the same LU on port y with LUN number p or it must not see the LU at all on port y.
- The LU cannot appear as any other LUN number on port y.

- The LU must not be mapped to any subsystem port that is zoned for use directly by a host in a configuration where the subsystem is shared between a host and a cluster.

M-TID M-LUN mode enables LU virtualization by target port. In this mode, a single LU can be seen as different LUN numbers across all of the controller ports. For example, LU A can be LUN 0 on port 1, LUN 3 on port 2, and not visible at all on ports 3 and 4.

**Important:** The SAN Volume Controller does not support this.

In addition, M-TID M-LUN mode enables a single LU to be seen as multiple LUN numbers on the same controller port. For example, LU B can be LUN 1 and LUN 2 on controller port 1.

**Important:** The SAN Volume Controller does not support this.

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## Configuring the HDS TagmaStore USP and NSC systems

This section provides information about configuring the Hitachi Data Systems (HDS) TagmaStore Universal Storage Platform (USP) and Network Storage Controller (NSC) systems for attachment to a SAN Volume Controller. Models of the HDS USP and NSC are equivalent to HP and Sun models; therefore, the SAN Volume Controller also supports models of the HP StorageWorks XP series and the Sun StorEdge series.

The information in this section also applies to the supported models of the HP XP and the Sun StorEdge series.

### Supported models of the HDS USP and NSC

The SAN Volume Controller supports models of the Hitachi Data Systems (HDS) Universal Storage Platform (USP) and Network Storage Controller (NSC) series. Models of the HDS USP and NSC are equivalent to HP and Sun models; therefore, the SAN Volume Controller also supports models of the Sun StorEdge and the HP XP series.

See the following Web site for the latest supported models:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

### Supported firmware levels for HDS USP and NSC

The SAN Volume Controller supports the HDS USP and NSC series of controllers.

See the following Web site for specific firmware levels and the latest supported hardware:  
[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

### User interface on the HDS USP and NSC

Ensure that you are familiar with the user interface application that supports the HDS USP and NSC. The HDS USP and NSC is configured, managed, and monitored by a Service Processor (SVP). The SVP is a server that is connected to the HDS USP or NSC through a private local area network (LAN).

## Web server

The HDS USP and NSC use the Storage Navigator as the main configuration GUI. The Storage Navigator GUI runs on the SVP and is accessed through a Web browser.

## Logical units and target ports on the HDS USP and NSC

Logical units (LUs) that are exported by the HDS USP and NSC report identification descriptors in the vital product data (VPD). The SAN Volume Controller uses the LUN associated binary type-3 IEEE Registered Extended descriptor to identify the LU.

An LU path must be defined before an LU can be accessed by a host. The LU path relates a host group to a target port and to a set of LUs. Host initiator ports are added to the host group by worldwide port name (WWPN).

The HDS USP and NSC do not use LU groups so all LUs are independent. The LU access model is active-active and does not use preferred access ports. Each LU can be accessed from any target port that is mapped to the LU. Each target port has a unique WWPN and worldwide node name (WWNN). The WWPN matches the WWNN on each port.

**Note:** You must wait until the LU is formatted before presenting it to the SAN Volume Controller.

## Special LUs

The HDS USP and NSC can use any logical device (LDEV) as a Command Device. Command Devices are the target for HDS USP or NSC copy service functions. Therefore, do not export Command Devices to a SAN Volume Controller.

## Switch zoning limitations for the HDS USP and NSC

There are limitations in switch zoning for the SAN Volume Controller and the HDS USP or NSC.

The SAN Volume Controller can be connected to the HDS USP or NSC with the following restrictions:

- If an LU is mapped to a SAN Volume Controller port as LUN  $x$ , the LU must appear as LUN  $x$  for all mappings to target ports.
- Only fibre-channel connections can be used to connect a SAN Volume Controller to the HDS USP or NSC system.
- Because the SAN Volume Controller limits the number of worldwide node names (WWNNs) for each storage system and the HDS USP and NSC present a separate WWNN for each port, the number of target ports that the SAN Volume Controller can resolve as one storage system is limited. Perform the following steps to provide connections to more target ports:
  1. Divide the set of target ports into groups of 2 to 4.
  2. Assign a discrete set of LUs to each group.

The SAN Volume Controller can then view each group of target ports and the associated LUs as separate HDS USP or NSC systems. You can repeat this process to use all target ports.



## Controller splitting

You can split the HDS USP or NSC between other hosts and the SAN Volume Controller under the following conditions:

- A host cannot be simultaneously connected to both an HDS USP or NSC and a SAN Volume Controller.
- Port security must be enabled for target ports that are shared.
- An LU that is mapped to a SAN Volume Controller cannot be simultaneously mapped to another host.

## Concurrent maintenance on the HDS USP and NSC

Concurrent maintenance is the capability to perform I/O operations to an HDS USP or NSC while simultaneously performing maintenance operations on it. Concurrent firmware upgrades are supported with the SAN Volume Controller.

**Important:** An HDS Field Engineer must perform all maintenance procedures.

## Quorum disks on HDS USP and NSC

HDS USP and NSC systems are not approved hosts for quorum disks. Therefore, configurations that consist of a SAN Volume Controller cluster that is attached to only an HDS USP or NSC is not supported.

## Host type for HDS USP and NSC subsystems

When the HDS USP and NSC systems are attached to a SAN Volume Controller cluster, set the host mode attribute to Windows for each host group.

## Advanced functions for HDS USP and NSC

Some advanced functions of the HDS USP and NSC are not supported by the SAN Volume Controller.

### Advanced system functions

The following advanced system functions for HDS USP and NSC are not supported for disks that are managed by the SAN Volume Controller:

- TrueCopy
- ShadowImage
- Extended Copy Manager
- Extended Remote Copy
- NanoCopy
- Data migration
- RapidXchange
- Multiplatform Backup Restore
- Priority Access
- HARBOR File-Level Backup/Restore
- HARBOR File Transfer
- FlashAccess

## Advanced SAN Volume Controller functions

All advanced SAN Volume Controller functions are supported on logical unit (LU) that are exported by the HDS USP or NSC system.

### LU Expansion

The HDS USP and NSC support Logical Unit Expansion (LUSE). LUSE is *not* a concurrent operation. LUSE allows you to create a single LU by concatenating logical devices (LDEVs). Before LUSE can be performed, the LDEVs must be unmounted from hosts and paths must be removed.

**Attention:**

1. LUSE destroys all data that exists on the LDEV.
2. Do not perform LUSE on any LDEV that is used to export an LU to a SAN Volume Controller.

If data exists on an LDEV and you want to use image mode migration to import the data to a SAN Volume Controller, do not perform LUSE on the disk before you import the data.

LUs that are created using LUSE can be exported to a SAN Volume Controller.

### Virtual LVI/LUNs

The HDS USP and NSC support Virtual LVI/LUNs (VLL). VLL is *not* a concurrent operation. VLL allows you to create several LUs from a single LDEV. You can only create new LUs from free space on the LDEV.

**Attention:** Do not perform VLL on disks that are managed by the SAN Volume Controller.

LUs that are created using VLL can be exported to a SAN Volume Controller.

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## Configuring HP StorageWorks MA and EMA systems

This section provides information about configuring HP StorageWorks Modular Array (MA) and Enterprise Modular Array (EMA) systems for attachment to a SAN Volume Controller.

Both the HP MA and EMA use an HSG80 controller.

### HP MA and EMA definitions

The following terms are used in the IBM and HP documentation and have different meanings.

| IBM term                            | IBM definition                                                                                                                                         | HP term                             | HP definition                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>container</b>                    | A visual user-interface component that holds objects.                                                                                                  | <b>container</b>                    | (1) Any entity that is capable of storing data, whether it is a physical device or a group of physical devices. (2) A virtual, internal controller structure representing either a single disk or a group of disk drives that are linked as a storageset. Stripesets and mirrorsets are examples of storageset containers that the controller uses to create units. |
| <b>device</b>                       | A piece of equipment that is used with the computer. A device does not generally interact directly with the system, but is controlled by a controller. | <b>device</b>                       | In its physical form, a magnetic disk that can be attached to a SCSI bus. The term is also used to indicate a physical device that has been made part of a controller configuration; that is, a physical device that is known to the controller. Units (virtual disks) can be created from devices, once the devices have been made known to the controller.        |
| <b>just a bunch of disks (JBOD)</b> | See <i>non-RAID</i> .                                                                                                                                  | <b>just a bunch of disks (JBOD)</b> | A group of single-device logical units not configured into any other container type.                                                                                                                                                                                                                                                                                |
| <b>mirrorset</b>                    | See <i>RAID 1</i> .                                                                                                                                    | <b>mirrorset</b>                    | A RAID storageset of two or more physical disks that maintains a complete and independent copy of all data on the virtual disk. This type of storageset has the advantage of being highly reliable and extremely tolerant of device failure. Raid level 1 storagesets are referred to as mirrorsets.                                                                |
| <b>non-RAID</b>                     | Disks that are not in a redundant array of independent disks (RAID).                                                                                   | <b>non-RAID</b>                     | See <i>just a bunch of disks</i> .                                                                                                                                                                                                                                                                                                                                  |

| IBM term          | IBM definition                                                                                                                                                                                      | HP term           | HP definition                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>RAID 0</b>     | RAID 0 allows a number of disk drives to be combined and presented as one large disk. RAID 0 does not provide any data redundancy. If one drive fails, all data is lost.                            | <b>RAID 0</b>     | A RAID storage set that stripes data across an array of disk drives. A single logical disk spans multiple physical disks, allowing parallel data processing for increased I/O performance. While the performance characteristics of RAID level 0 is excellent, this RAID level is the only one that does not provide redundancy. RAID level 0 storage sets are referred to as stripe sets.                                               |
| <b>RAID 1</b>     | A form of storage array in which two or more identical copies of data are maintained on separate media. Also known as mirror set.                                                                   | <b>RAID 1</b>     | See <i>mirror set</i> .                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>RAID 5</b>     | A form of parity RAID in which the disks operate independently, the data strip size is no smaller than the exported block size, and parity check data is distributed across the disks in the array. | <b>RAID 5</b>     | See <i>RAID set</i> .                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>RAID set</b>   | See <i>RAID 5</i> .                                                                                                                                                                                 | <b>RAID set</b>   | A specially developed RAID storage set that stripes data and parity across three or more members in a disk array. A RAID set combines the best characteristics of RAID level 3 and RAID level 5. A RAID set is the best choice for most applications with small to medium I/O requests, unless the application is write intensive. A RAID set is sometimes called parity RAID. RAID level 3/5 storage sets are referred to as RAID sets. |
| <b>partition</b>  | A logical division of storage on a fixed disk.                                                                                                                                                      | <b>partition</b>  | A logical division of a container represented to the host as a logical unit.                                                                                                                                                                                                                                                                                                                                                             |
| <b>stripe set</b> | See <i>RAID 0</i> .                                                                                                                                                                                 | <b>stripe set</b> | See <i>RAID 0</i> .                                                                                                                                                                                                                                                                                                                                                                                                                      |

## Configuring HP MA and EMA systems

The HP MA and EMA systems provide functions that are compatible with the SAN Volume Controller.

This task assumes that the system is not in use.

**Note:** When you configure a SAN Volume Controller cluster to work with an HP MA or EMA, you must not exceed the limit of 96 process logins.

Perform the following procedure to enable support of an HP, MA, or EMA system.

1. Verify that the front panel of the SAN Volume Controller is clear of errors.
2. Ensure that the HP StorageWorks Operator Control Panel (OCP) on each system is clear of errors. The Operator Control Panel consists of seven green LEDs at the rear of each HSG80 controller.
3. Ensure that you can use an HP StorageWorks command-line interface (CLI) to configure the HSG80 controllers.
4. Issue the **SHOW THIS** command and **SHOW OTHER** command to verify the following:
  - a. Ensure that the system firmware is at a supported level. See the following Web site for the latest firmware support:  
[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145).
  - b. Ensure that the controllers are configured for MULTIBUS FAILOVER with each other.
  - c. Ensure that the controllers are running in SCSI-3 mode.
  - d. Ensure that MIRRORING\_CACHE is enabled.
  - e. Ensure that the Host Connection Table is *not* locked.
5. Issue the **SHOW DEVICES FULL** command to verify the following:
  - a. Ensure that none of the LUNs are TRANSPORTABLE.
  - b. Ensure that all LUNs are configured. For example, the LUNs report their serial numbers and TRANSFER\_RATE\_REQUESTED correctly.
6. Issue the **SHOW FAILEDSET** command to verify that there are no failing disks.

**Note:** To verify, there should be no orange lights on any disks in the system.

7. Issue the **SHOW UNITS FULL** command to verify the following:
  - a. Ensure that all LUNs are set to RUN and NOWRITEPROTECT.
  - b. Ensure that all LUNs are ONLINE to either THIS or OTHER controller.
  - c. Ensure that all LUNs that are to be made available to the SAN Volume Controller have ALL access.
  - d. Ensure that all LUNs do not specify Host Based Logging.
8. Issue the **SHOW CONNECTIONS FULL** command to verify that you have enough spare entries for all combinations of SAN Volume Controller ports and HP MA or EMA ports.
9. Connect up to four fibre-channel cables between the fibre-channel switches and the HP MA or EMA system.
10. Ensure that the fibre-channel switches are zoned so that the SAN Volume Controller and the HP MA or EMA system are in a zone.
11. Issue the **SHOW THIS** command and **SHOW OTHER** command to verify that each connected port is running. The following is an example of the output that is displayed: `PORT_1_TOPOLOGY=FABRIC`.

12. Issue the **SHOW CONNECTIONS FULL** command to verify that the new connections have been created for each SAN Volume Controller port and HP MA or EMA port combination.
13. Verify that No rejected hosts is displayed at the end of the SHOW CONNECTIONS output.
14. Perform the following steps from the SAN Volume Controller command-line interface (CLI):
  - a. Issue the **svctask detectmdisk** CLI command to discover the controller.
  - b. Issue the **svcinfolcontroller** CLI command to verify that the two HSG80 serial numbers appear under the ctrl s/n.
  - c. Issue the **svcinfolmdisk** CLI command to verify that the additional MDisks that correspond to the UNITS shown in the HP MA or EMA system.

You can now use the SAN Volume Controller CLI commands to create an MDisk group. You can also create and map VDIs from these MDisk groups. Check the front panel of the SAN Volume Controller to ensure that there are no errors. After the host has reloaded the fibre-channel driver, you can perform I/O to the VDIs. See the *IBM System Storage SAN Volume Controller Host Attachment Guide* for detailed information.

### **Partitioning LUNs on HP MA and EMA systems**

For SAN Volume Controller software version 4.2.1 and later, you cannot partition HSG80 LUNs. To check if any HSG80 LUNs are partitioned, use the SHOW UNITS command in the HSG80 CLI. Partition is displayed in the Used By column for the LUNs that are partitioned.

## **Supported models of HP MA and EMA systems**

The SAN Volume Controller supports models of the HP MA and EMA systems.

See the following Web site for the latest supported models:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

**Attention:** The SAN Volume Controller only supports configurations in which the HSG80 cache is enabled in writeback mode. Running with only a single controller results in a single point of data loss.

## **Supported firmware levels for HP MA and EMA systems**

The HP MA and EMA systems must use a firmware level that is supported by the SAN Volume Controller.

See the following Web site for specific firmware levels and the latest supported hardware:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

**Note:** Concurrent upgrade of the system firmware is not supported with the SAN Volume Controller.

## **Concurrent maintenance on HP MA and EMA systems**

Concurrent maintenance is the capability to perform I/O operations to an HP MA or EMA system while simultaneously performing maintenance operations on it.

**Note:** HP MA and EMA maintenance documentation uses the phrase *rolling upgrade* in place of *concurrent maintenance*. See this documentation because in some instances you must reduce the level of I/O before you can perform the maintenance procedure.

The HP MA and EMA systems allow concurrent replacement of the following components:

- Drive
- EMU
- Blower
- Dual power supply (One unit can be removed and replaced. The fan speed increases when only one power supply unit is present.)

The controller component is hot-pluggable, but concurrent maintenance of SAN Volume Controller I/O is not supported.

The HP MA and EMA systems do not allow concurrent replacement of the following components:

- Single power supply (in a single power-supply configuration, the enclosure is disabled when the power supply fails.)
- SCSI bus cables
- I/O module
- Cache

## Configuration interface for HP MA and EMA systems

The Command Console configuration and service utility is the configuration interface for the HP MA and EMA systems.

The configuration and service utility can connect to the system in the following ways:

- RS232 interface
- In-band over fibre channel
- Over TCP/IP to a proxy agent, which then communicates with the system in-band over fibre channel.

For the Command Console to communicate with the HSG80 controllers, the host that runs the service utility must be able to access the HSG80 ports over the SAN. This host can therefore also access LUs that are visible to SAN Volume Controller nodes and cause data corruption. To avoid this, set the UNIT\_OFFSET option to 199 for all connections to this host. This ensures that the host is able to recognize only the CCL.

## Sharing the HP MA or EMA between a host and a SAN Volume Controller

There are restrictions for sharing HP MA and EMA subsystems between a host and a SAN Volume Controller cluster.

An HP MA or EMA can be shared between a host and a SAN Volume Controller cluster under the following conditions:

- A host cannot be connected to both a SAN Volume Controller cluster and an HP MA or EMA subsystem at the same time.

- Target ports cannot be shared between a host and a SAN Volume Controller cluster. Specifically, if an HSG80 port is in use by a SAN Volume Controller cluster, it cannot be present in a switch zone that enables a host to access the port.
- LUs and RAID arrays cannot be shared between a host and a SAN Volume Controller cluster.

## Switch zoning limitations for HP MA and EMA systems

There are limitations in switch zoning for the SAN Volume Controller and the HP MA and EMA systems.

**Attention:** The HP MA and EMA systems are supported with a single HSG80 controller or dual HSG80 controllers. Because the SAN Volume Controller only supports configurations in which the HSG80 cache is enabled in write-back mode, running with a single HSG80 controller results in a single point of data loss.

### Switch zoning

For SAN Volume Controller clusters that have installed software version 1.1.1, a single fibre-channel port that is attached to the system can be present in a switch zone that contains SAN Volume Controller fibre-channel ports, whether the HP MA or EMA system uses one or two HSG80 controllers. This guarantees that the nodes in the cluster can access at most one port on the HSG80 controller.

For SAN Volume Controller clusters that have software version 1.2.0 or later installed, switches can be zoned so that HSG80 controller ports are in the switch zone that contains all of the ports for each SAN Volume Controller node.

### Connecting to the SAN

Multiple ports from an HSG80 controller must be physically connected to the fibre-channel SAN to enable servicing of the HP MA or EMA system. However, switch zoning must be used as described in this topic.

**Note:** If the HP Command Console is not able to access a fibre-channel port on each of the HSG80 controllers in a two-controller system, there is a risk of an undetected single point of failure.

## Quorum disks on HP MA and EMA systems

Managed disks (MDisks) that are presented by the HP MA or EMA are chosen by the SAN Volume Controller as quorum disks.

The SAN Volume Controller uses a logical unit (LU) that is presented by an HSG80 controller as a quorum disk. The quorum disk is used even if the connection is by a single port, although this is not recommended. If you are connecting the HP MA or EMA system with a single fibre-channel port, ensure that you have another system on which to put your quorum disk. You can use the **svctask setquorum** command-line interface (CLI) command to move quorum disks to another system.

SAN Volume Controller clusters that are attached only to the HSG80 controllers are supported.



## Advanced functions for HP MA and EMA

Some advanced functions of the HP MA and EMA are not supported by the SAN Volume Controller.

### Advanced copy functions

Advanced copy functions for HP MA and EMA systems (for example, SnapShot and RemoteCopy) are not supported for disks that are managed by the SAN Volume Controller because the copy function does not extend to the SAN Volume Controller cache.

### Partitioning

HP MA and EMA support partitioning. A partition is a logical division of a container that is represented to the host as a logical unit (LU). A container can be a RAID array or a JBOD (just a bunch of disks). All container types are candidates for partitions. Any nontransportable disk or storage set can be divided into a maximum of eight partitions.

The following restrictions apply to partitioning:

- Partitioned containers are fully supported if the HSG80 controller is connected to the SAN by a single port.
- Partitioned containers are not configured by the SAN Volume Controller if the HSG80 controller is connected to the SAN by multiple ports.
- Partitioned containers are removed from the configuration if a single port connection becomes a multiport connection.
- Partitioned containers are configured if a multiport connection becomes a single port connection.

You must partition containers such that no spare capacity exists because there is no way to detect unused partitions. With a multiport connection, subsequent attempts to use this capacity removes all partitions on the container from the configuration.

### Dynamic array expansion (LU expansion)

HP MA and EMA systems do not provide dynamic array expansion.

### Write protection of LUNs

Write protection of LUNs is not supported for use with the SAN Volume Controller.

## SAN Volume Controller advanced functions

Virtual disks (VDisks) that are created from managed disks (MDisks) that are presented by an HSG80 controller can be used in SAN Volume Controller FlashCopy mappings, SAN Volume Controller Metro Mirror relationships, and SAN Volume Controller Global Mirror relationships.

## LU creation and deletion on the HP MA and EMA

Ensure you are familiar with the HSG80 controller container types for logical unit (LU) configuration.

Table 34 lists the valid container types.

*Table 34. HSG80 controller container types for LU configuration*

| Container                                                                                                                                                                                                                        | Number of Members | Maximum Size             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------------|
| JBOD - non transportable<br><br><b>Attention:</b> A JBOD provides no redundancy at the physical disk drive level. A single disk failure can result in the loss of an entire managed disk group and its associated virtual disks. | 1                 | disk size minus metadata |
| Mirrorset                                                                                                                                                                                                                        | 2 - 6             | smallest member          |
| RAIDset                                                                                                                                                                                                                          | 3 - 14            | 1.024 terabytes          |
| Stripeset                                                                                                                                                                                                                        | 2 - 24            | 1.024 terabytes          |
| Striped Mirrorset                                                                                                                                                                                                                | 2 - 48            | 1.024 terabytes          |

**Note:** LUs can be created and deleted on an HSG80 controller while I/O operations are performed to other LUs. You do not need to restart the HP MA or EMA subsystem.

## Configuring settings for the HP MA and EMA

The HP StorageWorks configuration interface provides configuration settings and options that are supported with the SAN Volume Controller.

The settings and options can have a scope of the following:

- Subsystem (global)
- Controller
- Port
- Logical unit
- Connection

### Global settings for HP MA and EMA systems

Global settings apply across HP MA and EMA systems.

The following table lists the global settings for HP MA and EMA systems:

*Table 35. HP MA and EMA global settings supported by the SAN Volume Controller*

| Option                | HSG80 controller default setting | SAN Volume Controller required setting |
|-----------------------|----------------------------------|----------------------------------------|
| DRIVE_ERROR_THRESHOLD | 800                              | Default                                |
| FAILEDSET             | Not defined                      | n/a                                    |

### Controller settings for HP MA and EMA

Controller settings apply across one HSG80 controller.

Table 36 on page 365 describes the options that can be set by HSG80 controller command-line interface (CLI) commands for each HSG80 controller.

Table 36. HSG80 controller settings that are supported by the SAN Volume Controller

| Option               | HSG80 controller default setting | SAN Volume Controller required setting |
|----------------------|----------------------------------|----------------------------------------|
| ALLOCATION_CLASS     | 0                                | Any value                              |
| CACHE_FLUSH_TIME     | 10                               | Any value                              |
| COMMMAND_CONSOLE_LUN | Not defined                      | Any value                              |
| CONNECTIONS_UNLOCKED | CONNECTIONS_UNLOCKED             | CONNECTIONS_UNLOCKED                   |
| NOIDENTIFIER         | Not defined                      | No identifier                          |
| MIRRORED_CACHE       | Not defined                      | Mirrored                               |
| MULTIBUS_FAILOVER    | Not defined                      | MULTIBUS_FAILOVER                      |
| NODE_ID              | Worldwide name as on the label   | Default                                |
| PROMPT               | None                             | Any value                              |
| REMOTE_COPY          | Not defined                      | Any value                              |
| SCSI_VERSION         | SCSI-2                           | SCSI-3                                 |
| SMART_ERROR_EJECT    | Disabled                         | Any value                              |
| TERMINAL_PARITY      | None                             | Any value                              |
| TERMINAL_SPEED       | 9600                             | Any value                              |
| TIME                 | Not defined                      | Any value                              |
| UPS                  | Not defined                      | Any value                              |

## Port settings for HP MA and EMA systems

Port settings are configurable at the port level.

**Restriction:** Only one port per HSG80 pair can be used with the SAN Volume Controller.

The port settings are set using the following commands:

- SET THIS PORT\_1\_TOPOLOGY=FABRIC
- SET THIS PORT\_2\_TOPOLOGY=FABRIC
- SET OTHER PORT\_1\_TOPOLOGY=FABRIC
- SET OTHER PORT\_2\_TOPOLOGY=FABRIC

These values can be checked using the following commands:

- SHOW THIS
- SHOW OTHER

Table 37 lists the HSG80 controller port settings that the SAN Volume Controller supports:

Table 37. HSG80 controller port settings supported by the SAN Volume Controller

| Option            | HSG80 default setting | SAN Volume Controller required setting |
|-------------------|-----------------------|----------------------------------------|
| PORT_1/2-AL-PA    | 71 or 72              | Not applicable                         |
| PORT_1/2_TOPOLOGY | Not defined           | FABRIC                                 |

**Note:** The HP MA and EMA systems support LUN masking that is configured with the **SET *unit number* ENABLE\_ACCESS\_PATH** command. When used with a SAN Volume Controller, the access path must be set to all ("**SET *unit number* ENABLE\_ACCESS\_PATH=ALL**") and all LUN masking must be handled exclusively by the SAN Volume Controller. You can use the **SHOW CONNECTIONS FULL** command to check access rights.

## LU settings for HP MA and EMA systems

Logical unit (LU) settings are configurable at the LU level.

Table 38 describes the options that must be set for each LU that is accessed by the SAN Volume Controller. LUs that are accessed by hosts can be configured differently.

*Table 38. HSG80 controller LU settings supported by the SAN Volume Controller*

| Option                                                                                                                                                                                           | HSG80 controller default setting | SAN Volume Controller required setting |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------------------------|
| TRANSFER_RATE_REQUESTED                                                                                                                                                                          | 20MHZ                            | Not applicable                         |
| TRANSPORTABLE/<br>NOTTRANSPORTABLE                                                                                                                                                               | NOTTRANSPORTABLE                 | NOTTRANSPORTABLE                       |
| ENABLE_ACCESS_PATH                                                                                                                                                                               | ENABLE_ACCESS_PATH=ALL           | ENABLE_ACCESS_PATH=ALL                 |
| DISABLE_ACCESS_PATH (See Note.)                                                                                                                                                                  | NO DEFAULT                       | NO DEFAULT                             |
| IDENTIFIER/ NOIDENTIFIER                                                                                                                                                                         | NOIDENTIFIER                     | Not applicable                         |
| MAX_READ_CACHE_SIZE                                                                                                                                                                              | 32                               | Not applicable                         |
| MAX_WRITE_CACHE_SIZE                                                                                                                                                                             | 32                               | 64 or higher                           |
| MAX_CACHED_TRANSFER_SIZE                                                                                                                                                                         | 32                               | Not applicable                         |
| PREFERRED_PATH/<br>NOPREFERRED_PATH                                                                                                                                                              | NOPREFERRED_PATH is set          | Not applicable                         |
| READ_CACHE/ NOREAD_CACHE                                                                                                                                                                         | READ_CACHE                       | Not applicable                         |
| READAHEAD_CACHE/<br>NOREADAHEAD_CACHE                                                                                                                                                            | READAHEAD_CACHE                  | Not applicable                         |
| RUN/ NORUN                                                                                                                                                                                       | RUN                              | RUN                                    |
| WRITE_LOG/NOWRITE_LOG                                                                                                                                                                            | NOWRITE_LOG                      | NOWRITE_LOG                            |
| WRITE_PROTECT/<br>NOWRITE_PROTECT                                                                                                                                                                | NOWRITE_PROTECT                  | NOWRITE_PROTECT                        |
| WRITEBACK_CACHE/<br>NOWRITEBACK_CACHE                                                                                                                                                            | WRITEBACK_CACHE                  | WRITEBACK_CACHE                        |
| Note: DISABLE_ACCESS_PATH can be used to disable access from specific hosts. It must always be overridden by using ENABLE_ACCESS_PATH=ALL on all connections to the SAN Volume Controller nodes. |                                  |                                        |

## Connection settings for HP MA and EMA systems

The HP MA and EMA systems provide options that are configurable at the connection level.

Table 39 on page 367 lists the default and required HSG80 controller connection settings:

Table 39. HSG80 connection default and required settings

| Option            | HSG80 controller default setting | HSG80 controller required setting |
|-------------------|----------------------------------|-----------------------------------|
| OPERATING_SYSTEM  | Not defined                      | WINNT                             |
| RESERVATION_STYLE | CONNECTION_BASED                 | Not applicable                    |
| UNIT_OFFSET       | 0                                | 0 or 199                          |

## Mapping and virtualization settings for HP MA and EMA

There are LUN mapping or masking and virtualization restrictions for HP MA and EMA subsystems that are in a SAN Volume Controller environment.

The HP StorageWorks configuration interface requires that you assign a unit number to each logical unit (LU) when it is defined. By default, the LUN is the unit number. It is possible for gaps to exist in the LUN range if the unit numbers that are used in the configuration commands are not contiguous. By default, each LUN is visible on all controller ports on both controllers.

### LUN masking

The HP MA and EMA subsystems support the concept of connection names. A maximum of 96 connection names that contain the following parameters are supported:

- HOST\_ID
- ADAPTER\_ID
- CONTROLLER
- PORT
- REJECTED\_HOST

**Note:** The SAN Volume Controller ports must not be in the REJECTED\_HOSTS list. This list can be seen with the **SHOW CONNECTIONS FULL** command.

You cannot use LUN masking to restrict the initiator ports or the target ports that the SAN Volume Controller uses to access LUs. Configurations that use LUN masking in this way are not supported. LUN masking can be used to prevent other initiators on the SAN from accessing LUs that the SAN Volume Controller uses, but the preferred method for this is to use SAN zoning.

### LU virtualization

The HP MA and EMA subsystems also provide LU virtualization by the port and by the initiator. This is achieved by specifying a UNIT\_OFFSET for the connection. The use of LU virtualization for connections between the HSG80 controller target ports and SAN Volume Controller initiator ports is not supported.

---

## Configuring the HP StorageWorks EVA system

This section provides information about configuring the HP StorageWorks Enterprise Virtual Array (EVA) system for attachment to a SAN Volume Controller.

## Supported models of the HP EVA

The SAN Volume Controller supports models of the HP EVA.

See the following Web site for the latest supported models:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Supported firmware levels for HP EVA

The SAN Volume Controller supports HP EVA.

See the following Web site for specific HP EVA firmware levels and the latest supported hardware:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Concurrent maintenance on the HP EVA

Concurrent maintenance is the capability to perform I/O operations to an HP EVA while simultaneously performing maintenance operations on it.

**Important:** All maintenance operations must be performed by an HP Field Engineer.

The SAN Volume Controller and HP EVA support concurrent hardware maintenance and firmware upgrade.

## User interface on the HP EVA system

Ensure that you are familiar with the user interface that supports the HP EVA system.

### Storage Management Appliance

HP EVA systems are configured, managed, and monitored through a Storage Management Appliance. The Storage Management Appliance is a PC server that runs a software agent called Command View EVA. The software agent is accessed using a user interface that is provided by a standard Web browser.

Command View EVA communicates in-band with the HSV controllers.

## Sharing the HP EVA controller between a host and the SAN Volume Controller

The HP EVA controller can be shared between a host and a SAN Volume Controller.

- A host must not be connected to both a SAN Volume Controller and an HP EVA system at the same time.
- LUs and RAID arrays must not be shared between a host and a SAN Volume Controller.

## Switch zoning limitations for the HP EVA system

Consider the following limitations when planning switch zoning and connection to the SAN.

## Fabric zoning

The SAN Volume Controller switch zone must include at least one target port from each HSV controller in order to have no single point of failure.

## Quorum disks on HP StorageWorks EVA systems

The SAN Volume Controller cluster selects managed disks (MDisks) that are presented by HP StorageWorks EVA systems as quorum disks.

## Copy functions for HP StorageWorks EVA systems

Advanced copy functions for HP StorageWorks EVA systems (for example, VSnap and SnapClone) cannot be used with disks that are managed by the SAN Volume Controller cluster because the copy function does not extend to the SAN Volume Controller cache.

## Logical unit configuration on the HP EVA

An EVA logical unit is referred to as a virtual disk (VDisk). An EVA system can support up to 512 VDIs. VDIs are created within a set of physical disk drives, referred to as a disk group. A VDisk is striped across all the drives in the group.

The minimum size of a disk group is eight physical drives. The maximum size of a disk group is all available disk drives.

EVA VDIs are created and deleted using the Command View EVA utility.

**Note:** A VDisk is formatted during the creation process; therefore, the capacity of the VDisk will determine the length of time it takes to be created and formatted. Ensure that you wait until the VDisk is created before you present it to the SAN Volume Controller.

A single VDisk can consume the entire disk group capacity or the disk group can be used for multiple VDIs. The amount of disk group capacity consumed by a VDisk depends on the VDisk capacity and the selected redundancy level. There are three redundancy levels:

- Vraid 1 - High redundancy (mirroring)
- Vraid 5 - Moderate redundancy (parity striping)
- Vraid 0 - No redundancy (striping)

## Logical unit creation and deletion on the HP EVA

EVA VDIs are created and deleted using the Command View EVA utility.

VDIs are formatted during creation. The time it takes to format the VDIs depends on the capacity.

**Note:** Selecting a host for presentation at creation time is not recommended. Ensure that you wait until the VDisk has been created before presenting it to the SAN Volume Controller.

## Logical unit presentation

A virtual disk (VDisk) must be explicitly presented to a host before it can be used for I/O operations.

The SAN Volume Controller supports LUN masking on an HP EVA controller. When presenting a VDisk, the LUN can be specified or allowed to default to the next available value.

The SAN Volume Controller supports LUN virtualization on an HP EVA controller. The LUN-host relationship is set on a per-host basis.

**Note:** All nodes and ports in the SAN Volume Controller cluster must be represented as one host to the HP EVA.

## Special LUs

The Console LU is a special VDisk that represents the SCSI target device. It is presented to all hosts as LUN 0.

## Configuration interface for the HP EVA

The HP EVA is configured, managed, and monitored through a Storage Management Appliance. The Storage Management Appliance is a server that runs a software agent called Command View EVA. The Command View EVA is accessed using a graphical user interface that is provided by a standard Web browser.

### In band

The Command View EVA system communicates in-band with the HSV controllers.

## Configuration settings for HP StorageWorks EVA systems

The HP StorageWorks EVA configuration interface provides configuration settings and options that can be used with SAN Volume Controller clusters.

The settings and options can have a scope of the following:

- System (global)
- Logical unit (LU)
- Host

### Global settings for HP StorageWorks EVA systems

Global settings apply across an HP StorageWorks EVA system.

Table 40 lists the system options that you can access using the Command View EVA.

*Table 40. HP StorageWorks EVA global options and required settings*

| Option                 | HP EVA default setting | SAN Volume Controller required setting |
|------------------------|------------------------|----------------------------------------|
| Console LUN ID         | 0                      | Any                                    |
| Disk replacement delay | 1                      | Any                                    |

### Logical unit options and settings for HP StorageWorks EVA systems

Logical unit (LU) settings are configurable at the LU level.

Table 41 on page 371 describes the options that must be set for each LU that is accessed by other hosts. LUs that are accessed by hosts can be configured differently.



Table 41. HP StorageWorks EVA LU options and required settings

| Option         | HP EVA Default Setting      | SAN Volume Controller Required Setting |
|----------------|-----------------------------|----------------------------------------|
| Capacity       | None                        | Any                                    |
| Write cache    | Write-through or Write-back | Write-back                             |
| Read cache     | On                          | On                                     |
| Redundancy     | Vraid0                      | Any                                    |
| Preferred path | No preference               | No preference                          |
| Write protect  | Off                         | Off                                    |

### Host options and settings for HP StorageWorks EVA systems

You must use specific settings to identify SAN Volume Controller clusters as hosts to HP StorageWorks EVA systems.

Table 42 lists the host options and settings that can be changed using the Command View EVA.

Table 42. HP EVA host options and required settings

| Option          | HP EVA Default Setting | SAN Volume Controller Required Setting |
|-----------------|------------------------|----------------------------------------|
| OS type         | -                      | Windows                                |
| Direct eventing | Disabled               | Disabled                               |

---

## Configuring HP MSA systems

This section provides information about configuring HP StorageWorks Modular Smart Array (MSA) systems for attachment to a SAN Volume Controller.

### Supported models of the HP MSA system

The SAN Volume Controller supports models of the HP MSA series of systems.

See the following Web site for the latest supported models:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

### Supported firmware levels for the HP MSA

The HP MSA system must use a firmware level that is supported by the SAN Volume Controller.

See the following Web site for specific firmware levels and the latest supported hardware:[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

### User interfaces on the HP MSA

Ensure that you are familiar with the user interface applications that are used by the HP MSA.

You can use the following configuration utilities with an HP MSA in a SAN Volume Controller environment:

- The CLI through an out-of-band configuration that is accessed through a host that is connected to the serial port of the HP MSA.
- The GUI through an in-band configuration that uses the HP ACU (Array Configuration Utility)

**Notes:**

1. If the HP ACU is installed in a configuration that HP does not support, some of its functionality might not be available.
2. If you use an in-band configuration, you must ensure that LUs that are used by the SAN Volume Controller cannot be accessed by a direct-attached host.

## Logical unit creation, deletion, and migration for HP StorageWorks MSA systems

Before you create, delete, or migrate logical units, you must read the storage configuration guidelines that are specified in the HP StorageWorks MSA documentation that is provided for this system.

### Creating arrays

An array is a collection of physical disks. Use the storage configuration guidelines for SAN Volume Controller clusters to create arrays on the HP StorageWorks MSA.

### Creating logical drives

The following types of RAID arrays are supported:

- RAID 1+0
- RAID 1
- RAID 5
- RAID 6 (ADG)

RAID 0 is not supported because it does not provide failure protection.

All stripe sizes are supported; however, use a consistent stripe size for the HP StorageWorks MSA.

Use the following settings for logical drives:

- Set Max Boot to disabled
- Set Array Accelerator to enabled.

**Note:** If you are using the CLI, use the cache=enabled setting.

### Presenting logical units to hosts

Set the Selective Storage Presentation (SSP), also known as ACL to enabled.

Use the following host profile settings:

```
Mode 0 = Peripheral Device LUN Addressing
Mode 1 = Asymmetric Failover
Mode 2 = Logical volumes connect as available on Backup Controller
Mode 3 = Product ID of 'MSA1000 Volume'
Mode 4 = Normal bad block handling
Mode 5 = Logout all initiators on TPRLO
Mode 6 = Fault management events not reported through Unit Attention
Mode 7 = Send FCP response info with SCSI status
Mode 8 = Do not send Unit Attention on failover
Mode 9 = SCSI inquiry revision field contains the actual version
Mode 10 = SCSI inquiry vendor field contains Compaq
Mode 11 = Power On Reset Unit Attention generated on FC Login or Logout
Mode 12 = Enforce Force Unit Access on Write
```

You can use the built-in Linux profile or Default profile to set the host profile settings. If you use the Default profile, you must issue the following Serial port CLI command to change the host profile settings:

```
change mode Default mode number
```

where *mode number* is the numeric value for the mode that you want to change.

See the documentation that is provided for your HP StorageWorks MSA for additional information.

**Important:** You must use the Serial port CLI or the SSP to recheck the connection objects after the configuration is complete.

## Migrating logical units

You can use the standard migration procedure to migrate logical units from the HP StorageWorks MSA to the SAN Volume Controller cluster with the following restrictions:

- You cannot share the HP StorageWorks MSA between a host and the SAN Volume Controller cluster. You must migrate all hosts at the same time.
- The subsystem device driver (SDD) and securepath cannot coexist because they have different qllogic driver requirements.
- The qllogic driver that is supplied by HP must be removed and the driver that is supported by IBM must be installed.

## Sharing the HP MSA between a host and the SAN Volume Controller

You must configure your environment so that only the SAN Volume Controller can access all logical units on the HP MSA. You can zone other hosts to communicate with the HP MSA for in-band configuration, but nothing else.

## Concurrent maintenance on the HP MSA

Concurrent maintenance is the capability to perform I/O operations to an HP MSA while simultaneously performing maintenance operations on it.

You can perform nondisruptive maintenance procedures concurrently on the following components:

- HP MSA controller
- HP MSA controller cache
- Cache battery pack

- Variable speed blower
- Power supply
- Disk drive
- SFP transceiver

## Quorum disks on the HP MSA

The SAN Volume Controller cannot use logical units (LUs) that are exported by the HP MSA as quorum disks.

## Advanced functions for the HP MSA

The SAN Volume Controller Copy Service functions and RAID migration utilities are not supported for logical units (LUs) that are presented by the HP MSA.

## Global settings for HP MSA systems

Global settings apply across an HP MSA system.

The following table lists the global settings for an HP MSA system:

| Option                 | Required setting                                                                         |
|------------------------|------------------------------------------------------------------------------------------|
| Expand Priority        | All supported<br><b>Note:</b> Performance impact of high priority                        |
| Rebuild Priority       | All supported<br><b>Note:</b> Performance impact of high priority                        |
| Array Accelerator      | On<br><b>Note:</b> Set on all logical drives that are used by the SAN Volume Controller. |
| Read-Write cache ratio | All supported                                                                            |
| Name of controller     | Not important                                                                            |

---

## Configuring NEC iStorage systems

This section provides information about configuring NEC iStorage systems for attachment to a SAN Volume Controller.

### Supported firmware levels for the NEC iStorage

The NEC iStorage system must use a firmware level that is supported by the SAN Volume Controller.

See the following Web site for specific firmware levels and the latest supported hardware: [www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

### Logical unit creation and deletion for NEC iStorage systems

You can create or delete logical units for NEC iStorage systems. See the storage configuration guidelines that are specified in the NEC iStorage documentation that is provided for this system.

### Platform type for NEC iStorage

You must set all logical units that the SAN Volume Controller accesses to platform type AX (AIX).

## Access control methods for NEC iStorage

You can use access control to restrict access from hosts and SAN Volume Controller clusters. You do not need to use access control to allow a SAN Volume Controller cluster to use all of the defined logical units on the system.

The following table lists the access control methods that are available:

| Method    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Port Mode | Allows access to logical units that you want to define on a per storage controller port basis. SAN Volume Controller visibility (through switch zoning, physical cabling, etc.) must allow the SAN Volume Controller cluster to have the same access from all nodes and the accessible controller ports have been assigned the same set of logical units with the same logical unit number. This method of access control is not recommended for SAN Volume Controller connection. |
| WWN Mode  | Allows access to logical units using the WWPN of each of the ports of an accessing host device. All WWPNs of all the SAN Volume Controller nodes in the same cluster must be added to the list of linked paths in the controller configuration. This becomes the list of host (SAN Volume Controller) ports for an LD Set or group of logical units. This method of access control allows sharing because different logical units can be accessed by other hosts.                  |

## Setting cache allocations for NEC iStorage

Cache allocations can be set manually; however, changes to the default settings can adversely effect performance and cause you to lose access to the system.

## Snapshot Volume and Link Volume for NEC iStorage

You cannot use Copy Services logical volumes with logical units that are assigned to the SAN Volume Controller.

---

## Configuring NetApp FAS systems

This section provides information about configuring the Network Appliance (NetApp) Fibre-attached Storage (FAS) systems for attachment to a SAN Volume Controller. Models of the NetApp FAS system are equivalent to the IBM System Storage N5000 series and the IBM System Storage N7000 series; therefore, the SAN Volume Controller also supports models of the IBM N5000 series and the IBM N7000 series.

**Attention:** You must configure NetApp FAS systems in single-image mode. SAN Volume Controller does not support NetApp FAS systems that are in multiple-image mode.

The information in this section also applies to the supported models of the IBM N5000 series and the IBM N7000 series.

## Supported models of the NetApp FAS system

The SAN Volume Controller supports models of the NetApp FAS200, FAS900, FAS3000 and FAS6000 series of systems.

See the following Web site for the latest supported models:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Supported firmware levels for the NetApp FAS

The NetApp FAS must use a firmware level that is supported by the SAN Volume Controller.

See the following Web site for specific firmware levels and the latest supported hardware:[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## User interfaces on the NetApp FAS

Ensure that you are familiar with the user interface applications that support the NetApp FAS.

See the documentation that is provided with your NetApp FAS system for more information about the Web server and CLI.

### Web server

You can manage, configure, and monitor the NetApp FAS through the FileView GUI.

### CLI

You can access the command-line interface through a direct connection to the filer serial console port or by using the filer IP address to establish a telnet session.

## Logical units and target ports on NetApp FAS systems

For the NetApp FAS systems, a logical unit (LU) is a subdirectory in an internal file system.

LUs that are exported by the NetApp FAS system report identification descriptors in the vital product data (VPD). The SAN Volume Controller cluster uses the LUN-associated binary type-3 IEEE Registered Extended descriptor to identify the LU. For a NetApp LUN that is mapped to the SAN Volume Controller cluster, set the LUN Protocol Type to Linux.

The NetApp FAS system does not use LU groups so that all LUs are independent. The LU access model is active-active. Each LU has a preferred filer, but can be accessed from either filer. The preferred filer contains the preferred access ports for the LU. The SAN Volume Controller cluster detects and uses this preference.

The NetApp FAS reports a different worldwide port name (WWPN) for each port and a single worldwide node name (WWNN).

## Creating logical units on the NetApp FAS

To create logical units, you must identify a volume from which to create the logical unit and specify the amount of space to use.

Perform the following steps to create logical units:

1. Log on to the NetApp FAS.
2. Go to **Filer View** and authenticate.
3. Click **Volumes** and identify a volume to use to create an LU. A list of volumes is displayed.

4. Identify a volume that has sufficient free space for the LUN size that you want to use.
5. Click **LUNs** on the left panel.
6. Click **Add** in the list.
7. Enter the following:
  - a. In the **Path** field, enter `/vol/volx/lun_name` where *volx* is the name of the volume identified above and *lun\_name* is a generic name.
  - b. In the **LUN Type** field, enter Image.
  - c. Leave the **Description** field blank.
  - d. In the **Size** field, enter a LUN Size.
  - e. In the **Units** field, enter the LUN Size in units.
  - f. Select the **Space Reserved** box.

**Note:** If the Space Reserved box is not selected and the file system is full, the LUN goes offline. The managed disk group also goes offline and you cannot access the virtual disks.

- g. Click **Add**.

**Note:** To check the LUN settings, go to the Manage LUNs section and click the LUN you want to view. Ensure that the Space Reserved setting is set.

## Deleting logical units on the NetApp FAS

You can delete logical units.

Perform the following steps to delete logical units:

1. Log on to the NetApp FAS.
2. Go to **Filer View** and authenticate.
3. Click **LUNs** on the left panel.
4. Click **Manage**. A list of LUNs is displayed.
5. Click the LUN that you want to delete.
6. Click **Delete**.
7. Confirm the LUN that you want to delete.

## Creating host objects for the NetApp FAS

You can create host objects.

Perform the following steps to create host objects:

1. Log on to the NetApp FAS.
2. Go to **Filer View** and authenticate.
3. Click **LUNs** on the left panel.
4. Click **Initiator Groups**.
5. Click **Add** in the list.
6. Enter the following:
  - a. In the **Group Name** field, enter the name of the initiator group or host.
  - b. In the **Type** list, select FCP.
  - c. In the **Operating System** field, select Linux.

- d. In the **Initiators** field, enter the list of WWPNs of all the ports of the nodes in the cluster that are associated with the host.

**Note:** Delete the WWPNs that are displayed in the list and manually enter the list of SAN Volume Controller node ports. You must enter the ports of all nodes in the SAN Volume Controller cluster.

7. Click **Add**.

## Presenting LUNs to hosts for NetApp FAS

You can present LUNs to hosts.

Perform the following steps to present LUNs to hosts:

1. Log on to the NetApp FAS.
2. Go to **Filer View** and authenticate.
3. Click **LUNs** on the left panel.
4. Click **Manage**. A list of LUNs is displayed.
5. Click the LUN that you want to map.
6. Click **Map LUN**.
7. Click **Add Groups to Map**.
8. Select the name of the host or initiator group from the list and click **Add**.

### Notes:

- a. You can leave the LUN ID section blank. A LUN ID is assigned based on the information the controllers are currently presenting.
  - b. If you are re-mapping the LUN from one host to another, you can also select the **Unmap** box.
9. Click **Apply**.

## Switch zoning limitations for NetApp FAS systems

There are limitations in switch zoning for SAN Volume Controller clusters and NetApp FAS systems.

### Fabric zoning

The SAN Volume Controller switch zone must include at least one target port from each filer to avoid a single point of failure.

### Target port sharing

Target ports can be shared between the SAN Volume Controller cluster and other hosts. However, you must define separate initiator groups (igroups) for the SAN Volume Controller initiator ports and the host ports.

### Host splitting

A single host cannot be connected to both the SAN Volume Controller cluster and the NetApp FAS to avoid the possibility of an interaction between multipathing drivers.



## Controller splitting

You can connect other hosts directly to both the NetApp FAS and the SAN Volume Controller cluster under the following conditions:

- Target ports are dedicated to each host or are in a different igroup than the SAN Volume Controller cluster
- LUNs that are in the SAN Volume Controller cluster igroup are not included in any other igroup

## Concurrent maintenance on the NetApp FAS

Concurrent maintenance is the capability to perform I/O operations to a NetApp FAS while simultaneously performing maintenance operations on it.

The SAN Volume Controller supports concurrent maintenance on the NetApp FAS.

## Quorum disks on the NetApp FAS

The SAN Volume Controller can use logical units (LUs) that are exported by the NetApp FAS as quorum disks.

## Advanced functions for the NetApp FAS

The SAN Volume Controller copy and migration functions are supported for logical units (LUs) that are presented by the NetApp FAS.

---

## Configuring Pillar Axiom systems

This section provides information about configuring Pillar Axiom systems for attachment to a SAN Volume Controller cluster.

### Supported models of Pillar Axiom systems

SAN Volume Controller clusters can be used with some models of the Pillar Axiom series of systems.

See the following Web site for the latest models that can be used with SAN Volume Controller clusters:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

### Supported firmware levels of Pillar Axiom systems

You must ensure that the firmware level of the Pillar Axiom system can be used with the SAN Volume Controller cluster.

See the following Web site for specific firmware levels and the latest supported hardware:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

### Concurrent maintenance on Pillar Axiom systems

Concurrent maintenance is the capability to perform I/O operations to a Pillar Axiom system while simultaneously performing maintenance operations on it.

Because some maintenance operations restart the Pillar Axiom system, you cannot perform hardware maintenance or firmware upgrades while the system is attached to a SAN Volume Controller cluster.

## Pillar Axiom user interfaces

Ensure that you are familiar with the user interface applications that Pillar Axiom systems use. For more information, see the documentation that is included with the Pillar Axiom system.

### AxiomONE Storage Services Manager

The AxiomONE Storage Services Manager is a browser-based GUI that allows you to configure, manage, and troubleshoot Pillar Axiom systems.

### Pillar Data Systems CLI

The Pillar Data Systems command-line interface (CLI) communicates with the system through an XML-based application programming interface (API) over a TCP/IP network. The Pillar Data Systems CLI is installed through the AxiomONE Storage Service Manager. You can use the Pillar Data Systems CLI to issue all commands, run scripts, request input files to run commands, and run commands through a command prompt. The Pillar Data Systems CLI can run on all operating systems that can be used with Pillar Axiom systems.

### AxiomONE CLI

The AxiomONE CLI is installed through the AxiomONE Storage Service Manager. You can use the AxiomONE CLI to perform administrative tasks. The AxiomONE CLI can run on a subset of operating systems that can be used with Pillar Axiom systems.

## Logical units and target ports on Pillar Axiom systems

For Pillar Axiom systems, logical units are enumerated devices that have the same characteristics as LUNs.

### LUNs

You can use the AxiomONE Storage Services Manager to create and delete LUNs.

#### Important:

1. When you create a LUN, it is not formatted and therefore can still contain sensitive data from previous usage.
2. You cannot map more than 256 Pillar Axiom LUNs to a SAN Volume Controller cluster.

You can create LUNs in a specific volume group or in a generic volume group. A single LUN can use the entire capacity of a disk group. However, for SAN Volume Controller clusters, LUNs cannot exceed 2 TB. When LUNs are exactly 2 TB, a warning is issued in the SAN Volume Controller cluster error log.

The amount of capacity that the LUN uses is determined by the capacity of the LUN and the level of redundancy. You can define one of three levels of redundancy:

- Standard, which stores only the original data

- Double, which stores the original data and one copy
- Triple, which stores the original data and two copies

For all levels of redundancy, data is striped across multiple RAID-5 groups.

LUNs that are exported by the Pillar Axiom system report identification descriptors in the vital product data (VPD). The SAN Volume Controller cluster uses the LUN-associated binary type-2 IEEE Registered Extended descriptor to identify the LUN. The following format is used:

```
CCCCCCLLLLMMMMMM
```

where CCCCCC is the IEEE company ID (0x00b08), LLLL is a number that increments each time a LUN is created (0000–0xFFFD) and MMMMMM is the system serial number.

You can find the identifier in the AxiomONE Storage Services Manager. From the AxiomONE Storage Services Manager, click **Storage** → **LUNs** → **Identity**. The identifier is listed in the LUID column. To verify that the identifier matches the UID that the SAN Volume Controller cluster lists, issue the **svcinfo lsmdisk mdisk\_id** or **mdisk\_name** from the command-line interface and check the value in the UID column.

## Moving LUNs

If you want to migrate more than 256 LUNs on an existing Pillar Axiom system to the SAN Volume Controller cluster, you must use the SAN Volume Controller cluster migration function. The Pillar Axiom system allows up to 256 LUNs per host and the SAN Volume Controller cluster must be configured as a single host. Because the SAN Volume Controller cluster is not limited to 256 virtual disks, you can migrate your existing Pillar Axiom system set up to the SAN Volume Controller cluster. You must then virtualize groups of LUNs and then migrate the group to larger managed mode disks.

## Target ports

Pillar Axiom systems with one pair of controllers report a different worldwide port name (WWPN) for each port and a single worldwide node name (WWNN). Systems with more than one pair of controllers report a unique WWNN for each controller pair.

LUN groups are not used so that all LUNs are independent. The LUN access model is active-active/asymmetric with one controller having ownership of the LUN. All I/O operations to the LUN on this controller is optimized for performance. You can use the **svcinfo lsmdisk mdisk\_id** or **mdisk\_name** CLI command to determine the assigned controller for a LUN.

To balance I/O load across the controllers, I/O operations can be performed through any port. However, performance is higher on the ports of the controller that own the LUNs. By default, the LUNs that are mapped to the SAN Volume Controller cluster are accessed through the ports of the controller that owns the LUNs.

## Switch zoning limitations for Pillar Axiom systems

There are limitations in switch zoning for SAN Volume Controller clusters and Pillar Axiom systems.

## Fabric zoning

The SAN Volume Controller switch zone must include at least one target port from each Pillar Axiom controller to avoid a single point of failure.

## Target port sharing

Target ports can be shared between the SAN Volume Controller cluster and other hosts.

## Host splitting

A single host cannot be connected to both the SAN Volume Controller cluster and the Pillar Axiom system to avoid the possibility of an interaction between multipathing drivers.

## Controller splitting

Pillar Axiom system LUNs that are mapped to the SAN Volume Controller cluster cannot be mapped to other hosts. Pillar Axiom system LUNs that are *not* mapped to the SAN Volume Controller cluster can be mapped to other hosts.

## Configuration settings for Pillar Axiom systems

The AxiomONE Storage Services Manager provides configuration settings and options that can be used with SAN Volume Controller clusters.

The settings and options can have a scope of the following:

- System (global)
- Logical unit (LU)
- Host

### Global settings for Pillar Axiom systems

Global settings apply across a Pillar Axiom system.

Table 43 lists the system options that you can access using the AxiomONE Storage Services Manager.

Table 43. Pillar Axiom global options and required settings

| Option                                         | Pillar Axiom default setting | SAN Volume Controller required setting |
|------------------------------------------------|------------------------------|----------------------------------------|
| Enable Automatic Failback of NAS Control Units | Y                            | N/A                                    |
| Link Aggregation                               | N                            | N/A                                    |
| DHCP/Static                                    | -                            | Any                                    |
| Call-home                                      | -                            | Any                                    |

### Logical unit options and settings for Pillar Axiom systems

Logical unit (LU) settings are configurable at the LU level.

Table 44 on page 383 lists the options that must be set for each LU that is accessed by other hosts. LUs that are accessed by hosts can be configured differently. You can use the AxiomONE Storage Services Manager to change these settings.

Table 44. Pillar Axiom LU options and required settings

| Option                                                                                                                                                                                                                                                             | Pillar Axiom Default Setting | SAN Volume Controller Required Setting                                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| LUN Access                                                                                                                                                                                                                                                         | All hosts                    | Select hosts                                                                                                                  |
| Protocol                                                                                                                                                                                                                                                           | FC                           | FC                                                                                                                            |
| LUN Assignment                                                                                                                                                                                                                                                     | Auto                         | Any<br><br><b>Attention:</b> Do not change the LUN assignment after the LUNs are mapped to the SAN Volume Controller cluster. |
| Select Port Mask                                                                                                                                                                                                                                                   | All On                       | All On                                                                                                                        |
| Quality of Service                                                                                                                                                                                                                                                 | Various                      | No preference. See the note below.                                                                                            |
| <p><b>Note:</b> If you do not know the Quality of Service setting, you can use the following:</p> <ul style="list-style-type: none"> <li>• Priority vs other Volumes = Medium</li> <li>• Data is typically accessed = Mixed</li> <li>• I/O Bias = Mixed</li> </ul> |                              |                                                                                                                               |

## Host options and settings for Pillar Axiom systems

You must use specific settings to identify SAN Volume Controller clusters as hosts to Pillar Axiom systems.

Table 45 lists the host options and settings that can be changed using the AxiomONE Storage Services Manager.

Table 45. Pillar Axiom host options and required settings

| Option         | Pillar Axiom default setting | SAN Volume Controller required setting |
|----------------|------------------------------|----------------------------------------|
| Load balancing | Static                       | Static                                 |
| HP-UX          | N                            | N                                      |

## Quorum disks on Pillar Axiom systems

The SAN Volume Controller cluster selects managed disks (MDisks) that are presented by Pillar Axiom systems as quorum disks.

## Copy functions for Pillar Axiom systems

Advanced copy functions for Pillar Axiom systems (for example, Snap FS, Snap LUN, Volume Backup, Volume Copy, and Remote Copy) cannot be used with disks that are managed by the SAN Volume Controller cluster.

---

## Configuring IBM XIV systems

This section provides information about configuring IBM XIV systems for attachment to a SAN Volume Controller cluster.

## Supported IBM XIV models

SAN Volume Controller support for IBM XIV systems is specific to certain models.

The supported IBM XIV models are:

- XIV Nextra
- IBM XIV Type Number 2810

**Note:** Currently, only single racks are supported for both models.

See the following Web site for the latest IBM XIV and XIV Nextra system models that can be used with SAN Volume Controller clusters:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Supported IBM XIV firmware levels

You must ensure that SAN Volume Controller supports your IBM XIV firmware level.

See the following Web site for the supported firmware levels and hardware:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

## Concurrent maintenance on IBM XIV systems

Concurrent maintenance is the capability to perform I/O operations on an IBM XIV system while simultaneously performing maintenance operations on the system.

Because some maintenance operations restart IBM XIV systems, you cannot perform hardware maintenance or firmware upgrades while the system is attached to the SAN Volume Controller.

## IBM XIV user interfaces

Ensure that you are familiar with the IBM XIV user interface applications. For more information, see the documentation that is included with your IBM XIV system.

### IBM XIV Storage Management GUI

The IBM XIV Storage Management GUI is a Java-based GUI that you can use to configure, manage, and troubleshoot IBM XIV systems. The IBM XIV Storage Management GUI can run on all operating systems that can be used with IBM XIV systems.

### IBM XIV CLI

The IBM XIV command-line interface (XCLI) communicates with the systems through an XML-based API over a TCP/IP network. You can use the XCLI to issue all commands, run scripts, request input files to run commands, and run commands through a command prompt. The XCLI can run on all operating systems that can be used with IBM XIV systems.

## Logical units and target ports on IBM XIV systems

On IBM XIV systems, logical units (LUs) are enumerated devices that have the same characteristics as LUNs.

### LUNs

An IBM XIV Logical Unit is referred to as a *volume*. IBM XIV and XIV Nextra volumes are enumerated devices that all share identical characteristics.

A single IBM XIV volume can potentially consume the entire capacity that is allocated for SAN Volume Controller managed disk groups, and it can also exceed the SAN Volume Controller 2 TB LUN size limit. Any LUN that is 2 TB or larger is truncated to 2 TB, and a warning message is generated for each path to the LUN.

IBM XIV volumes consume chunks of 17,179,869,184 bytes (17 GB), although you can create volumes with an arbitrary block count.

### LUN IDs

LUNs that are exported by IBM XIV systems report Identification Descriptors 0, 1, and 2 in VPD page 0x83. SAN Volume Controller uses the EUI-64 compliant type 2 descriptor `CCCCCCMMMMMMLLLL`, where `CCCCCC` is the IEEE company ID, `MMMMMM` is the System Serial Number transcribed to hexadecimal (`10142->0x010142`, for example) and `LLLL` is `0000-0xFFFF`, which increments each time a LUN is created. You can identify the `LLLL` value by using the IBM XIV Storage Management GUI or CLI to display the volume serial number.

### LUN creation and deletion

IBM XIV LUNs are created and deleted using the IBM XIV Storage Management GUI or CLI. LUNs are formatted to all zeros upon creation, but to avoid a significant formatting delay, zeros are not written.

### Special LUNs

IBM XIV systems do not use a special LUN; storage can be presented using any valid LUN, including 0.

### LU access model

IBM XIV systems have no specific ownership of any LUN by any module. Because data is striped over all disks in the system, performance is generally unaffected by the choice of a target port.

### LU grouping

IBM XIV systems do not use LU grouping; all LUNs are independent entities. To protect a single IBM XIV volume from accidental deletion, you can create a consistency group containing all LUNs that are mapped to a single SAN Volume Controller cluster.

### LU preferred access port

There are no preferred access ports for IBM XIV systems.

## Detecting ownership

Ownership is not relevant to IBM XIV systems.

## LUN presentation on XIV Nextra systems

XIV Nextra LUNs are presented to the SAN Volume Controller interface using the following rules:

- LUNs can be presented to one or more selected hosts.
- XIV Nextra maps consist of sets of LUN pairs and linked hosts.
- A volume can only appear once in a map.
- A LUN can only appear once in a map.
- A host can only be linked to one map.

To present XIV Nextra LUNs to the SAN Volume Controller, do the following:

1. Create a map with all of the volumes that you intend to manage with the SAN Volume Controller cluster.
2. Link the WWPN for all node ports in the SAN Volume Controller cluster into the map. Each SAN Volume Controller node port WWPN is recognized as a separate host by XIV Nextra systems.

## LUN presentation on IBM XIV Type Number 2810 systems

IBM XIV Type Number 2810 LUNs are presented to the SAN Volume Controller interface using the following rules:

- LUNs can be presented to one or more selected hosts or clusters.
- Clusters are collections of hosts.

To present IBM XIV Type Number 2810 LUNs to the SAN Volume Controller, do the following:

1. Use the IBM SAN Volume Controller console to create a SAN Volume Controller cluster.
2. Create a host for each node in the SAN Volume Controller.
3. Add a port to each host that you created in step 2. You must add a port for each port on the corresponding node.
4. Map volumes to the cluster that you created in step 1.

## Target ports on XIV Nextra systems

XIV Nextra systems are single-rack systems. All XIV Nextra WWNNs include zeros as the last two hexadecimal digits. In the following example, WWNN 2000001738279E00 is IEEE extended; the WWNNs that start with the number 1 are IEEE 48 bit:

```
WWNN 2000001738279E00
WWPN 1000001738279E13
WWPN 1000001738279E10
WWPN 1000001738279E11
WWPN 1000001738279E12
```



## Target ports on IBM XIV Type Number 2810 systems

IBM XIV Type Number 2810 systems are multi-rack systems, but only single racks are supported. All IBM XIV Type Number 2810 WWNNs include zeros as the last four hexadecimal digits. For example:

```
WWNN 5001738000030000
WWPN 5001738000030153
WWPN 5001738000030121
```

## Switch zoning limitations for IBM XIV systems

There are limitations in switch zoning for SAN Volume Controller clusters and IBM XIV systems.

### Fabric zoning

To avoid a single point of failure, the SAN Volume Controller switch zone must include at least one target port from each IBM XIV controller.

### Target port sharing

Target ports can be shared between the SAN Volume Controller cluster and other hosts.

### Host splitting

To avoid the possibility of an interaction between multipathing drivers, a single host cannot be connected to both the SAN Volume Controller cluster and the IBM XIV system.

### Controller splitting

IBM XIV system LUNs that are mapped to the SAN Volume Controller cluster cannot be mapped to other hosts. IBM XIV system LUNs that are *not* mapped to the SAN Volume Controller cluster can be mapped to other hosts.

## Configuration settings for IBM XIV systems

The IBM XIV Storage Management GUI provides configuration settings and options that can be used with SAN Volume Controller clusters.

### Logical unit options and settings for IBM XIV systems

Logical unit (LU) settings for IBM XIV systems are configurable at the LU level.

Table 46 on page 388 lists the options that must be set for each LU that is accessed by other hosts. LUs that are accessed by hosts can be configured differently. You can use the IBM XIV and XIV Nextra Storage Management GUI or CLI to change these settings.

Table 46. IBM XIV options and required settings

| Option                                                                                                                                                                                                                                                                            | Data Type | Range                                                                              | IBM XIV and XIV Nextra default setting | SAN Volume Controller setting |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------------------------------------------------------------------------------|----------------------------------------|-------------------------------|
| Capacity                                                                                                                                                                                                                                                                          | int       | 17,179,869,184 bytes (17 GB), up to the total system capacity<br><br>ORBlock count | None                                   | Any                           |
| <b>Notes:</b> <ul style="list-style-type: none"> <li>• SAN Volume Controller supports up to 2 TB.</li> <li>• LUNs are allocated in 17-GB chunks.</li> <li>• Using a block count results in LUNs that are arbitrarily sized, but that still consume multiples of 17 GB.</li> </ul> |           |                                                                                    |                                        |                               |

## Host options and settings for IBM XIV systems

You must use specific settings to identify SAN Volume Controller clusters as hosts to IBM XIV systems.

An XIV Nextra host is a single WWPN, so one XIV Nextra host must be defined for each SAN Volume Controller node port in the cluster. An XIV Nextra host is considered to be a single SCSI initiator. Up to 256 XIV Nextra hosts can be presented to each port. Each SAN Volume Controller host object that is associated with the XIV Nextra system must be associated with the same XIV Nextra LUN map because each LU can only be in a single map.

An IBM XIV Type Number 2810 host can consist of more than one WWPN. Configure each SAN Volume Controller node as an IBM XIV Type Number 2810 host, and create a cluster of IBM XIV systems that corresponds to each of the SAN Volume Controller nodes in the SAN Volume Controller cluster.

Table 47 lists the host options and settings that can be changed using the IBM XIV and XIV Nextra Storage Management GUI.

Table 47. IBM XIV Type Number 2810 and XIV Nextra host options and required settings

| Option | Data type | Range    | IBM XIV Type Number 2810 and XIV Nextra default setting | SAN Volume Controller required setting | Notes                                          |
|--------|-----------|----------|---------------------------------------------------------|----------------------------------------|------------------------------------------------|
| Type   | Enum      | FC/iSCSI | Not applicable                                          | FC                                     | The Type must be FC for SAN Volume Controller. |

Table 47. IBM XIV Type Number 2810 and XIV Nextra host options and required settings (continued)

| Option                                                                                                                         | Data type | Range            | IBM XIV Type Number 2810 and XIV Nextra default setting | SAN Volume Controller required setting | Notes                                                                                                                                                                                |
|--------------------------------------------------------------------------------------------------------------------------------|-----------|------------------|---------------------------------------------------------|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| XIV Nextra <code>map_set_special_type</code> CLI command or IBM XIV Type Number 2810 <code>special_type_set</code> CLI command | Enum      | default/<br>hpux | default                                                 | default                                | This command is used by hpux hosts only. Do not use the command for SAN Volume Controller LUNs.                                                                                      |
| WWPN                                                                                                                           | int64     | Any              | Not applicable                                          | Node port                              | For XIV Nextra, one host for each node port WWPN in the cluster must be defined. For IBM XIV, Type Number 2810 one host port for each node port WWPN in the cluster must be defined. |
| LUN Map                                                                                                                        | String    | Any              | Not applicable                                          | Any                                    | For XIV Nextra, each SAN Volume Controller host in the XIV Nextra system must be associated with the same LUN map because each LU can be only in a single map.                       |

## Quorum disks on IBM XIV systems

The SAN Volume Controller cluster selects managed disks (MDisks) that are presented by IBM XIV systems as quorum disks.

## Clearing SCSI reservations and registrations

You must not use the `vol_clear_keys` command to clear SCSI reservations and registrations on volumes that are managed by SAN Volume Controller.

## **Copy functions for IBM XIV systems**

Advanced copy functions for IBM XIV systems such as SnapShot and remote mirroring cannot be used with disks that are managed by the SAN Volume Controller cluster. Thin provisioning is not supported for use with SAN Volume Controller.

---

## Chapter 12. IBM System Storage support for Microsoft Volume Shadow Copy Service

The SAN Volume Controller provides support for the Microsoft Volume Shadow Copy Service. The Microsoft Volume Shadow Copy Service can provide a point-in-time (shadow) copy of a Windows host volume while the volume is mounted and files are in use.

The following components are used to provide support for the service:

- SAN Volume Controller
- The cluster CIM server
- IBM System Storage hardware provider, known as the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software
- Microsoft Volume Shadow Copy Service

The IBM System Storage hardware provider is installed on the Windows host.

To provide the point-in-time shadow copy, the components complete the following process:

1. A backup application on the Windows host initiates a snapshot backup.
2. The Volume Shadow Copy Service notifies the IBM System Storage hardware provider that a copy is needed.
3. The SAN Volume Controller prepares the volumes for a snapshot.
4. The Volume Shadow Copy Service quiesces the software applications that are writing data on the host and flushes file system buffers to prepare for the copy.
5. The SAN Volume Controller creates the shadow copy using the FlashCopy Copy Service.
6. The Volume Shadow Copy Service notifies the writing applications that I/O operations can resume, and notifies the backup application that the backup was successful.

The Volume Shadow Copy Service maintains a free pool of virtual disks (VDisks) for use as a FlashCopy target and a reserved pool of VDisks. These pools are implemented as virtual host systems on the SAN Volume Controller.

---

### Installation overview

The steps for implementing the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software must be completed in the correct sequence.

Before you begin, you must have experience with or knowledge of administering a Windows Server operating system.

You must also have experience with or knowledge of administering a SAN Volume Controller.

Complete the following tasks:

1. Verify that the system requirements are met.

2. Install the SAN Volume Controller Console if it is not already installed.
3. Install the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software.
4. Verify the installation.
5. Create a free pool of volumes and a reserved pool of volumes on the SAN Volume Controller.
6. Optionally, you reconfigure the services to change the configuration that you established during the installation.

## System requirements for the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software

Ensure that your system satisfies the following requirements before you install the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software on a Microsoft Windows Server 2003 or 2008 operating system.

The following software is required:

- CIM server with SAN Volume Controller version 4.3.1 or later installed
- Nodes with SAN Volume Controller version 4.3.1 or later installed, with FlashCopy enabled.
- IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software version 3.2 or later.
- Windows Server 2003 or Windows Server 2008 operating system. The following editions of Windows Server 2003 and Windows Server 2008 are supported:
  - Standard Server Edition 32-bit version
  - Enterprise Edition, 32-bit version
  - Standard Server Edition 64-bit version
  - Enterprise Edition, 64-bit version

## Installing the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software

This section includes the steps to install the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software on a Windows server.

**Important:** You must install and configure a SAN Volume Controller CIM server before you install the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software.

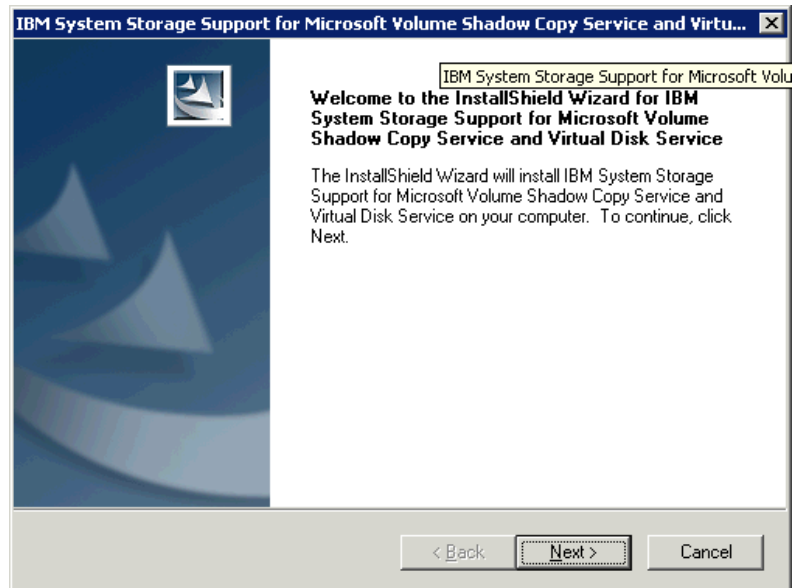
You must satisfy all of the prerequisites that are listed in the system requirements section before starting the installation.

Perform the following steps to install the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software on the Windows server:

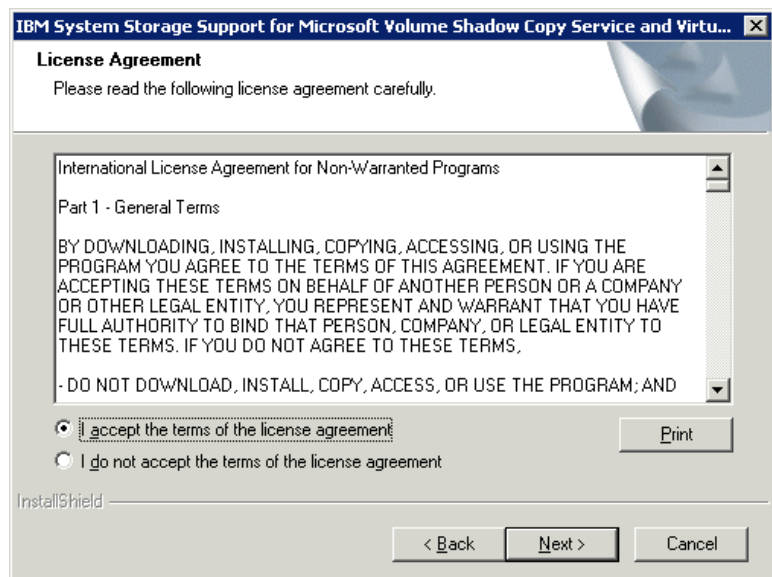
1. Log on to Windows as an administrator.
2. Download the IBM VSS Host Installation Package file from the following Web site:

www.ibm.com/storage/support/2145

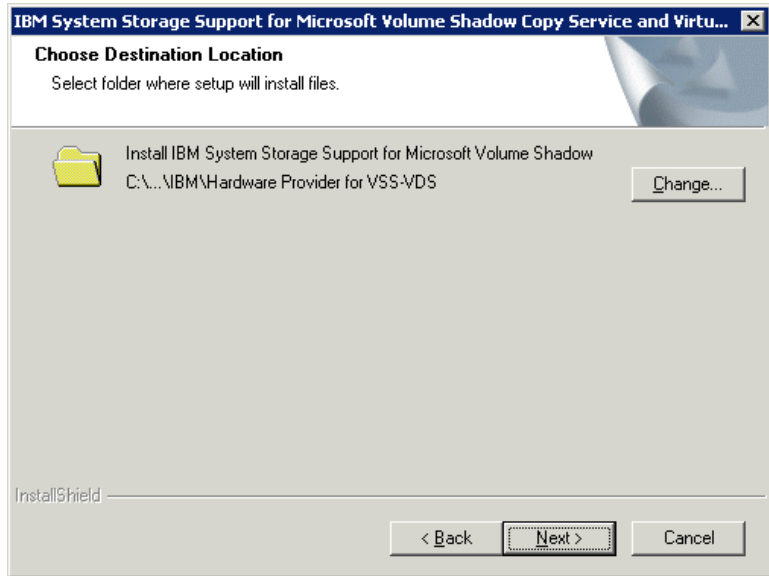
3. Double click on the name of the file that you downloaded in step 2 on page 392 to start the installation process. The Welcome panel is displayed.



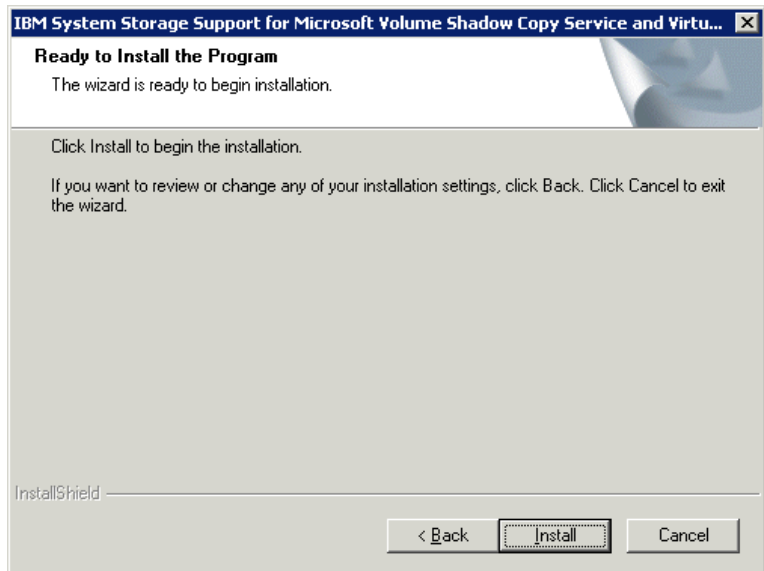
4. Click **Next** to continue. The License Agreement panel is displayed. You can click **Cancel** at any time to exit the installation. To move back to previous screens while using the wizard, click **Back**.



5. Read the license agreement information. Select whether you accept the terms of the license agreement, and click **Next**. If you do not accept, you cannot continue with the installation. The Choose Destination Location panel is displayed.

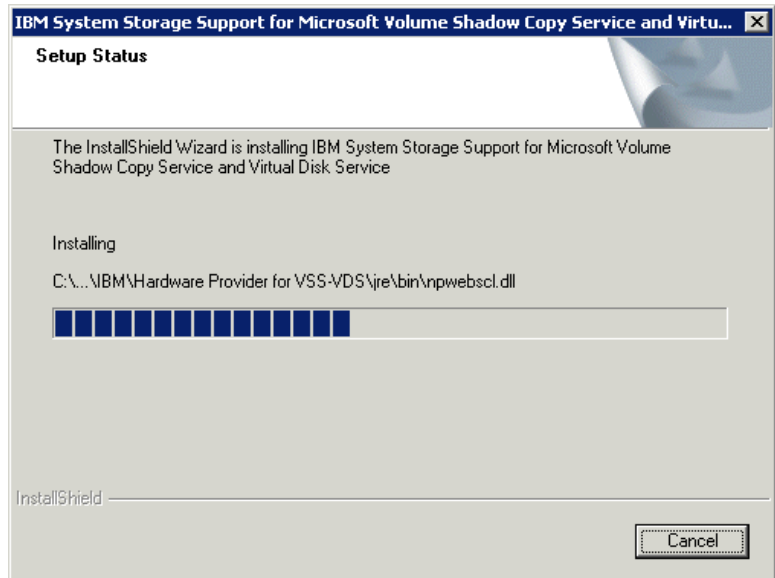


6. Click **Next** to accept the default directory where the setup program will install the files, or click **Change** to select a different directory. Click **Next**. The Ready to Install the Program panel is displayed.

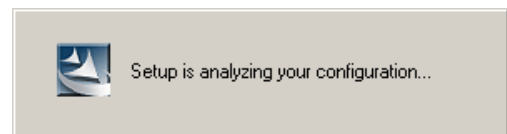


7. Click **Install** to begin the installation. To exit the wizard and end the installation, click **Cancel**. The Setup Status panel is displayed.

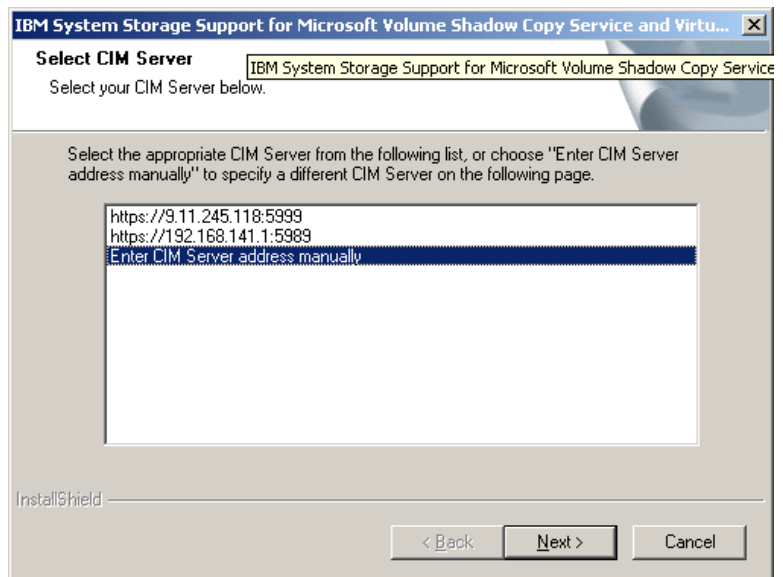




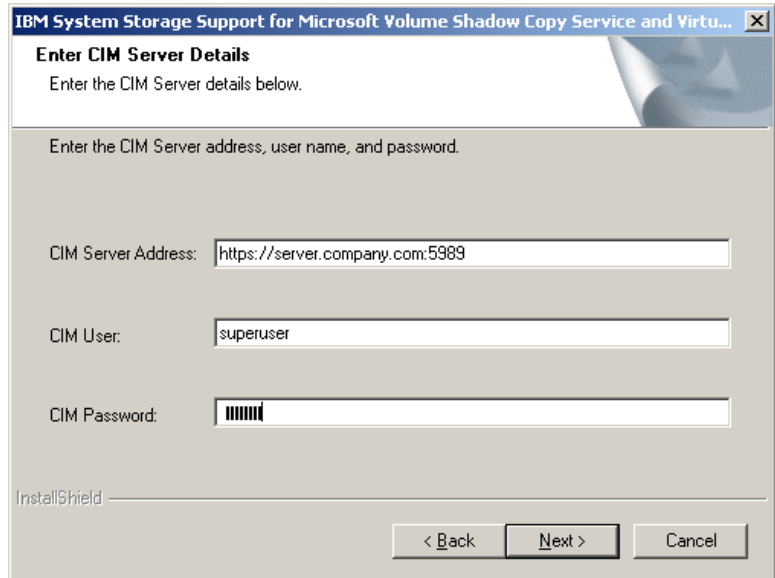
The program setup verifies your configuration.



The Select CIM Server panel is displayed.



8. Select the required CIM server, or select **Enter the CIM Server address manually**, and click **Next**. The Enter CIM Server Details panel is displayed.



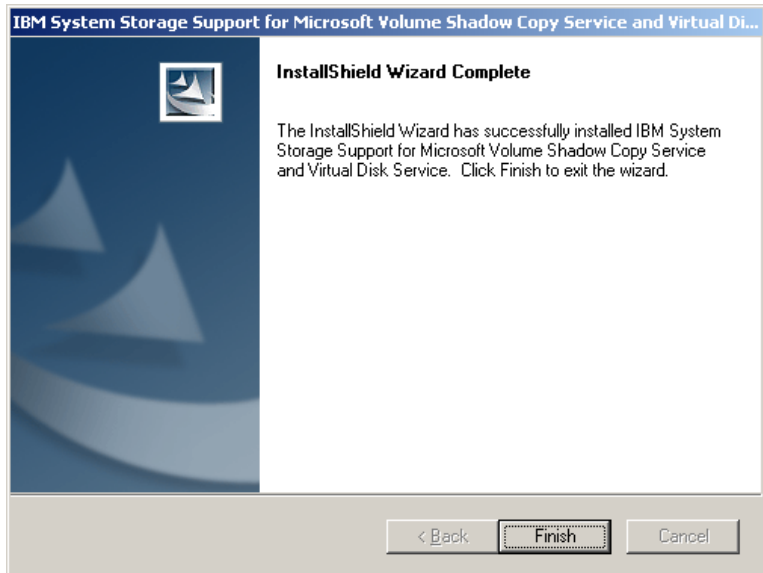
9. Enter the following information in the fields:

- In the **CIM Server Address** field, type the name of the server where the SAN Volume Controller Console is installed.
- In the **CIM User** field, type the user name that the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software will use to gain access to the CIM server. For example, enter the name administrator.
- In the **CIM Password** field, type the password for the user name that the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software will use to gain access to the CIM server and click **Next**.

**Notes:**

- a. If these settings change after installation, you can use the **ibmvcfg.exe** tool to update Microsoft Volume Shadow Copy and Virtual Disk Services software with the new settings.
- b. If you do not have the CIM agent server, port, or user information, contact your CIM agent administrator.

The InstallShield Wizard Complete panel is displayed.



10. Click **Finish**. If necessary, the InstallShield Wizard prompts you to restart the system.
11. Make the IBM Hardware Provider for VSS-VDS aware of the SAN Volume Controller, as follows:
  - a. Open a command prompt.
  - b. Change directories to the hardware provider directory; the default directory is **C:\Program Files\IBM\Hardware Provider for VSS-VDS\**.
  - c. Use the **ibmvcfg** command to set the IP address for the SAN Volume Controller cluster, as follows:
 

```
ibmvcfg set targetSVC ip_address
```

The *ip\_address* value must be the SAN Volume Controller cluster IP address.

## Creating the free and reserved pools of volumes

The IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software maintains a free and a reserved pool of volumes. Because these objects do not exist on the SAN Volume Controller, the free and reserved pool of volumes are implemented as virtual host systems. You must define these two virtual host systems on the SAN Volume Controller.

When a shadow copy is created, the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software selects a volume in the free pool, assigns it to the reserved pool, and then removes it from the free pool. This protects the volume from being overwritten by other Volume Shadow Copy Service users.

To successfully perform a Volume Shadow Copy Service operation, there must be enough virtual disks (VDisks) mapped to the free pool. The VDisks must be the same size as the source VDisks.

Use the SAN Volume Controller Console or the SAN Volume Controller command-line interface (CLI) to perform the following steps:

1. Create a host for the free pool of VDisks.

- You can use the default name VSS\_FREE or specify a different name.
  - Associate the host with the worldwide port name (WWPN) 5000000000000000 (15 zeroes).
2. Create a virtual host for the reserved pool of volumes.
    - You can use the default name VSS\_RESERVED or specify a different name.
    - Associate the host with the WWPN 5000000000000001 (14 zeroes).
  3. Map the logical units (VDisks) to the free pool of volumes.

**Restriction:** The VDisks cannot be mapped to any other hosts.

- If you already have VDisks created for the free pool of volumes, you must assign the VDisks to the free pool.
4. Create VDisk-to-host mappings between the VDisks selected in step 3 and the VSS\_FREE host to add the VDisks to the free pool. Alternatively, you can use the **ibmvcfg add** command to add VDisks to the free pool.
  5. Verify that the VDisks have been mapped.

If you do not use the default WWPNs 5000000000000000 and 5000000000000001, you must configure the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software with the WWPNs.

## Verifying the installation

This task verifies that the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software is correctly installed on the Windows server.

Perform the following steps to verify the installation:

1. Click **Start** → **All Programs** → **Administrative Tools** → **Services** from the Windows server task bar. The **Services** panel is displayed.
2. Ensure that the service named IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software appears and that **Status** is set to Started and **Startup Type** is set to Automatic.
3. Open a command prompt window and issue the following command:  
vssadmin list providers
4. Ensure that the service named IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software is listed as a provider.
5. Use the **ibmvcfg listvols** command to test the connection to the IBM System Storage Productivity Center or master console.

If you are able to successfully perform all of these verification tasks, the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software was successfully installed on the Windows server.

---

## Changing the configuration parameters

You can change the parameters that you defined when you installed the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software. You must use the **ibmvcfg.exe** utility to change the parameters.

Table 48 on page 399 describes the configuration commands that are provided by the **ibmvcfg.exe** utility.

Table 48. Configuration commands

| Command                                       | Description                                                                                                                                                                                                                                                                                | Example                                             |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
| ibmvcfg showcfg                               | Lists the current settings.                                                                                                                                                                                                                                                                | showcfg                                             |
| ibmvcfg set username<br><username>            | Sets the user name to access the CIM server.                                                                                                                                                                                                                                               | set username johnny                                 |
| ibmvcfg set password<br><password>            | Sets the password of the user name that will access the CIM server.                                                                                                                                                                                                                        | set password mypassword                             |
| ibmvcfg set targetSVC<br><ipaddress>          | Specifies the IP address of the SAN Volume Controller on which the VDIs are located when VDIs are moved to and from the free pool with the ibmvcfg add and ibmvcfg rem commands.<br><br>The IP address is overridden if you use the -s flag with the ibmvcfg add and ibmvcfg rem commands. | set targetSVC<br>64.157.185.191                     |
| ibmvcfg set backgroundCopy                    | Sets the background copy rate for FlashCopy.                                                                                                                                                                                                                                               | set backgroundCopy 80                               |
| ibmvcfg set incrementalFC                     | Specifies if incremental FlashCopy has to be used on SAN Volume Controller for the shadow copy.                                                                                                                                                                                            | ibmvcfg set incrementalFC<br>yes                    |
| ibmvcfg set usingSSL                          | Specifying the Secure Sockets Layer (SSL) protocol is required to use a CIM server.                                                                                                                                                                                                        | ibmvcfg set usingSSL yes                            |
| ibmvcfg set cimomHost<br><server name>        | Sets the CIM server for the cluster.                                                                                                                                                                                                                                                       | ibmvcfg set cimomHost<br>cimomserver                |
| ibmvcfg set namespace<br><namespace>          | Specifies the namespace value that master console is using.                                                                                                                                                                                                                                | ibmvcfg set namespace<br>\root\ibm                  |
| ibmvcfg set vssFreeInitiator<br><WWPN>        | Specifies the WWPN of the host. The default value is 5000000000000000. Modify this value only if there is a host already in your environment with a WWPN of 5000000000000000.                                                                                                              | ibmvcfg set<br>vssFreeInitiator<br>5000000000000000 |
| ibmvcfg set<br>vssReservedInitiator<br><WWPN> | Specifies the WWPN of the host. The default value is 5000000000000001. Modify this value only if there is a host already in your environment with a WWPN of 5000000000000001.                                                                                                              | ibmvcfg set<br>vssFreeInitiator<br>5000000000000001 |

## Adding, removing, or listing volumes and FlashCopy relationships

You can use the `ibmvcfg.exe` utility to perform the pool management tasks of adding, removing, or listing volumes and FlashCopy relationships.

The IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software maintains a free pool of volumes and a reserved pool of volumes. These pools are implemented as virtual host systems on the SAN Volume Controller.

Table 49 describes the `ibmvfcg.exe` commands for adding or removing volumes from the free pool of volumes and listing or deleting FlashCopy relationships.

Table 49. Pool management commands

| Command                               | Description                                                                                                                                                                                                                                                                                                     | Example                                                                                                                                                           |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>ibmvfcg listvols</code>         | Lists all virtual disks (VDisks), including information about size, location, and VDisk to host mappings.                                                                                                                                                                                                       | <code>ibmvfcg listvols</code>                                                                                                                                     |
| <code>ibmvfcg listvols all</code>     | Lists all VDIs, including information about size, location, and VDisk to host mappings.                                                                                                                                                                                                                         | <code>ibmvfcg listvols all</code>                                                                                                                                 |
| <code>ibmvfcg listvols free</code>    | Lists the volumes that are currently in the free pool.                                                                                                                                                                                                                                                          | <code>ibmvfcg listvols free</code>                                                                                                                                |
| <code>ibmvfcg add -s ipaddress</code> | Adds one or more volumes to the free pool of volumes. Use the <code>-s</code> parameter to specify the IP address of the SAN Volume Controller where the VDIs are located. The <code>-s</code> parameter overrides the default IP address that is set with the <code>ibmvfcg set targetSVC</code> command.      | <code>ibmvfcg add vdisk12</code><br><code>ibmvfcg add 600507</code><br><code>68018700035000000</code><br><code>0000000BA</code><br><code>-s 66.150.210.141</code> |
| <code>ibmvfcg rem -s ipaddress</code> | Removes one or more volumes from the free pool of volumes. Use the <code>-s</code> parameter to specify the IP address of the SAN Volume Controller where the VDIs are located. The <code>-s</code> parameter overrides the default IP address that is set with the <code>ibmvfcg set targetSVC</code> command. | <code>ibmvfcg rem vdisk12</code><br><code>ibmvfcg rem 600507</code><br><code>68018700035000000</code><br><code>0000000BA</code><br><code>-s 66.150.210.141</code> |
| <code>ibmvfcg list infc</code>        | Lists all the FlashCopy relationships on the SAN Volume Controller. This command lists both incremental and nonincremental FlashCopy relationships.                                                                                                                                                             | <code>ibmvfcg list infc</code>                                                                                                                                    |
| <code>ibmvfcg del</code>              | Deletes one or more FlashCopy relationships. Use the serial number of the FlashCopy target to delete the relationship.                                                                                                                                                                                          | <code>ibmvfcg del</code><br><code>68018700035000000</code><br><code>0000000BA</code>                                                                              |

## Error codes

The IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software logs error messages in the Windows Event Viewer and in private log files.

You can view error messages by going to the following locations on the Windows server where the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software is installed:

- The Windows Event Viewer in Application Events. Check this log first.
- The log file `ibmVSS.log`, which is located in the directory where the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software is installed.

Table 50 lists the errors messages that are reported by the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software.

*Table 50. Error messages for the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software*

| Code | Message                                                                                   | Symbolic name                          |
|------|-------------------------------------------------------------------------------------------|----------------------------------------|
| 1000 | JVM Creation failed.                                                                      | ERR_JVM                                |
| 1001 | Class not found: %1.                                                                      | ERR_CLASS_NOT_FOUND                    |
| 1002 | Some required parameters are missing.                                                     | ERR_MISSING_PARAMS                     |
| 1003 | Method not found: %1.                                                                     | ERR_METHOD_NOT_FOUND                   |
| 1004 | A missing parameter is required. Use the configuration utility to set this parameter: %1. | ERR_REQUIRED_PARAM                     |
| 1600 | The recovery file could not be created.                                                   | ERR_RECOVERY_FILE_<br>CREATION_FAILED  |
| 1700 | ibmGetLunInfo failed in AreLunsSupported.                                                 | ERR_ARELUNSSUPPORTED_<br>IBMGETLUNINFO |
| 1800 | ibmGetLunInfo failed in FillLunInfo.                                                      | ERR_FILLLUNINFO_IBMGETLUNINFO          |
| 1900 | Failed to delete the following temp files: %1                                             | ERR_GET_TGT_CLEANUP                    |
| 2500 | Error initializing log.                                                                   | ERR_LOG_SETUP                          |
| 2501 | Unable to search for incomplete Shadow Copies. Windows Error: %1.                         | ERR_CLEANUP_LOCATE                     |
| 2502 | Unable to read incomplete Shadow Copy Set information from file: %1.                      | ERR_CLEANUP_READ                       |
| 2503 | Unable to cleanup snapshot stored in file: %1.                                            | ERR_CLEANUP_SNAPSHOT                   |
| 2504 | Cleanup call failed with error: %1.                                                       | ERR_CLEANUP_FAILED                     |
| 2505 | Unable to open file: %1.                                                                  | ERR_CLEANUP_OPEN                       |

Table 50. Error messages for the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software (continued)

| Code | Message                                                                       | Symbolic name                       |
|------|-------------------------------------------------------------------------------|-------------------------------------|
| 2506 | Unable to create file: %1.                                                    | ERR_CLEANUP_CREATE                  |
| 2507 | HBA: Error loading hba library: %1.                                           | ERR_HBAAPI_LOAD                     |
| 3000 | An exception occurred. Check the ESSService log.                              | ERR_ESSSERVICE_EXCEPTION            |
| 3001 | Unable to initialize logging.                                                 | ERR_ESSSERVICE_LOGGING              |
| 3002 | Unable to connect to the CIM agent. Check your configuration.                 | ERR_ESSSERVICE_CONNECT              |
| 3003 | Unable to get the Storage Configuration Service. Check your configuration.    | ERR_ESSSERVICE_SCS                  |
| 3004 | An internal error occurred with the following information: %1.                | ERR_ESSSERVICE_INTERNAL             |
| 3005 | Unable to find the VSS_FREE controller.                                       | ERR_ESSSERVICE_FREE_CONTROLLER      |
| 3006 | Unable to find the VSS_RESERVED controller. Check your configuration.         | ERR_ESSSERVICE_RESERVED_CONTROLLER  |
| 3007 | Unable to find suitable targets for all volumes.                              | ERR_ESSSERVICE_INSUFFICIENT_TARGETS |
| 3008 | The assign operation failed. Check the CIM agent log for details.             | ERR_ESSSERVICE_ASSIGN_FAILED        |
| 3009 | The withdraw FlashCopy operation failed. Check the CIM agent log for details. | ERR_ESSSERVICE_WITHDRAW_FAILED      |

## Uninstalling the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software

You must use Windows to uninstall the IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software from the Windows server.

Perform the following steps to uninstall the software:

1. Log on to the Windows server as the local administrator.
2. Click **Start** → **Control Panel** from the task bar. The Control Panel window is displayed.
3. Double-click **Add or Remove Programs**. The Add or Remove Programs window is displayed.
4. Select **IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software** and click **Remove**.
5. Click **Yes** when you are prompted to verify that you want to completely remove the program and all of its components.
6. Click **Finish**.



The IBM System Storage Support for Microsoft Volume Shadow Copy Service and Virtual Disk Service software is no longer installed on the Windows server.



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## Appendix A. Error Codes

Error codes provide a unique entry to service procedures. Each error code has an error ID that uniquely identifies the condition that caused the error.

Error IDs are recorded in the error log. When the number of error IDs of a specific type for a specific resource exceeds a predetermined threshold, an SNMP trap might be raised and an e-mail might be sent, depending on the cluster configuration. Different SNMP traps are signaled, depending on the severity of the error event. The SNMP type is used by the Call Home e-mail service to determine the recipients, the title, and the contents of the e-mail. The following SNMP types are possible:

**Error** This type identifies unexpected conditions that might be the result of a system failure. If configured, this type causes an SNMP trap to be sent to the monitoring application. An e-mail can also be sent to the IBM Support Center and the system administrator.

### Warning

This type identifies unexpected conditions that might be experienced during user operations. These conditions can result from device errors or incorrect user actions. If configured, this type causes an SNMP trap to be sent to the monitoring application. An e-mail can also be sent to the system administrator.

### Information

This type identifies conditions where a user might want to be notified of the completion of an operation. If configured, this type causes an SNMP trap to be sent to the monitoring application. An e-mail can also be sent to the system administrator.

Table 51 lists the error codes and corresponding error IDs.

Table 51. Error codes

| Error ID | SNMP Type | Condition                                                                                                                                                                                                                 | Error Code |
|----------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 009177   | W         | A physical disk FlashCopy feature license is required.                                                                                                                                                                    | 3035       |
| 009178   | W         | A physical disk Metro Mirror and Global Mirror feature license is required.                                                                                                                                               | 3036       |
| 009179   | W         | A virtualization feature license is required.                                                                                                                                                                             | 3025       |
| 009020   | E         | An automatic cluster recovery has started. All configuration commands are blocked.                                                                                                                                        | 1001       |
| 009040   | E         | The error log is full.                                                                                                                                                                                                    | 1002       |
| 009052   | E         | The following causes are possible: <ul style="list-style-type: none"><li>• The node is missing</li><li>• The node is no longer a functional member of the cluster</li><li>• One or more nodes are not available</li></ul> | 1195       |
| 009100   | W         | The software install process has failed.                                                                                                                                                                                  | 2010       |
| 009101   | W         | The software upgrade package delivery has failed.                                                                                                                                                                         | 2010       |
| 009150   | W         | Unable to connect to the SMTP (e-mail) server                                                                                                                                                                             | 2600       |

Table 51. Error codes (continued)

| Error ID | SNMP Type | Condition                                                                                                                                                                                                                | Error Code |
|----------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 009151   | W         | Unable to send mail through the SMTP (e-mail) server                                                                                                                                                                     | 2601       |
| 009170   | W         | The Metro Mirror or Global Mirror feature capacity is not set.                                                                                                                                                           | 3030       |
| 009171   | W         | The FlashCopy feature capacity is not set.                                                                                                                                                                               | 3031       |
| 009172   | W         | The Virtualization feature has exceeded the amount that is licensed.                                                                                                                                                     | 3032       |
| 009173   | W         | The FlashCopy feature has exceeded the amount that is licensed.                                                                                                                                                          | 3032       |
| 009174   | W         | The Metro Mirror or Global Mirror feature has exceeded the amount that is licensed.                                                                                                                                      | 3032       |
| 009176   | W         | The value set for the virtualization feature capacity is not valid.                                                                                                                                                      | 3029       |
| 010002   | E         | The node ran out of base event sources. As a result, the node has stopped and exited the cluster.                                                                                                                        | 2030       |
| 010003   | W         | The number of device logins has reduced.                                                                                                                                                                                 | 1630       |
| 010006   | E         | A software error has occurred.                                                                                                                                                                                           | 2030       |
| 010008   | E         | The block size is invalid, the capacity or LUN identity has changed during the managed disk initialization.                                                                                                              | 1660       |
| 010010   | E         | The managed disk is excluded because of excessive errors.                                                                                                                                                                | 1310       |
| 010011   | E         | The remote port is excluded for a managed disk and node.                                                                                                                                                                 | 1220       |
| 010012   | E         | The local port is excluded.                                                                                                                                                                                              | 1210       |
| 010013   | E         | The login is excluded.                                                                                                                                                                                                   | 1230       |
| 010017   | E         | A timeout has occurred as a result of excessive processing time.                                                                                                                                                         | 1340       |
| 010018   | E         | An error recovery procedure has occurred.                                                                                                                                                                                | 1370       |
| 010019   | E         | A managed disk I/O error has occurred.                                                                                                                                                                                   | 1310       |
| 010020   | E         | The managed disk error count threshold has exceeded.                                                                                                                                                                     | 1310       |
| 010021   | E         | There are too many devices presented to the cluster.                                                                                                                                                                     | 1200       |
| 010022   | E         | There are too many managed disks presented to the cluster.                                                                                                                                                               | 1200       |
| 010023   | E         | There are too many LUNs presented to a node.                                                                                                                                                                             | 1200       |
| 010025   | W         | A disk I/O medium error has occurred.                                                                                                                                                                                    | 1320       |
| 010026   | E         | There are no managed disks that can be used as a quorum disk.                                                                                                                                                            | 1330       |
| 010027   | E         | The quorum disk is not available.                                                                                                                                                                                        | 1335       |
| 010028   | W         | A controller configuration is not supported.                                                                                                                                                                             | 1625       |
| 010029   | E         | A login transport fault has occurred.                                                                                                                                                                                    | 1360       |
| 010030   | E         | A managed disk error recovery procedure (ERP) has occurred. The node or controller reported the following: <ul style="list-style-type: none"> <li>• Sense</li> <li>• Key</li> <li>• Code</li> <li>• Qualifier</li> </ul> | 1370       |
| 010035   | W         | A quorum disk is configured on the controller that is set to not allow quorum.                                                                                                                                           | 1570       |

Table 51. Error codes (continued)

| Error ID | SNMP Type | Condition                                                                                                                                    | Error Code |
|----------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 010031   | E         | One or more MDisks on a controller are degraded.                                                                                             | 1623       |
| 010032   | W         | The controller configuration limits failover.                                                                                                | 1625       |
| 010033   | E         | The controller configuration uses the RDAC mode; this is not supported.                                                                      | 1624       |
| 010034   | E         | Persistent unsupported controller configuration.                                                                                             | 1695       |
| 010040   | E         | The controller system device is only connected to the node through a single initiator port.                                                  | 1627       |
| 010041   | E         | The controller system device is only connected to the node through a single target port.                                                     | 1627       |
| 010042   | E         | The controller system device is only connected to the cluster nodes through a single target port.                                            | 1627       |
| 010043   | E         | The controller system device is only connected to the cluster nodes through half of the expected target ports.                               | 1627       |
| 010044   | E         | The controller system device has disconnected all target ports to the cluster nodes.                                                         | 1627       |
| 020001   | E         | There are too many medium errors on the managed disk.                                                                                        | 1610       |
| 020002   | E         | A managed disk group is offline.                                                                                                             | 1620       |
| 020003   | W         | There are insufficient virtual extents.                                                                                                      | 2030       |
| 030000   | W         | The trigger prepare command has failed because of a cache flush failure.                                                                     | 1900       |
| 030010   | W         | The mapping is stopped because of the error that is indicated in the data.                                                                   | 1910       |
| 030020   | W         | The mapping is stopped because of a cluster or complete I/O group failure, and the current state of the relationship could not be recovered. | 1895       |
| 050001   | W         | The relationship is stopped because of a cluster or complete I/O group failure, and the current state of the mapping could not be recovered. | 1700       |
| 050002   | W         | A Metro Mirror or Global Mirror relationship or consistency group exists within a cluster, but its partnership has been deleted.             | 3080       |
| 050010   | W         | A Metro Mirror or Global Mirror relationship has stopped because of a persistent I/O error.                                                  | 1920       |
| 050020   | W         | A Metro Mirror or Global Mirror relationship has stopped because of an error that is not a persistent I/O error.                             | 1720       |
| 060001   | W         | The space-efficient virtual disk copy is offline because there is insufficient space.                                                        | 1865       |
| 060002   | W         | The space-efficient virtual disk copy is offline because the metadata is corrupt.                                                            | 1862       |
| 060003   | W         | The space-efficient virtual disk copy is offline because the repair has failed.                                                              | 1860       |
| 062001   | W         | Unable to mirror medium error during VDisk copy synchronization                                                                              | 1950       |
| 062002   | W         | The mirrored VDisk is offline because the data cannot be synchronized.                                                                       | 1870       |

Table 51. Error codes (continued)

| Error ID | SNMP Type | Condition                                                                                                                                                                        | Error Code |
|----------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 062003   | W         | The repair process for the mirrored disk has stopped because there is a difference between the copies.                                                                           | 1600       |
| 072001   | E         | A system board hardware failure has occurred. This error applies to only the SAN Volume Controller 2145-4F2 model.                                                               | 1020       |
| 072004   | E         | A CMOS battery failure has occurred. This error applies to the SAN Volume Controller 2145-4F2, the SAN Volume Controller 2145-8F2 and the SAN Volume Controller 2145-8F4 models. | 1670       |
| 072005   | E         | A CMOS battery failure has occurred. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                        | 1670       |
| 072006   | E         | A CMOS battery failure has occurred. This error applies to only the SAN Volume Controller 2145-8A4 model.                                                                        | 1670       |
| 072101   | E         | The processor is missing. This error applies to both the SAN Volume Controller 2145-8F2 and the SAN Volume Controller 2145-8F4 models.                                           | 1025       |
| 072102   | E         | The processor is missing. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                                   | 1025       |
| 073001   | E         | The fibre-channel adapter card has detected an incorrect number of fibre-channel adapters. This error applies to only the SAN Volume Controller 2145-4F2 model.                  | 1010       |
| 073002   | E         | The fibre-channel adapter has failed. This error applies to only the SAN Volume Controller 2145-4F2 model.                                                                       | 1050       |
| 073003   | E         | The fibre-channel ports are not operational.                                                                                                                                     | 1060       |
| 073004   | E         | The fibre-channel adapter has detected a PCI bus error. This error applies to only the SAN Volume Controller 2145-4F2 model.                                                     | 1012       |
| 073005   | E         | A cluster path failure has occurred.                                                                                                                                             | 1550       |
| 073006   | W         | The SAN is not correctly zoned. As a result, more than 512 ports on the SAN have logged into one SAN Volume Controller port.                                                     | 1800       |
| 073101   | E         | The 2-port fibre-channel adapter card in slot 1 is missing. This error applies to only the SAN Volume Controller 2145-8F2 model.                                                 | 1014       |
| 073102   | E         | The 2-port fibre-channel adapter in slot 1 has failed. This error applies to only the SAN Volume Controller 2145-8F2 model.                                                      | 1054       |
| 073104   | E         | The 2-port fibre-channel adapter in slot 1 has detected a PCI bus error. This error applies to only the SAN Volume Controller 2145-8F2 model.                                    | 1017       |
| 073201   | E         | The 2-port fibre-channel adapter in slot 2 is missing. This error applies to only the SAN Volume Controller 2145-8F2 model.                                                      | 1015       |
| 073202   | E         | The 2-port fibre-channel adapter in slot 2 has failed. This error applies to only the SAN Volume Controller 2145-8F2 model.                                                      | 1056       |
| 073204   | E         | The 2-port fibre-channel adapter in slot 2 has detected a PCI bus error. This error applies to only the SAN Volume Controller 2145-8F2 model.                                    | 1018       |

Table 51. Error codes (continued)

| Error ID | SNMP Type | Condition                                                                                                                                                                                                                                                      | Error Code |
|----------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 073251   | E         | The 4-port fibre-channel adapter in slot 1 is missing. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                                                                                    | 1011       |
| 073252   | E         | The 4-port fibre-channel adapter in slot 1 has failed. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                                                                                    | 1055       |
| 073258   | E         | The 4-port fibre-channel adapter in slot 1 has detected a PCI bus error. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                                                                  | 1013       |
| 073261   | E         | The 4-port fibre-channel adapter in slot 1 has detected a PCI bus error. This error applies to only the SAN Volume Controller 2145-8A4 model.                                                                                                                  | 1011       |
| 073262   | E         | The 4-port fibre-channel adapter in slot 1 has detected a PCI bus error. This error applies to only the SAN Volume Controller 2145-8A4 model.                                                                                                                  | 1055       |
| 073268   | E         | The 4-port fibre-channel adapter in slot 1 has detected a PCI bus error. This error applies to only the SAN Volume Controller 2145-8A4 model.                                                                                                                  | 1013       |
| 073301   | E         | The 4-port fibre-channel adapter in slot 2 is missing. This error applies to only the SAN Volume Controller 2145-8F4 model.                                                                                                                                    | 1016       |
| 073302   | E         | The 4-port fibre-channel adapter in slot 2 has failed. This error applies to only the SAN Volume Controller 2145-8F4 model.                                                                                                                                    | 1057       |
| 073304   | E         | The 4-port fibre-channel adapter in slot 2 has detected a PCI bus error. This error applies to only the SAN Volume Controller 2145-8F4 model.                                                                                                                  | 1019       |
| 073305   | E         | One or more fibre-channel ports are running at a speed that is lower than the last saved speed. This error applies to the SAN Volume Controller 2145-8F4, SAN Volume Controller 2145-8G4, and the SAN Volume Controller 2145-8A4 models.                       | 1065       |
| 073310   | E         | A duplicate fibre-channel frame has been detected, which indicates that there is an issue with the fibre-channel fabric. Other fibre-channel errors might also be generated.                                                                                   | 1203       |
| 074001   | W         | Unable to determine the vital product data (VPD) for an FRU. This is probably because a new FRU has been installed and the software does not recognize that FRU. The cluster continues to operate; however, you must upgrade the software to fix this warning. | 2040       |
| 074002   | E         | The node warm started after a software error.                                                                                                                                                                                                                  | 2030       |
| 075001   | E         | The flash boot device has failed. This error applies to the SAN Volume Controller 2145-4F2, the SAN Volume Controller 2145-8F2, and the SAN Volume Controller 2145-8F4 models.                                                                                 | 1040       |
| 075002   | E         | The flash boot device has recovered. This error applies to the SAN Volume Controller 2145-4F2, the SAN Volume Controller 2145-8F2, and the SAN Volume Controller 2145-8F4 models.                                                                              | 1040       |

Table 51. Error codes (continued)

| Error ID | SNMP Type | Condition                                                                                                                                                                                    | Error Code |
|----------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 075005   | E         | A service controller read failure has occurred. This error applies to the SAN Volume Controller 2145-4F2, the SAN Volume Controller 2145-8F2, and the SAN Volume Controller 2145-8F4 models. | 1044       |
| 075011   | E         | The flash boot device has failed. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                                       | 1040       |
| 075012   | E         | The flash boot device has recovered. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                                    | 1040       |
| 075015   | E         | A service controller read failure has occurred. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                         | 1044       |
| 075021   | E         | The flash boot device has failed. This error applies to only the SAN Volume Controller 2145-8A4 model.                                                                                       | 1040       |
| 075022   | E         | The flash boot device has recovered. This error applies to only the SAN Volume Controller 2145-8A4 model.                                                                                    | 1040       |
| 075025   | E         | A service controller read failure has occurred. This error applies to only the SAN Volume Controller 2145-8A4 model.                                                                         | 1044       |
| 076001   | E         | The internal disk for a node has failed.                                                                                                                                                     | 1030       |
| 076002   | E         | The hard disk is full and cannot capture any more output.                                                                                                                                    | 2030       |
| 077001   | E         | The system board service processor shows that fan 1 has failed. This error applies to only the SAN Volume Controller 2145-4F2 model.                                                         | 1070       |
| 077002   | E         | The system board service processor shows that fan 2 has failed. This error applies to only the SAN Volume Controller 2145-4F2 model.                                                         | 1070       |
| 077003   | E         | The system board service processor shows that fan 3 has failed. This error applies to only the SAN Volume Controller 2145-4F2 model.                                                         | 1070       |
| 077004   | E         | The system board service processor shows that fan 4 has failed. This error applies to only the SAN Volume Controller 2145-4F2 model.                                                         | 1070       |
| 077005   | E         | The system board service processor shows that fan 5 has failed. This error applies to only the SAN Volume Controller 2145-4F2 model.                                                         | 1071       |
| 077011   | E         | The system board service processor shows that the ambient temperature threshold has exceeded. This error applies to only the SAN Volume Controller 2145-4F2 model.                           | 1075       |
| 077012   | E         | The system board service processor shows that temperature warning threshold has exceeded. This error applies to only the SAN Volume Controller 2145-4F2 model.                               | 1076       |
| 077013   | E         | The system board service processor shows that the soft or hard shutdown temperature threshold has exceeded. This error applies to only the SAN Volume Controller 2145-4F2 model.             | 1077       |
| 077021   | E         | The system board service processor shows that Voltage 1, (12 volt) is outside the set thresholds. This error applies to only the SAN Volume Controller 2145-4F2 model.                       | 1080       |



Table 51. Error codes (continued)

| Error ID | SNMP Type | Condition                                                                                                                                                                   | Error Code |
|----------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 077022   | E         | The system board service processor shows that Voltage 2, (5 volt) is outside the set thresholds. This error applies to only the SAN Volume Controller 2145-4F2 model.       | 1080       |
| 077023   | E         | The system board service processor shows that Voltage 3, (3.3 volt) is outside the set thresholds. This error applies to only the SAN Volume Controller 2145-4F2 model.     | 1080       |
| 077024   | E         | The system board service processor shows that Voltage 4, (2.5 volt) is outside the set thresholds. This error applies to only the SAN Volume Controller 2145-4F2 model.     | 1081       |
| 077025   | E         | The system board service processor shows that Voltage 5, (1.5 volt) is outside the set thresholds. This error applies to only the SAN Volume Controller 2145-4F2 model.     | 1081       |
| 077026   | E         | The system board service processor shows that Voltage 6, (1.25 volt) is outside the set thresholds. This error applies to only the SAN Volume Controller 2145-4F2 model.    | 1081       |
| 077027   | E         | The system board service processor shows that Voltage 7, (CPU volts) is outside the set thresholds. This error applies to only the SAN Volume Controller 2145-4F2 model.    | 1081       |
| 077101   | E         | The service processor shows a fan 40×40×28 failure. This error applies to both the SAN Volume Controller 2145-8F2 and the SAN Volume Controller 2145-8F4 models.            | 1090       |
| 077102   | E         | The service processor shows a fan 40×40×56 failure. This error applies to both the SAN Volume Controller 2145-8F2 and the SAN Volume Controller 2145-8F4 models.            | 1091       |
| 077105   | E         | The service processor shows a fan failure. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                             | 1089       |
| 077106   | E         | The service processor shows a fan failure. This error applies to only the SAN Volume Controller 2145-8A4 model.                                                             | 1089       |
| 077111   | E         | The node ambient temperature threshold has exceeded. This error applies to both the SAN Volume Controller 2145-8F2 and the SAN Volume Controller 2145-8F4 models.           | 1094       |
| 077112   | E         | The node processor warning temperature threshold has exceeded. This error applies to both the SAN Volume Controller 2145-8F2 and the SAN Volume Controller 2145-8F4 models. | 1093       |
| 077113   | E         | The node processor or ambient critical threshold has exceeded. This error applies to both the SAN Volume Controller 2145-8F2 and the SAN Volume Controller 2145-8F4 models. | 1092       |
| 077121   | E         | System board - any voltage high. This error applies to both the SAN Volume Controller 2145-8F2 and the SAN Volume Controller 2145-8F4 models.                               | 1100       |
| 077124   | E         | System board - any voltage low. This error applies to both the SAN Volume Controller 2145-8F2 and the SAN Volume Controller 2145-8F4 models.                                | 1105       |
| 077128   | E         | A power management board voltage failure has occurred. This error applies to both the SAN Volume Controller 2145-8F2 and the SAN Volume Controller 2145-8F4 models.         | 1110       |

Table 51. Error codes (continued)

| Error ID | SNMP Type | Condition                                                                                                                                                                                                | Error Code |
|----------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 077161   | E         | The node ambient temperature threshold has exceeded. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                                | 1094       |
| 077162   | E         | The node processor warning temperature threshold has exceeded. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                      | 1093       |
| 077163   | E         | The node processor or ambient critical threshold has exceeded. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                      | 1092       |
| 077165   | E         | The node ambient temperature threshold has exceeded. This error applies to only the SAN Volume Controller 2145-8A4 model.                                                                                | 1094       |
| 077166   | E         | The node processor warning temperature threshold has exceeded. This error applies to only the SAN Volume Controller 2145-8A4 model.                                                                      | 1093       |
| 077167   | E         | The node processor or ambient critical threshold has exceeded. This error applies to only the SAN Volume Controller 2145-8A4 model.                                                                      | 1092       |
| 077171   | E         | System board - any voltage high. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                                                    | 1101       |
| 077172   | E         | System board - any voltage high. This error applies to only the SAN Volume Controller 2145-8A4 model.                                                                                                    | 1101       |
| 077174   | E         | System board - any voltage low. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                                                     | 1106       |
| 077175   | E         | System board - any voltage low. This error applies to only the SAN Volume Controller 2145-8A4 model.                                                                                                     | 1106       |
| 077178   | E         | A power management board voltage failure has occurred. This error applies to only the SAN Volume Controller 2145-8G4 model.                                                                              | 1110       |
| 078001   | E         | A power domain error has occurred. Both nodes in a pair are powered by the same uninterruptible power supply.                                                                                            | 1155       |
| 079000   | W         | Data has not been recovered on virtual disks (VDisks).                                                                                                                                                   | 1850       |
| 079500   | W         | The limit on the number of cluster secure shell (SSH) sessions has been reached.                                                                                                                         | 2500       |
| 079501   | W         | Unable to access the Network Time Protocol (NTP) network time server.                                                                                                                                    | 2700       |
| 081001   | E         | An Ethernet port failure has occurred.                                                                                                                                                                   | 1400       |
| 082001   | E         | A server error has occurred.                                                                                                                                                                             | 2100       |
| 083001   | E         | An uninterruptible power supply communications failure has occurred. The RS232 connection between a node and its uninterruptible power supply is faulty. This error applies to only the 2145 UPS model.  | 1145       |
| 083002   | E         | The uninterruptible power supply output is unexpectedly high. The uninterruptible power supply is probably connected to a non-SAN Volume Controller load. This error applies to only the 2145 UPS model. | 1165       |
| 083003   | E         | The uninterruptible power supply battery has reached end of life. This error applies to only the 2145 UPS model.                                                                                         | 1190       |

Table 51. Error codes (continued)

| Error ID | SNMP Type | Condition                                                                                                                                                                                                   | Error Code |
|----------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 083004   | E         | An uninterruptible power supply battery failure has occurred. This error applies to only the 2145 UPS model.                                                                                                | 1180       |
| 083005   | E         | An uninterruptible power supply electronics failure has occurred. This error applies to only the 2145 UPS model.                                                                                            | 1170       |
| 083006   | E         | Uninterruptible power supply frame fault                                                                                                                                                                    | 1175       |
| 083007   | E         | Uninterruptible power supply frame fault overcurrent. This error applies to only the 2145 UPS model.                                                                                                        | 1160       |
| 083008   | E         | An uninterruptible power supply failure has occurred. This error applies to only the 2145 UPS model.                                                                                                        | 1185       |
| 083009   | E         | Uninterruptible power supply ac input power fault. This error applies to only the 2145 UPS model.                                                                                                           | 1140       |
| 083010   | E         | An uninterruptible power supply configuration error has occurred. This error applies to only the 2145 UPS model.                                                                                            | 1150       |
| 083011   | E         | Uninterruptible power supply ambient over temperature. This error applies to only the 2145 UPS model.                                                                                                       | 1135       |
| 083012   | E         | Uninterruptible power supply over temperature warning. This error applies to only the 2145 UPS model.                                                                                                       | 3000       |
| 083013   | E         | The cross cable test was bypassed because of an internal uninterruptible power supply software error. This error applies to only the 2145 UPS model.                                                        | 3010       |
| 083101   | E         | An uninterruptible power supply communications failure has occurred. The RS232 connection between a node and its uninterruptible power supply is faulty. This error applies to only the 2145 UPS-1U model.  | 1146       |
| 083102   | E         | The uninterruptible power supply output is unexpectedly high. The uninterruptible power supply is probably connected to a non-SAN Volume Controller load. This error applies to only the 2145 UPS-1U model. | 1166       |
| 083103   | E         | The uninterruptible power supply battery has reached end of life. This error applies to only the 2145 UPS-1U model.                                                                                         | 1191       |
| 083104   | E         | An uninterruptible power supply battery failure has occurred. This error applies to only the 2145 UPS-1U model.                                                                                             | 1181       |
| 083105   | E         | An uninterruptible power supply electronics failure has occurred. This error applies to only the 2145 UPS-1U model.                                                                                         | 1171       |
| 083107   | E         | Uninterruptible power supply overcurrent. This error applies to only the 2145 UPS-1U model.                                                                                                                 | 1161       |
| 083108   | E         | An uninterruptible power supply failure has occurred. This error applies to only the 2145 UPS-1U model.                                                                                                     | 1186       |
| 083109   | E         | Uninterruptible power supply ac input power fault. This error applies to only the 2145 UPS-1U model.                                                                                                        | 1141       |
| 083110   | E         | An uninterruptible power supply configuration error has occurred. This error applies to only the 2145 UPS-1U model.                                                                                         | 1151       |
| 083111   | E         | Uninterruptible power supply ambient over temperature. This error applies to only the 2145 UPS-1U model.                                                                                                    | 1136       |
| 083112   | E         | Uninterruptible power supply over temperature warning. This error applies to only the 2145 UPS-1U model.                                                                                                    | 3001       |

Table 51. Error codes (continued)

| Error ID | SNMP Type | Condition                                                                                                                                | Error Code |
|----------|-----------|------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 083113   | E         | An uninterruptible power supply software error has occurred. This error applies to only the 2145 UPS-1U model.                           | 3011       |
| 010012   | E         | A local port on the 4-port fibre-channel adapter has been excluded. This error applies to only the SAN Volume Controller 2145-8A4 model. | 1210       |
| 081001   | E         | An Ethernet connection error has occurred. This error applies to only the SAN Volume Controller 2145-8A4 model.                          | 1400       |

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## Appendix B. Event codes

The system generates information and configuration event codes.

There are two different types of event codes:

- Information event codes
- Configuration event codes

Information event codes provide information on the status of an operation. Information event codes are recorded in the error log and an SNMP trap is raised.

Configuration event codes are generated when configuration parameters are set. Configuration event codes are recorded in a separate log and do not raise SNMP traps. Their error fixed flags are ignored.

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### Information event codes

The information event codes provide information on the status of an operation.

Information event codes are recorded in the error log and, if configured, an SNMP trap is raised and an e-mail is sent.

Information event codes can be either SNMP trap type I (information) or type W (warning). You can use the SNMP trap type that is included in the e-mail to determine if the information event was caused by an expected or unexpected condition. An information event report of type (W) might require user attention. Table 52 provides a list of information event codes, the SNMP type, and the meaning of the event code.

*Table 52. Information event codes*

| Event code | SNMP Type | Description                                                                       |
|------------|-----------|-----------------------------------------------------------------------------------|
| 980221     | I         | The error log is cleared.                                                         |
| 980310     | I         | A degraded or offline managed disk group is now online.                           |
| 980435     | W         | Failed to obtain directory listing from remote node.                              |
| 980440     | W         | Failed to transfer file from remote node.                                         |
| 980446     | I         | The secure delete is complete.                                                    |
| 980501     | W         | The virtualization amount is close to the limit that is licensed.                 |
| 980502     | W         | The FlashCopy feature is close to the limit that is licensed.                     |
| 980503     | W         | The Metro Mirror or Global Mirror feature is close to the limit that is licensed. |
| 981001     | W         | The cluster fabric view has been updated by a multiphase discovery.               |
| 981007     | W         | The managed disk is not on the preferred path.                                    |

Table 52. Information event codes (continued)

| Event code | SNMP Type | Description                                                                                                                                                                                  |
|------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 981014     | W         | The LUN discovery has failed. The cluster has a connection to a device through this node but this node cannot discover the unmanaged or managed disk that is associated with this LUN.       |
| 981015     | W         | The LUN capacity equals or exceeds the maximum. Only the first 2 TB of the disk can be accessed.                                                                                             |
| 981020     | W         | The managed disk error count warning threshold has been met.                                                                                                                                 |
| 981022     | I         | Managed disk view smoothing start                                                                                                                                                            |
| 982003     | W         | Insufficient virtual extents.                                                                                                                                                                |
| 982004     | W         | The migration suspended because of insufficient virtual extents or too many media errors on the source managed disk.                                                                         |
| 982007     | W         | Migration has stopped.                                                                                                                                                                       |
| 982009     | I         | Migration is complete.                                                                                                                                                                       |
| 982010     | W         | Copied disk I/O medium error.                                                                                                                                                                |
| 983001     | I         | The FlashCopy is prepared.                                                                                                                                                                   |
| 983002     | I         | The FlashCopy is complete.                                                                                                                                                                   |
| 983003     | W         | The FlashCopy has stopped.                                                                                                                                                                   |
| 984001     | W         | First customer data being pinned in a virtual disk working set.                                                                                                                              |
| 984002     | I         | All customer data in a virtual disk working set is now unpinned.                                                                                                                             |
| 984003     | W         | The virtual disk working set cache mode is in the process of changing to synchronous destage because the virtual disk working set has too much pinned data.                                  |
| 984004     | I         | Virtual disk working set cache mode now allows asynchronous destage because enough customer data has now been unpinned for that virtual disk working set.                                    |
| 985001     | I         | The Metro Mirror or Global Mirror background copy is complete.                                                                                                                               |
| 985002     | I         | The Metro Mirror or Global Mirror is ready to restart.                                                                                                                                       |
| 985003     | W         | Unable to find path to disk in the remote cluster within the timeout period.                                                                                                                 |
| 986001     | W         | The space-efficient virtual disk copy data in a node is pinned.                                                                                                                              |
| 986002     | I         | All space-efficient virtual disk copy data in a node is unpinned.                                                                                                                            |
| 986010     | I         | The space-efficient virtual disk (VDisk) copy import has failed and the new VDisk is offline; either upgrade the SAN Volume Controller software to the required version or delete the VDisk. |
| 986011     | I         | The space-efficient virtual disk copy import is successful.                                                                                                                                  |
| 986020     | W         | A space-efficient virtual disk copy space warning has occurred.                                                                                                                              |
| 986030     | I         | A space-efficient virtual disk copy repair has started.                                                                                                                                      |

Table 52. Information event codes (continued)

| Event code | SNMP Type | Description                                                                                                                                                                                                                                                 |
|------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 986031     | I         | A space-efficient virtual disk copy repair is successful.                                                                                                                                                                                                   |
| 986032     | I         | A space-efficient virtual disk copy validation is started.                                                                                                                                                                                                  |
| 986033     | I         | A space-efficient virtual disk copy validation is successful.                                                                                                                                                                                               |
| 986201     | I         | A medium error has been repaired for the mirrored copy.                                                                                                                                                                                                     |
| 986203     | W         | A mirror copy repair, using the validate option cannot complete.                                                                                                                                                                                            |
| 986204     | I         | A mirror disk repair is complete and no differences are found.                                                                                                                                                                                              |
| 986205     | I         | A mirror disk repair is complete and the differences are resolved.                                                                                                                                                                                          |
| 986206     | W         | A mirror disk repair is complete and the differences are set to medium errors.                                                                                                                                                                              |
| 986207     | I         | The mirror disk repair has been started.                                                                                                                                                                                                                    |
| 986208     | W         | A mirror copy repair, using the set medium error option, cannot complete.                                                                                                                                                                                   |
| 986209     | W         | A mirror copy repair, using the resync option, cannot complete.                                                                                                                                                                                             |
| 987102     | W         | A node power-off has been requested from the power switch.                                                                                                                                                                                                  |
| 987103     | W         | Coldstart.                                                                                                                                                                                                                                                  |
| 987301     | W         | The connection to a configured remote cluster has been lost.                                                                                                                                                                                                |
| 987400     | W         | The node unexpectedly lost power but has now been restored to the cluster.                                                                                                                                                                                  |
| 988100     | W         | An overnight maintenance procedure has failed to complete. Resolve any hardware and configuration problems that you are experiencing on the SAN Volume Controller cluster. If the problem persists, contact your IBM service representative for assistance. |
| 989001     | W         | A managed disk group space warning has occurred.                                                                                                                                                                                                            |

## Configuration event codes

Configuration event codes are generated when configuration parameters are set.

Configuration event codes are recorded in a separate log. They do not raise SNMP traps or send e-mails. Their error fixed flags are ignored. Table 53 provides a list of the configuration event codes and their meanings.

Table 53. Configuration event codes

| Event code | Description                                                               |
|------------|---------------------------------------------------------------------------|
| 990101     | Modify cluster (attributes in the <code>svctask chcluster</code> command) |
| 990102     | The e-mail test completed successfully                                    |
| 990103     | The e-mail test failed                                                    |

Table 53. Configuration event codes (continued)

| Event code | Description                                                                                          |
|------------|------------------------------------------------------------------------------------------------------|
| 990105     | Delete node from cluster (attributes in the <b>svctask rmnode</b> command)                           |
| 990106     | Create host (attributes in the <b>svctask mkhost</b> command)                                        |
| 990112     | Cluster configuration dumped to file (attributes from the <b>svcluster -x dumpconfig</b> command)    |
| 990117     | Create cluster (attributes in the <b>svctask mkcluster</b> command)                                  |
| 990118     | Modify node (attributes in the <b>svctask chnode</b> command)                                        |
| 990119     | Configure set controller name                                                                        |
| 990120     | Shut down node (attributes in the <b>svctask stopcluster</b> command)                                |
| 990128     | Modify host (attributes in the <b>svctask chhost</b> command)                                        |
| 990129     | Delete node (attributes in the <b>svctask rmnode</b> command)                                        |
| 990138     | Virtual disk modify (attributes in the <b>svctask chvdisk</b> command)                               |
| 990140     | Virtual disk delete (attributes in the <b>svctask rmvdisk</b> command)                               |
| 990144     | Modify managed disk group (attributes in the <b>svctask chmdiskgrp</b> command)                      |
| 990145     | Delete managed disk group (attributes in the <b>svctask rmdiskgrp</b> command)                       |
| 990148     | Create managed disk group (attributes in the <b>svctask mkmdiskgrp</b> command)                      |
| 990149     | Modify managed disk (attributes in the <b>svctask chmdisk</b> command)                               |
| 990150     | Modify managed disk                                                                                  |
| 990158     | Managed disk included                                                                                |
| 990159     | Quorum created                                                                                       |
| 990160     | Quorum destroy                                                                                       |
| 990168     | Modify the I/O group a virtual disk is assigned to                                                   |
| 990169     | Create a new virtual disk (attributes in the <b>svctask mkvdisk</b> command)                         |
| 990173     | Add a managed disk to managed disk group (attributes in the <b>svctask addmdisk</b> command)         |
| 990174     | Delete a managed disk from managed disk group (attributes in the <b>svctask rmdisk</b> command)      |
| 990178     | Add a port to a Host (attributes in the <b>svctask addhostport</b> command)                          |
| 990179     | Delete a port from a Host (attributes in the <b>svctask rmhostport</b> command)                      |
| 990182     | Create a virtual disk to Host SCSI mapping (attributes in the <b>svctask mkvdiskhostmap</b> command) |
| 990183     | Delete an virtual disk to Host SCSI mapping (attributes in the <b>svctask rmdiskhostmap</b> command) |
| 990184     | Create a FlashCopy mapping (attributes in the <b>svctask mkfcmap</b> command)                        |
| 990185     | Modify a FlashCopy mapping (attributes in the <b>svctask chfcmap</b> command)                        |



Table 53. Configuration event codes (continued)

| Event code | Description                                                                                                                     |
|------------|---------------------------------------------------------------------------------------------------------------------------------|
| 990186     | Delete a FlashCopy mapping (attributes in the <b>svctask rmfcmap</b> command)                                                   |
| 990187     | Prepare a FlashCopy mapping (attributes in the <b>svctask prestartfcmap</b> command)                                            |
| 990188     | Prepare a FlashCopy consistency group (attributes in the <b>svctask prestartfcconsistgrp</b> command)                           |
| 990189     | Trigger a FlashCopy mapping (attributes in the <b>svctask startfcmap</b> command)                                               |
| 990190     | Trigger a FlashCopy consistency group (attributes in the <b>svctask startfcconsistgrp</b> command)                              |
| 990191     | Stop a FlashCopy mapping (attributes in the <b>svctask stopfcmap</b> command)                                                   |
| 990192     | Stop a FlashCopy consistency group (attributes in the <b>svctask stopfcconsistgrp</b> command)                                  |
| 990193     | FlashCopy set name                                                                                                              |
| 990194     | Delete a list of ports from a Host (attributes in the <b>svctask rmhostport</b> command)                                        |
| 990196     | Shrink a virtual disk.                                                                                                          |
| 990197     | Expand a virtual disk (attributes in the <b>svctask expandvdisksize</b> command)                                                |
| 990198     | Expand single extent a virtual disk                                                                                             |
| 990199     | Modify the I/O governing rate for a virtual disk                                                                                |
| 990203     | Initiate manual managed disk discovery (attributes in the <b>svctask detectmdisk</b> command)                                   |
| 990204     | Create FlashCopy consistency group (attributes in the <b>svctask mkfcconsistgrp</b> command)                                    |
| 990205     | Modify FlashCopy consistency group (attributes in the <b>svctask chfcconsistgrp</b> command)                                    |
| 990206     | Delete FlashCopy consistency group (attributes in the <b>svctask rmfcconsistgrp</b> command)                                    |
| 990207     | Delete a list of Hosts (attributes in the <b>svctask rmhost</b> command)                                                        |
| 990213     | Change the I/O group a node belongs to (attributes in the <b>svctask chiogrp</b> command)                                       |
| 990216     | Apply software upgrade (attributes in the <b>svcservicetask applysoftware</b> command)                                          |
| 990219     | Analyze error log (attributes in the <b>svctask finderr</b> command)                                                            |
| 990220     | Dump error log (attributes in the <b>svctask dumperrlog</b> command)                                                            |
| 990222     | Fix error log entry (attributes in the <b>svctask cherrstate</b> command)                                                       |
| 990223     | Migrate a single extent (attributes in the <b>svctask migrateexts</b> command)                                                  |
| 990224     | Migrate a number of extents                                                                                                     |
| 990225     | Create a Metro Mirror or Global Mirror or Global Mirror relationship (attributes in the <b>svctask mkrrelationship</b> command) |
| 990226     | Modify a Metro Mirror or Global Mirror relationship (attributes in the <b>svctask chrrelationship</b> command)                  |

Table 53. Configuration event codes (continued)

| Event code | Description                                                                                                            |
|------------|------------------------------------------------------------------------------------------------------------------------|
| 990227     | Delete a Metro Mirror or Global Mirror relationship (attributes in the <b>svctask rmrrelationship</b> command)         |
| 990229     | Start a Metro Mirror or Global Mirror relationship (attributes in the <b>svctask startcrrelationship</b> command)      |
| 990230     | Stop a Metro Mirror or Global Mirror relationship (attributes in the <b>svctask stopcrrelationship</b> command)        |
| 990231     | Switch a Metro Mirror or Global Mirror relationship (attributes in the <b>svctask switchcrrelationship</b> command)    |
| 990232     | Start a Metro Mirror or Global Mirror consistency group (attributes in the <b>svctask startcrconsistgrp</b> command)   |
| 990233     | Stop a Metro Mirror or Global Mirror consistency group (attributes in the <b>svctask stopcrconsistgrp</b> command)     |
| 990234     | Switch a Metro Mirror or Global Mirror consistency group (attributes in the <b>svctask switchcrconsistgrp</b> command) |
| 990235     | Managed disk migrated to a managed disk group                                                                          |
| 990236     | Virtual disk migrated to a new managed disk                                                                            |
| 990237     | Create partnership with remote cluster (attributes in the <b>svctask mkpartnership</b> command)                        |
| 990238     | Modify partnership with remote cluster (attributes in the <b>svctask chpartnership</b> command)                        |
| 990239     | Delete partnership with remote cluster (attributes in the <b>svctask rmpartnership</b> command)                        |
| 990240     | Create a Metro Mirror or Global Mirror consistency group (attributes in the <b>svctask mkrconsistgrp</b> command)      |
| 990241     | Modify a Metro Mirror or Global Mirror consistency group (attributes in <b>svctask chrconsistgrp</b> )                 |
| 990242     | Delete a Metro Mirror or Global Mirror consistency group (attributes in the <b>svctask rmrconsistgrp</b> command)      |
| 990245     | Node pend                                                                                                              |
| 990246     | Node remove                                                                                                            |
| 990247     | Node unpend                                                                                                            |
| 990380     | Time zone changed (attributes in the <b>svctask settimezone</b> command)                                               |
| 990383     | Change cluster time (attributes in the <b>svctask setclustertime</b> command)                                          |
| 990385     | System time changed                                                                                                    |
| 990386     | SSH key added (attributes in the <b>svctask addsshkey</b> command)                                                     |
| 990387     | SSH key removed (attributes in the <b>svctask rmsshkey</b> command)                                                    |
| 990388     | All SSH keys removed (attributes in the <b>svctask rmallsshkeys</b> command)                                           |
| 990390     | Add node to the cluster                                                                                                |
| 990395     | Shutdown or reset node                                                                                                 |
| 990410     | The software installation has started.                                                                                 |
| 990415     | The software installation has completed.                                                                               |
| 990420     | The software installation has failed.                                                                                  |

Table 53. Configuration event codes (continued)

| Event code | Description                                                                 |
|------------|-----------------------------------------------------------------------------|
| 990423     | The software installation has stalled.                                      |
| 990425     | The software installation has stopped.                                      |
| 990430     | The Planar Serial Number has changed.                                       |
| 990501     | The licensed feature has changed. See the license settings log for details. |
| 990510     | The configuration limits have been changed.                                 |
| 991024     | I/O tracing has finished and the managed disk has been triggered.           |
| 991025     | The autoexpand setting of the VDisk has been modified.                      |
| 991026     | The primary copy of the VDisk has been modified.                            |
| 991027     | The VDisk synchronization rate has been modified.                           |
| 991028     | The space-efficient VDisk warning capacity has been modified.               |
| 991029     | A mirrored copy has been added to a VDisk.                                  |
| 991030     | A repair of mirrored VDisk copies has started.                              |
| 991031     | A VDisk copy has been split from a mirrored VDisk.                          |
| 991032     | A VDisk copy has been removed from a mirrored VDisk.                        |



---

## Appendix C. SCSI error reporting

SAN Volume Controller nodes can notify their hosts of errors for SCSI commands that are issued.

### SCSI status

Some errors are part of the SCSI architecture and are handled by the host application or device drivers without reporting an error. Some errors, such as read and write I/O errors and errors that are associated with the loss of nodes or loss of access to backend devices, cause application I/O to fail. To help troubleshoot these errors, SCSI commands are returned with the Check Condition status and a 32-bit event identifier is included with the sense information. The identifier relates to a specific error in the SAN Volume Controller cluster error log.

If the host application or device driver captures and stores this error information, you can relate the application failure to the error log.

Table 54 describes the SCSI status and codes that are returned by the SAN Volume Controller nodes.

Table 54. SCSI status

| Status                       | Code | Description                                                                                                                                                                                                                    |
|------------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Good                         | 00h  | The command was successful.                                                                                                                                                                                                    |
| Check condition              | 02h  | The command failed and sense data is available.                                                                                                                                                                                |
| Condition met                | 04h  | N/A                                                                                                                                                                                                                            |
| Busy                         | 08h  | An Auto-Contingent Allegiance condition exists and the command specified NACA=0.                                                                                                                                               |
| Intermediate                 | 10h  | N/A                                                                                                                                                                                                                            |
| Intermediate - condition met | 14h  | N/A                                                                                                                                                                                                                            |
| Reservation conflict         | 18h  | Returned as specified in SPC2 and SAM2 where a reserve or persistent reserve condition exists.                                                                                                                                 |
| Task set full                | 28h  | The initiator has at least one task queued for that LUN on this port.                                                                                                                                                          |
| ACA active                   | 30h  | This is reported as specified in SAM-2.                                                                                                                                                                                        |
| Task aborted                 | 40h  | This is returned if TAS is set in the control mode page 0Ch. The SAN Volume Controller node has a default setting of TAS=0, which is cannot be changed; therefore, the SAN Volume Controller node does not report this status. |

### SCSI Sense

SAN Volume Controller nodes notify the hosts of errors on SCSI commands. Table 55 on page 424 defines the SCSI sense keys, codes and qualifiers that are returned by the SAN Volume Controller nodes.

Table 55. SCSI sense keys, codes, and qualifiers

| Key | Code | Qualifier | Definition                                                                    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----|------|-----------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2h  | 04h  | 01h       | Not Ready. The logical unit is in the process of becoming ready.              | The node lost sight of the cluster and cannot perform I/O operations. The additional sense does not have additional information.                                                                                                                                                                                                                                                                                                                                                                          |
| 2h  | 04h  | 0Ch       | Not Ready. The target port is in the state of unavailable.                    | The following conditions are possible: <ul style="list-style-type: none"> <li>• The node lost sight of the cluster and cannot perform I/O operations. The additional sense does not have additional information.</li> <li>• The node is in contact with the cluster but cannot perform I/O operations to the specified logical unit because of either a loss of connectivity to the backend controller or some algorithmic problem. This sense is returned for offline virtual disks (VDisks).</li> </ul> |
| 3h  | 00h  | 00h       | Medium error                                                                  | This is only returned for read or write I/Os. The I/O suffered an error at a specific LBA within its scope. The location of the error is reported within the sense data. The additional sense also includes a reason code that relates the error to the corresponding error log entry. For example, a RAID controller error or a migrated medium error.                                                                                                                                                   |
| 4h  | 08h  | 00h       | Hardware error. A command to logical unit communication failure has occurred. | The I/O suffered an error that is associated with an I/O error that is returned by a RAID controller. The additional sense includes a reason code that points to the sense data that is returned by the controller. This is only returned for I/O type commands. This error is also returned from FlashCopy target VDisks in the prepared and preparing state.                                                                                                                                            |
| 5h  | 25h  | 00h       | Illegal request. The logical unit is not supported.                           | The logical unit does not exist or is not mapped to the sender of the command.                                                                                                                                                                                                                                                                                                                                                                                                                            |

## Reason codes

The reason code appears in bytes 20-23 of the sense data. The reason code provides the SAN Volume Controller node specific log entry. The field is a 32-bit unsigned

number that is presented with the most significant byte first. Table 56 lists the reason codes and their definitions.

If the reason code is not listed in Table 56, the code refers to a specific error in the SAN Volume Controller cluster error log that corresponds to the sequence number of the relevant error log entry.

*Table 56. Reason codes*

| Reason code (decimal) | Description                                                                                                                                                                                      |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 40                    | The resource is part of a stopped FlashCopy mapping.                                                                                                                                             |
| 50                    | The resource is part of a Metro Mirror or Global Mirror relationship and the secondary LUN is the offline.                                                                                       |
| 51                    | The resource is part of a Metro Mirror or Global Mirror and the secondary LUN is read only.                                                                                                      |
| 60                    | The node is offline.                                                                                                                                                                             |
| 71                    | The resource is not bound to any domain.                                                                                                                                                         |
| 72                    | The resource is bound to a domain that has been recreated.                                                                                                                                       |
| 73                    | Running on a node that has been contracted out for some reason that is not attributable to any path going offline.                                                                               |
| 80                    | Wait for the repair to complete, or delete the virtual disk.                                                                                                                                     |
| 81                    | Wait for the validation to complete, or delete the virtual disk.                                                                                                                                 |
| 82                    | An offline space-efficient VDisk has caused data to be pinned in the directory cache. Adequate performance cannot be achieved for other space-efficient VDIsks, so they have been taken offline. |
| 85                    | The VDisk has been taken offline because checkpointing to the quorum disk failed.                                                                                                                |
| 86                    | The <b>svctask repairvdiskcopy -medium</b> command has created a virtual medium error where the copies differed.                                                                                 |





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## Appendix D. Object types

You can use the object code to determine the object type.

Table 57 lists the object codes and corresponding object types.

*Table 57. Object types*

| Object code | Object type     |
|-------------|-----------------|
| 1           | mdisk           |
| 2           | mdiskgrp        |
| 3           | vdisk           |
| 4           | node            |
| 5           | host            |
| 7           | iogroup         |
| 8           | fcgrp           |
| 9           | rcgrp           |
| 10          | fcmap           |
| 11          | rcmap           |
| 12          | wwpn            |
| 13          | cluster         |
| 15          | hba             |
| 16          | device          |
| 17          | SCSI lun        |
| 18          | quorum          |
| 19          | time seconds    |
| 20          | ExtSInst        |
| 21          | ExtInst         |
| 22          | percentage      |
| 23          | system board    |
| 24          | processor       |
| 25          | processor cache |
| 26          | memory module   |
| 27          | fan             |
| 28          | fc card         |
| 29          | fc device       |
| 30          | software        |
| 31          | front panel     |
| 32          | ups             |
| 33          | port            |
| 34          | adapter         |
| 35          | migrate         |

Table 57. Object types (continued)

| Object code | Object type |
|-------------|-------------|
| 36          | count       |
| 37          | e-mail      |
| 38          | VDisk copy  |

---

## Accessibility

Accessibility features help a user who has a physical disability, such as restricted mobility or limited vision, to use software products successfully.

### Features

These are the major accessibility features in the SAN Volume Controller Console:

- You can use screen-reader software and a digital speech synthesizer to hear what is displayed on the screen. The following screen reader has been tested: Window-Eyes v6.1.
- You can operate all features using the keyboard instead of the mouse.
- You can change the initial delay and repeat rate of the up and down buttons to two seconds when you use the front panel of the SAN Volume Controller to set or change an IPv4 address. This feature is documented in the applicable sections of the SAN Volume Controller publications.

### Navigating by keyboard

You can use keys or key combinations to perform operations and initiate many menu actions that can also be done through mouse actions. You can navigate the SAN Volume Controller Console and help system from the keyboard by using the following key combinations:

- To traverse to the next link, button, or topic, press Tab inside a frame (page).
- To expand or collapse a tree node, press → or ←, respectively.
- To move to the next topic node, press V or Tab.
- To move to the previous topic node, press ^ or Shift+Tab.
- To scroll all the way up or down, press Home or End, respectively.
- To go back, press Alt+←.
- To go forward, press Alt+→.
- To go to the next frame, press Ctrl+Tab.
- To move to the previous frame, press Shift+Ctrl+Tab.
- To print the current page or active frame, press Ctrl+P.
- To select, press Enter.

### Accessing the publications

You can view the publications for the SAN Volume Controller in Adobe Portable Document Format (PDF) using the Adobe Acrobat Reader. The PDFs are provided at the following Web site:

[www.ibm.com/storage/support/2145](http://www.ibm.com/storage/support/2145)

#### Related reference

“SAN Volume Controller library and related publications” on page xvii

A list of other publications that are related to this product are provided to you for your reference.



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## Glossary

This glossary includes terms for the IBM System Storage SAN Volume Controller.

This glossary includes selected terms and definitions from A Dictionary of Storage Networking Terminology ([www.snia.org/education/dictionary](http://www.snia.org/education/dictionary)), copyrighted 2001 by the Storage Networking Industry Association, 2570 West El Camino Real, Suite 304, Mountain View, California 94040-1313. Definitions derived from this book have the symbol (S) after the definition.

The following cross-references are used in this glossary:

**See** Refers the reader to one of two kinds of related information:

- A term that is the expanded form of an abbreviation or acronym. This expanded form of the term contains the full definition.
- A synonym or more preferred term.

**See also**

Refers the reader to one or more related terms.

**Contrast with**

Refers the reader to a term that has an opposite or substantively different meaning.

### Numerics

**2145** A hardware machine type for the IBM System Storage SAN Volume Controller. Models of the SAN Volume Controller are expressed as the number 2145 followed by "-xxx", such as 2145-8G4. Hardware models for the 2145 include 2145-4F2, 2145-8F2, 2145-8F4, 2145-8G4, and 2145-8A4.

### A

**access mode**

One of three different modes in which a logical unit (LU) in a disk controller system can operate. See also *image mode*, *managed space mode*, and *unconfigured mode*.

**Address Resolution Protocol (ARP)**

A protocol that dynamically maps an IP address to a network adapter address in a local area network.

**agent code**

An open-systems standard that interprets Common Information Model (CIM) requests and responses as they transfer between the client application and the device.

**application server**

A host that is attached to the storage area network (SAN) and that runs applications.

**ARP** See *Address Resolution Protocol*.

**array** An ordered collection, or group, of physical storage devices that are used to define logical volumes or devices.

**association**

A class that contains two references that define a relationship between two referenced objects.

**asymmetric virtualization**

A virtualization technique in which the virtualization engine is outside the data path and performs a metadata-style service. The metadata server contains all the mapping and locking tables while the storage devices contain only data. See also *symmetric virtualization*.

**auxiliary virtual disk**

The virtual disk that contains a backup copy of the data and that is used in disaster recovery scenarios. See also *master virtual disk*.

**availability**

The ability of a system to continue working, with perhaps a decrease in performance, after individual components fail.

**B****bandwidth**

The range of frequencies an electronic system can transmit or receive. The greater the bandwidth of a system, the more information the system can transfer in a given period of time.

**bitmap**

A coded representation in which each bit, or group of bits, represents or corresponds to an item; for example, a configuration of bits in main storage in which each bit indicates whether a peripheral device or a storage block is available or in which each group of bits corresponds to one pixel of a display image.

**blade** One component in a system that is designed to accept some number of components (blades). Blades could be individual servers that plug into a multiprocessing system or individual port cards that add connectivity to a switch. A blade is typically a hot-swappable hardware device.

**block** A unit of data storage on a disk drive.

**block virtualization**

The act of applying virtualization to one or more block-based (storage) services for the purpose of providing a new aggregated, higher-level, richer, simpler, or secure block service to clients. Block virtualization functions can be nested. A disk drive, RAID system, or volume manager all perform some form of block-address to (different) block-address mapping or aggregation. See also *virtualization*.

**Boolean**

Pertaining to the processes used in the algebra formulated by George Boole.

**C**

**cache** A high-speed memory or storage device used to reduce the effective time required to read data from or write data to lower-speed memory or a device. Read cache holds data in anticipation that it will be requested by a client. Write cache holds data written by a client until it can be safely stored on more permanent storage media such as disk or tape.

**Call Home**

In SAN Volume Controller, a communication service that sends data and

event notifications to a service provider. The machine can use this link to place a call to IBM or to another service provider when service is required.

**capacity licensing**

A type of licensing that grants you the use of a number of terabytes (TB) for virtualization, a number of terabytes for Metro Mirror and Global Mirror relationships, and a number of terabytes for FlashCopy mappings.

**cascading**

The process of connecting two or more fibre-channel hubs or switches together to increase the number of ports or extend distances.

**CIM** See *Common Information Model*.

**CIM object manager (CIMOM)**

The common conceptual framework for data management that receives, validates, and authenticates the CIM requests from the client application. It then directs the requests to the appropriate component or service provider.

**CIMOM**

See *CIM object manager*.

**class** The definition of an object within a specific hierarchy. A class can have properties and methods and can serve as the target of an association.

**CLI** See *command line interface*.

**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.

**client application**

A storage management program that initiates Common Information Model (CIM) requests to the CIM agent for the device.

**cluster**

In SAN Volume Controller, up to four pairs of nodes that provide a single configuration and service interface.

**command line-interface (CLI)**

A type of computer interface in which the input command is a string of text characters.

**Common Information Model (CIM)**

A set of standards developed by the Distributed Management Task Force (DMTF). CIM provides a conceptual framework for storage management and an open approach to the design and implementation of storage systems, applications, databases, networks, and devices.

**concurrent maintenance**

Service that is performed on a unit while it is operational.

In SAN Volume Controller, the ability for one node in the cluster to be turned off for maintenance without interrupting access to the VDisk data provided by the cluster.

**configuration node**

A node that acts as the focal point for configuration commands and manages the data that describes the cluster configuration.

**connected**

In a Global Mirror relationship, pertaining to the status condition that occurs when two clusters can communicate.

**consistency group**

A group of copy relationships between virtual disks that are managed as a single entity.

**consistent copy**

In a Metro or Global Mirror relationship, a copy of a secondary virtual disk (VDisk) that is identical to the primary VDisk from the viewpoint of a host system, even if a power failure occurred while I/O activity was in progress.

**consistent-stopped**

In a Global Mirror relationship, the state that occurs when the secondary virtual disk (VDisk) contains a consistent image, but the image might be out-of-date with respect to the primary VDisk. This state can happen when a relationship was in the consistent-synchronized state when an error occurred that forced a freeze of the consistency group. This state can also happen when a relationship is created with the create-consistent flag set to TRUE.

**consistent-synchronized**

In a Global Mirror relationship, the status condition that occurs when the primary virtual disk (VDisk) is accessible for read and write I/O operations. The secondary VDisk is accessible for read-only I/O operations. See also *primary virtual disk* and *secondary virtual disk*.

**container**

A data storage location; for example, a file, directory, or device.

A software object that holds or organizes other software objects or entities.

**contingency capacity**

Initially, a fixed amount of unused real capacity that is maintained on a space-efficient virtual disk that is configured to automatically expand its real capacity. It is also the difference between the used capacity and the new real capacity when the real capacity is changed manually.

**copied**

In a FlashCopy mapping, a state that indicates that a copy has been started after the copy relationship was created. The copy process is complete and the target disk has no further dependence on the source disk.

**copying**

A status condition that describes the state of a pair of virtual disks (VDisks) that have a copy relationship. The copy process has been started but the two virtual disks are not yet synchronized.

**Copy Services**

The services that enable you to copy virtual disks (VDisks): FlashCopy, Metro, and Global Mirror.

**counterpart SAN**

A nonredundant portion of a redundant storage area network (SAN). A counterpart SAN provides all the connectivity of the redundant SAN but without the redundancy. Each counterpart SANs provides an alternate path for each SAN-attached device. See also *redundant SAN*.

**cross-volume consistency**

In SAN Volume Controller, a consistency group property that guarantees consistency between virtual disks when an application issues dependent write operations that span multiple virtual disks.

## D

### **data migration**

The movement of data from one physical location to another without disrupting I/O operations.

### **degraded**

Pertaining to a valid configuration that has suffered a failure but continues to be supported and legal. Typically, a repair action can be performed on a degraded configuration to restore it to a valid configuration.

### **dense wavelength division multiplexing (DWDM)**

A technology that places many optical signals onto one single-mode fiber using slightly different optical frequencies. DWDM enables many data streams to be transferred in parallel.

### **dependent write operations**

A set of write operations that must be applied in the correct order to maintain cross-volume consistency.

### **destage**

A write command initiated by the cache to flush data to disk storage.

**device** In the CIM Agent, the storage server that processes and hosts client application requests.

IBM definition: A piece of equipment that is used with the computer and does not generally interact directly with the system, but is controlled by a controller.

HP definition: In its physical form, a magnetic disk that can be attached to a SCSI bus. The term is also used to indicate a physical device that has been made part of a controller configuration; that is, a physical device that is known to the controller. Units (virtual disks) can be created from devices after the devices have been made known to the controller.

### **device provider**

A device-specific handler that serves as a plug-in for the Common Information Model (CIM); that is, the CIM object manager (CIMOM) uses the handler to interface with the device.

### **directed maintenance procedures**

The set of maintenance procedures that can be run for a cluster. These procedures are run from within the SAN Volume Controller application and are documented in the *IBM System Storage SAN Volume Controller Troubleshooting Guide*.

### **disconnected**

In a Metro or Global Mirror relationship, pertains to two clusters when they cannot communicate.

### **discovery**

The automatic detection of a network topology change, for example, new and deleted nodes or links.

### **disk controller**

A device that coordinates and controls the operation of one or more disk drives and synchronizes the operation of the drives with the operation of the system as a whole. Disk controllers provide the storage that the cluster detects as managed disks (MDisks).

### **disk drive**

A disk-based, nonvolatile, storage medium.

**disk zone**

A zone defined in the storage area network (SAN) fabric in which the SAN Volume Controller can detect and address the logical units that the disk controllers present.

**Distributed Management Task Force (DMTF)**

An organization that defines standards for the management of distributed systems. See also *Common Information Model*.

**DMP** See *directed maintenance procedures*.

**DMTF**

See *Distributed Management Task Force*.

**domain name server**

In the Internet suite of protocols, a server program that supplies name-to-address conversion by mapping domain names to IP addresses.

**DRAM**

See *dynamic random access memory*.

**DWDM**

See *dense wavelength division multiplexing*.

**dynamic random access memory (DRAM)**

A storage in which the cells require repetitive application of control signals to retain stored data.

**E**

**EC** See *engineering change*.

**EIA** See *Electronic Industries Alliance*.

**Electronic Industries Alliance (EIA)**

An alliance of four trade associations: The Electronic Components, Assemblies & Materials Association (ECA); the Government Electronics and Information Technology Association (GEIA); the JEDEC Solid State Technology Association (JEDEC); and the Telecommunications Industry Association (TIA). Prior to 1998, EIA was the Electronic Industries Association and the group dates back to 1924.

**empty** In a Global Mirror relationship, a status condition that exists when the consistency group contains no relationships.

**engineering change (EC)**

A correction for a defect of hardware or software that is applied to a product.

**error code**

A value that identifies an error condition.

**ESS** See *IBM TotalStorage Enterprise Storage Server*.

**exclude**

To remove a managed disk (MDisk) from a cluster because of certain error conditions.

**excluded**

In SAN Volume Controller, the status of a managed disk that the cluster has removed from use after repeated access errors.

**extent** A unit of data that manages the mapping of data between managed disks and virtual disks.

## F

**fabric** In fibre-channel technology, a routing structure, such as a switch, that receives addressed information and routes it to the appropriate destination. A fabric can consist of more than one switch. When multiple fibre-channel switches are interconnected, they are described as cascading. See also *cascading*.

**fabric port (F\_port)**

A port that is part of a fibre-channel fabric. An F\_port on a fibre-channel fabric connects to the node port (N\_port) on a node.

**failover**

In SAN Volume Controller, the function that occurs when one redundant part of the system takes over the workload of another part of the system that has failed.

**FCIP** See *Fibre Channel over IP*.

**fibre channel**

A technology for transmitting data between computer devices at a data rate of up to 4 Gbps. It is especially suited for attaching computer servers to shared storage devices and for interconnecting storage controllers and drives.

**fibre-channel extender**

A device that extends a fibre-channel link over a greater distance than is supported by the standard, usually a number of miles or kilometers. Devices must be deployed in pairs at each end of a link.

**Fibre Channel over IP (FCIP)**

A network storage technology that combines the features of the Fibre Channel Protocol and the Internet Protocol (IP) to connect distributed SANs over large distances.

**Fibre Channel Protocol (FCP)**

A protocol that is used in fibre-channel communications with five layers that define how fibre-channel ports interact through their physical links to communicate with other ports.

**field replaceable unit (FRU)**

An assembly that is replaced in its entirety when any one of its components fails. An IBM service representative performs the replacement. In some cases, a field replaceable unit might contain other field replaceable units.

**FlashCopy mapping**

A relationship between two virtual disks.

**FlashCopy relationship**

See *FlashCopy mapping*.

**FlashCopy service**

In SAN Volume Controller, a copy service that duplicates the contents of a source virtual disk (VDisk) to a target VDisk. In the process, the original contents of the target VDisk are lost. See also *point-in-time copy*.

**F\_port** See *fabric port*.

**FRU** See *field replaceable unit*.

## G

### gateway

An entity that operates above the link layer and translates, when required, the interface and protocol used by one network into those used by another distinct network.

**GB** See *gigabyte*.

**GBIC** See *gigabit interface converter*.

### **gigabit interface converter (GBIC)**

An interface module that converts the light stream from a fibre-channel cable into electronic signals for use by the network interface card.

### **gigabyte (GB)**

In decimal notation, 1 073 741 824 bytes.

### **Global Mirror**

An asynchronous copy service that enables host data on a particular source virtual disk (VDisk) to be copied to the target VDisk that is designated in the relationship.

**grain** In a FlashCopy bitmap, the unit of data represented by a single bit.

### **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*.

## H

### **hardcoded**

Pertaining to software instructions that are statically encoded and not intended to be altered.

**HBA** See *host bus adapter*.

### **HLUN**

See *virtual disk*.

**hop** One segment of a transmission path between adjacent nodes in a routed network.

**host** An open-systems computer that is connected to the SAN Volume Controller through a fibre-channel interface.

### **host bus adapter (HBA)**

In SAN Volume Controller, an interface card that connects a host bus, such as a peripheral component interconnect (PCI) bus, to the storage area network.

### **host ID**

In SAN Volume Controller, a numeric identifier assigned to a group of host fibre-channel ports for the purpose of logical unit number (LUN) mapping. For each host ID, there is a separate mapping of Small Computer System Interface (SCSI) IDs to virtual disks (VDisks).

### **host zone**

A zone defined in the storage area network (SAN) fabric in which the hosts can address the SAN Volume Controllers.



**hub** A fibre-channel device that connects nodes into a logical loop by using a physical star topology. Hubs will automatically recognize an active node and insert the node into the loop. A node that fails or is powered off is automatically removed from the loop.

A communications infrastructure device to which nodes on a multi-point bus or loop are physically connected. Commonly used in Ethernet and fibre-channel networks to improve the manageability of physical cables. Hubs maintain the logical loop topology of the network of which they are a part, while creating a “hub and spoke” physical star layout. Unlike switches, hubs do not aggregate bandwidth. Hubs typically support the addition or removal of nodes from the bus while it is operating. (S)  
Contrast with *switch*.

## I

### **IBM System Storage Productivity Center (SSPC)**

An integrated hardware and software solution that provides a single point of entry for managing SAN Volume Controller clusters, IBM System Storage DS8000 systems, and other components of a data storage infrastructure.

### **IBM TotalStorage Enterprise Storage Server (ESS)**

An IBM product that provides an intelligent disk-storage system across an enterprise.

**ID** See *identifier*.

### **identifier (ID)**

A sequence of bits or characters that identifies a user, program device, or system to another user, program device, or system.

**idle** In a FlashCopy mapping, the state that occurs when the source and target virtual disks (VDisks) act as independent VDIsks even if a mapping exists between the two. Read and write caching is enabled for both the source and the target.

**idling** The status of a pair of virtual disks (VDIsks) that have a defined copy relationship for which no copy activity has yet been started.

In a Metro or Global Mirror relationship, the state that indicates that the master virtual disks (VDIsks) and auxiliary VDIsks are operating in the primary role. Consequently, both VDIsks are accessible for write I/O operations.

### **idling-disconnected**

In a Global Mirror relationship, the state that occurs when the virtual disks (VDIsks) in this half of the consistency group are all operating in the primary role and can accept read or write I/O operations.

### **illegal configuration**

A configuration that will not operate and will generate an error code to indicate the cause of the problem.

### **image mode**

An access mode that establishes a one-to-one mapping of extents in the managed disk (MDisk) with the extents in the virtual disk (VDisk). See also *managed space mode* and *unconfigured mode*.

### **image VDisk**

A virtual disk (VDisk) in which there is a direct block-for-block translation from the managed disk (MDisk) to the VDisk.

**IML** See *initial microcode load*.

**inconsistent**

In a Metro or Global Mirror relationship, pertaining to a secondary virtual disk (VDisk) that is being synchronized with the primary VDisk.

**inconsistent-copying**

In a Global Mirror relationship, the state that occurs when the primary virtual disk (VDisk) is accessible for read and write input/output (I/O) operations, but the secondary VDisk is not accessible for either. This state occurs after a **start** command is issued to a consistency group that is in the inconsistent-stopped state. This state also occurs when a **start** command is issued, with the force option, to a consistency group that is in the idling or consistent-stopped state.

**inconsistent-disconnected**

In a Global Mirror relationship, a state that occurs when the virtual disks (VDisks) in the half of the consistency group that is operating in the secondary role are not accessible for either read or write I/O operations.

**inconsistent-stopped**

In a Global Mirror relationship, the state that occurs when the primary virtual disk (VDisk) is accessible for read and write input/output (I/O) operations, but the secondary VDisk is not accessible for either read or write I/O operations.

**indication**

An object representation of an event.

**initial microcode load (IML)**

In SAN Volume Controller, the process by which the run-time code and data for a node are loaded into memory and initialized.

**initiator**

The system component that originates an I/O command over an I/O bus or network. I/O adapters, network interface cards, and intelligent controller device I/O bus control ASICs are typical initiators. (S) See also *logical unit number*.

**input/output (I/O)**

Pertaining to a functional unit or communication path involved in an input process, an output process, or both, concurrently or not, and to the data involved in such a process.

**instance**

An individual object that is a member of some class. In object-oriented programming, an object is created by instantiating a class.

**integrity**

The ability of a system to either return only correct data or respond that it cannot return correct data.

**Internet Protocol (IP)**

In the Internet suite of protocols, a connectionless protocol that routes data through a network or interconnected networks and acts as an intermediary between the higher protocol layers and the physical network. IPv4 is the dominant network layer protocol on the Internet, and IPv6 is designated as its successor. IPv6 provides a much larger address space, which enables greater flexibility in assigning addresses and simplifies routing and renumbering.

**interswitch link (ISL)**

The physical connection that carries a protocol for interconnecting multiple routers and switches in a storage area network.

**I/O** See *input/output*.

**I/O group**

A collection of virtual disks (VDisks) and node relationships that present a common interface to host systems.

**I/O throttling rate**

The maximum rate at which an I/O transaction is accepted for this virtual disk (VDisk).

**IP** See *Internet Protocol*.

**IP address**

The unique 32-bit address that specifies the location of each device or workstation in the Internet. For example, 9.67.97.103 is an IP address.

**ISL** See *interswitch link*.

**ISL hop**

A hop on an interswitch link (ISL). Considering all pairs of node ports (N-ports) in a fabric and measuring distance only in terms of interswitch links (ISLs) in the fabric, the number of ISLs traversed is the number of ISL hops on the shortest route between the pair of nodes that are farthest apart in the fabric.

**J****JBOD (just a bunch of disks)**

IBM definition: See *non-RAID*.

HP definition: A group of single-device logical units not configured into any other container type.

**L**

**LBA** See *logical block address*.

**least recently used (LRU)**

An algorithm used to identify and make available the cache space that contains the least-recently used data.

**line card**

See *blade*.

**local fabric**

In SAN Volume Controller, those storage area network (SAN) components (such as switches and cables) that connect the components (nodes, hosts, switches) of the local cluster together.

**local/remote fabric interconnect**

The storage area network (SAN) components that are used to connect the local and remote fabrics together.

**logical block address (LBA)**

The block number on a disk.

**logical unit (LU)**

An entity to which Small Computer System Interface (SCSI) commands are addressed, such as a virtual disk (VDisk) or managed disk (MDisk).

**logical unit number (LUN)**

The SCSI identifier of a logical unit within a target. (S)

**longitudinal redundancy check (LRC)**

A method of error checking during data transfer that involves checking parity.

**LRC** See *longitudinal redundancy check*.

**LRU** See *least recently used*.

**LU** See *logical unit*.

**LUN** See *logical unit number*.

**LUN masking**

A process that allows or prevents I/O to the disk drives through the host-bus-adaptor (HBA) device or operating-system device driver.

**M****managed disk (MDisk)**

A Small Computer System Interface (SCSI) logical unit that a redundant array of independent disks (RAID) controller provides and a cluster manages. The MDisk is not visible to host systems on the storage area network (SAN).

**managed disk group**

A collection of managed disks (MDisks) that, as a unit, contain all the data for a specified set of virtual disks (VDisks).

**Managed Object Format (MOF)**

A language for defining Common Information Model (CIM) schemas.

**managed space mode**

An access mode that enables virtualization functions to be performed. See also *image mode* and *unconfigured mode*.

**Management Information Base (MIB)**

Simple Network Management Protocol (SNMP) units of managed information that specifically describe an aspect of a system, such as the system name, hardware number, or communications configuration. A collection of related MIB objects is defined as a MIB.

**mapping**

See *FlashCopy mapping*.

**master console**

A single point from which to manage the IBM System Storage SAN Volume Controller. For SAN Volume Controller version 4.2.1 and earlier, the master console was purchased either as software that was installed and configured on a server or as a hardware platform with preinstalled operating system and master console software. See *IBM System Storage Productivity Center*.

**master virtual disk**

The virtual disk (VDisk) that contains a production copy of the data and that an application accesses. See also *auxiliary virtual disk*.

**MB** See *megabyte*.

**MDisk**

See *managed disk*.

**megabyte (MB)**

In decimal notation, 1 048 576 bytes.

**mesh configuration**

A network that contains a number of small SAN switches configured to create a larger switched network. With this configuration, four or more switches are connected together in a loop with some of the paths short circuiting the loop. An example of this configuration is to have four switches connected together in a loop with ISLs for one of the diagonals.

**method**

A way to implement a function on a class.

**Metro Mirror**

A synchronous copy service that enables host data on a particular source virtual disk (VDisk) to be copied to the target VDisk that is designated in the relationship.

**MIB** See *Management Information Base*.

**migration**

See *data migration*.

**mirrored virtual disk**

A virtual disk (VDisk) with two VDisk copies.

**mirrorset**

IBM definition: See *RAID-1*.

HP definition: A RAID storageset of two or more physical disks that maintain a complete and independent copy of the data from the virtual disk. This type of storageset has the advantage of being highly reliable and extremely tolerant of device failure. Raid level 1 storagesets are referred to as mirrorsets.

**MOF** See *Managed Object Format (MOF)*.

**N****namespace**

The scope within which a Common Information Model (CIM) schema applies.

**node** One SAN Volume Controller. Each node provides virtualization, cache, and Copy Services to the storage area network (SAN).

**node name**

A name identifier associated with a node. (SNIA)

**node port (N\_port)**

A port that connects a node to a fabric or to another node. N\_ports connect to fabric ports (F\_ports) or to other N\_ports of other nodes. N\_ports handle creation, detection, and flow of message units to and from the connected systems. N\_ports are end points in point-to-point links.

**node rescue**

In SAN Volume Controller, the process by which a node that has no valid software installed on its hard disk drive can copy the software from another node connected to the same fibre-channel fabric.

**non-RAID**

Disks that are not in a redundant array of independent disks (RAID). HP definition: See *JBOD*.

## N\_port

See *node port*.

## O

**object** In object-oriented design or programming, a concrete realization of a class that consists of data and the operations associated with that data.

### **object model**

A representation, such as a diagram, of objects in a given system. Using symbols similar to standard flowchart symbols, an object model depicts the classes the objects belong to, their associations with each other, the attributes that make them unique, and the operations that the objects can perform and that can be performed on them.

### **object name**

An object that consists of a namespace path and a model path. The namespace path provides access to the Common Information Model (CIM) implementation managed by the CIM Agent, and the model path provides navigation within the implementation.

### **object path**

An object that consists of a namespace path and a model path. The namespace path provides access to the Common Information Model (CIM) implementation managed by the CIM Agent, and the model path provides navigation within the implementation.

### **offline**

Pertaining to the operation of a functional unit or device that is not under the continual control of the system or of a host.

**online** Pertaining to the operation of a functional unit or device that is under the continual control of the system or of a host.

### **operating set**

In SAN Volume Controller, the set of nodes that are operating together to deliver storage services.

### **overallocated volume**

See *space-efficient virtual disk*.

### **oversubscription**

The ratio of the sum of the traffic that is on the initiator N-node connections to the traffic that is on the most heavily loaded interswitch links (ISLs), where more than one ISL is connected in parallel between these switches. This definition assumes a symmetrical network and a specific workload that is applied equally from all initiators and sent equally to all targets. See also *symmetrical network*.

## P

### **partition**

IBM definition: A logical division of storage on a fixed disk.

HP definition: A logical division of a container represented to the host as a logical unit.

### **partner node**

The other node that is in the I/O group to which this node belongs.

### **partnership**

In Metro or Global Mirror operations, the relationship between two

clusters. In a cluster partnership, one cluster is defined as the local cluster and the other cluster as the remote cluster.

**paused**

In SAN Volume Controller, the process by which the cache component quiesces all ongoing I/O activity below the cache layer.

**pend** To cause to wait for an event.

**petabyte (PB)**

In decimal notation, 1 125 899 906 842 624 bytes.

**PDU** See *power distribution unit*.

**physical disk licensing**

A type of licensing that grants you the use of a number of physical disks for virtualization. You can also license the use of the Metro Mirror and Global Mirror feature, the use of the FlashCopy feature, or both of these features.

**PLUN** See *managed disk*.

**point-in-time copy**

The instantaneous copy that the FlashCopy service makes of the source virtual disk (VDisk). In some contexts, this copy is known as a  $T_0$  copy.

**port** The physical entity within a host, SAN Volume Controller, or disk controller system that performs the data communication (transmitting and receiving) over the fibre channel.

**port ID**

An identifier associated with a port.

**power distribution unit (PDU)**

A device that distributes electrical power to multiple devices in the rack. It typically is rack-mounted and provides circuit breakers and transient voltage suppression.

**power-on self-test**

A diagnostic test that servers or computers run when they are turned on.

**prepared**

In a Global Mirror relationship, the state that occurs when the mapping is ready to start. While in this state, the target virtual disk (VDisk) is offline.

**preparing**

In a Global Mirror relationship, the state that occurs when any changed write data for the source virtual disk (VDisk) is flushed from the cache. Any read or write data for the target VDisk is discarded from the cache.

**primary virtual disk**

In a Metro or Global Mirror relationship, the target of write operations issued by the host application.

**property**

In the Common Information Model (CIM), an attribute that is used to characterize instances of a class.

**PuTTY**

A client program that allows you to run remote sessions on your computer through specific network protocols, such as SSH, Telnet, and Rlogin.

## Q

### qualifier

A value that provides additional information about a class, association, indication, method, method parameter, instance, property, or reference.

### quorum

A set of nodes that operates as a cluster. Each node has a connection to every other node in the cluster. If a connection failure causes the cluster to split into two or more groups of nodes that have full connection within the group, the quorum is the group that is selected to operate as the cluster. Typically, this is the larger group of nodes, but the quorum disk serves as a tiebreaker if the groups are the same size.

### queue depth

The number of I/O operations that can be run in parallel on a device.

### quorum disk

A managed disk (MDisk) that contains a reserved area that is used exclusively for cluster management. The quorum disk is accessed in the event that it is necessary to determine which half of the cluster continues to read and write data.

### quorum index

A number that can be either: 0, 1 or 2

## R

**rack** A free-standing framework that holds the devices and card enclosure.

**RAID** See *redundant array of independent disks*.

### RAID 0

IBM definition: RAID 0 allows a number of disk drives to be combined and presented as one large disk. RAID 0 does not provide any data redundancy. If one drive fails, all data is lost.

HP definition: A RAID storageset that stripes data across an array of disk drives. A single logical disk spans multiple physical disks, allowing parallel data processing for increased I/O performance. While the performance characteristics of RAID level 0 is excellent, this RAID level is the only one that does not provide redundancy. Raid level 0 storagesets are referred to as stripesets.

### RAID 1

SNIA dictionary definition: A form of storage array in which two or more identical copies of data are maintained on separate media. (S)

IBM definition: A form of storage array in which two or more identical copies of data are maintained on separate media. Also known as mirrorset.

HP definition: See *mirrorset*.

### RAID 5

SNIA definition: A form of parity RAID in which the disks operate independently, the data strip size is no smaller than the exported block size, and parity check data is distributed across the array's disks. (S)

IBM definition: See the SNIA definition.

HP definition: A specially developed RAID storageset that stripes data and parity across three or more members in a disk array. A RAIDset combines the best characteristics of RAID level 3 and RAID level 5. A RAIDset is the



best choice for most applications with small to medium I/O requests, unless the application is write intensive. A RAIDset is sometimes called parity RAID. RAID level 3/5 storagesets are referred to as RAIDsets.

**RAID 10**

A type of RAID that optimizes high performance while maintaining fault tolerance for up to two failed disk drives by striping volume data across several disk drives and mirroring the first set of disk drives on an identical set.

**real capacity**

The amount of storage that is allocated to a virtual disk copy from a managed disk group.

**redundant ac-power switch**

A device that provides input power redundancy by attaching a SAN Volume Controller to two independent power sources. If the main source becomes unavailable, the redundant ac-power switch automatically provides power from a secondary (backup) source. When power is restored, the redundant ac-power switch automatically changes back to the main power source.

**redundant array of independent disks (RAID)**

A collection of two or more disk drives that present the image of a single disk drive to the system. In the event of a single device failure, the data can be read or regenerated from the other disk drives in the array.

**redundant SAN**

A storage area network (SAN) configuration in which any one single component might fail, but connectivity between the devices within the SAN is maintained, possibly with degraded performance. This configuration is normally achieved by splitting the SAN into two, independent, counterpart SANs. See also *counterpart SAN*.

**reference**

A pointer to another instance that defines the role and scope of an object in an association.

**rejected**

A status condition that describes a node that the cluster software has removed from the working set of nodes in the cluster.

**relationship**

In Metro or Global Mirror, the association between a master virtual disk (VDisk) and an auxiliary VDisk. These VDIsks also have the attributes of a primary or secondary VDisk. See also *auxiliary virtual disk*, *master virtual disk*, *primary virtual disk*, and *secondary virtual disk*.

**reliability**

The ability of a system to continue to return data even if a component fails.

**remote fabric**

In Global Mirror, the storage area network (SAN) components (switches and cables) that connect the components (nodes, hosts, and switches) of the remote cluster.

**roles**

Authorization is based on roles that map to the administrator and service roles in an installation. The switch translates these roles into SAN Volume Controller administrator and service user IDs when a connection is made to the node for the SAN Volume Controller.

## S

**SAN** See *storage area network*.

**SAN Volume Controller fibre-channel port fan in**

The number of hosts that can see any one SAN Volume Controller port.

**SATA** See *Serial Advanced Technology Attachment*.

**schema**

A group of object classes defined for and applicable to a single namespace. Within the CIM Agent, the supported schemas are the ones that are loaded through the managed object format (MOF).

**SCSI** See *Small Computer Systems Interface*.

**SCSI back-end layer**

The layer in a Small Computer Systems Interface (SCSI) network that performs the following functions: controls access to individual disk controller systems that are managed by the cluster; receives requests from the virtualization layer, processes them, and sends them to managed disks; addresses SCSI-3 commands to the disk controller systems on the storage area network (SAN).

**SCSI front-end layer**

The layer in a Small Computer Systems Interface (SCSI) network that receives I/O commands sent from hosts and provides the SCSI-3 interface to hosts. SCSI logical unit numbers (LUNs) are mapped to virtual disks (VDisks) in this layer as well. Thus, the layer converts SCSI read and write commands that are addressed to LUNs into commands that are addressed to specific VDIs.

**SDD** See *subsystem device driver (SDD)*.

**secondary virtual disk**

In Metro or Global Mirror, the virtual disk (VDisk) in a relationship that contains a copy of data written by the host application to the primary VDisk.

**Secure Shell (SSH)**

A program to log in to another computer over a network, to run commands in a remote machine, and to move files from one machine to another.

**Secure Sockets Layer (SSL)**

A security protocol that provides communication privacy. With SSL, client/server applications can communicate in a way that is designed to prevent eavesdropping, tampering, and message forgery.

**sequential VDisk**

A virtual disk that uses extents from a single managed disk.

**Serial Advanced Technology Attachment (SATA)**

The evolution of the ATA interface from a parallel bus to serial connection architecture. (S)

**Serial ATA**

See *Serial Advanced Technology Attachment*.

**server** In a network, the hardware or software that provides facilities to other stations; for example, a file server, a printer server, a mail server. The station making the request of the server is usually called the client.

**Service Location Protocol (SLP)**

In the Internet suite of protocols, a protocol that identifies and uses network hosts without having to designate a specific network host name.

**fibre-channel SFP connector**

See *small form-factor pluggable connector*.

**Simple Mail Transfer Protocol (SMTP)**

An Internet application protocol for transferring mail among users of the Internet. SMTP specifies the mail exchange sequences and message format. It assumes that the Transmission Control Protocol (TCP) is the underlying protocol.

**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).

**SLP** See *Service Location Protocol*.

**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) connector**

A compact optical transceiver that provides the optical interface to a fibre-channel cable.

**SMI-S** See *Storage Management Initiative Specification*.

**SMTP** See *Simple Mail Transfer Protocol*.

**SNIA** See *Storage Networking Industry Association*.

**SNMP**

See *Simple Network Management Protocol*.

**space-efficient VDisk**

See *space-efficient virtual disk*.

**space-efficient virtual disk**

A virtual disk that has different virtual capacities and real capacities.

**SSH** See *Secure Shell*.

**SSPC** See *IBM System Storage Productivity Center (SSPC)*.

**SSL** See *Secure Sockets Layer*.

**stand-alone relationship**

In FlashCopy, Metro Mirror, and Global Mirror, relationships that do not belong to a consistency group and that have a null consistency group attribute.

**stop** A configuration command that is used to stop the activity for all copy relationships in a consistency group.

**stopped**

The status of a pair of virtual disks (VDisks) that have a copy relationship that the user has temporarily broken because of a problem.

**storage area network (SAN)**

A network whose primary purpose is the transfer of data between computer systems and storage elements and among storage elements. A

SAN consists of a communication infrastructure, which provides physical connections, and a management layer, which organizes the connections, storage elements, and computer systems so that data transfer is secure and robust. (S)

**Storage Management Initiative Specification (SMI-S)**

A design specification developed by the Storage Networking Industry Association (SNIA) that specifies a secure and reliable interface that allows storage management systems to identify, classify, monitor, and control physical and logical resources in a storage area network. The interface is intended as a solution that integrates the various devices to be managed in a storage area network (SAN) and the tools used to manage them.

**Storage Networking Industry Association (SNIA)**

An association of producers and consumers of storage networking products whose goal is to further storage networking technology and applications. See [www.snia.org](http://www.snia.org).

**striped**

Pertains to a virtual disk (VDisk) that is created from multiple managed disks (MDisks) that are in the MDisk group. Extents are allocated on the MDisks in the order specified.

**stripeset**

See *RAID 0*.

**subsystem device driver (SDD)**

An IBM pseudo device driver designed to support the multipath configuration environments in IBM products.

**superuser authority**

Can issue any command-line interface (CLI) command. A superuser can view and work with the following panels: View users, Add cluster, Remove cluster, Add users, and Modify users. Only one Superuser role is available.

**suspended**

The status of a pair of virtual disks (VDisks) that have a copy relationship that has been temporarily broken because of a problem.

**switch**

A network infrastructure component to which multiple nodes attach. Unlike hubs, switches typically have internal bandwidth that is a multiple of link bandwidth, and the ability to rapidly switch node connections from one to another. A typical switch can accommodate several simultaneous full link bandwidth transmissions between different pairs of nodes. (S)  
Contrast with *hub*.

**symmetrical network**

A network in which all the initiators are connected at the same level and all the controllers are connected at the same level.

**symmetric virtualization**

A virtualization technique in which the physical storage in the form of Redundant Array of Independent Disks (RAID) is split into smaller chunks of storage known as *extents*. These extents are then concatenated, using various policies, to make virtual disks (VDisks). See also *asymmetric virtualization*.

**synchronized**

In Metro or Global Mirror, the status condition that exists when both virtual disks (VDisks) of a pair that has a copy relationship contain the same data.

**system**

A functional unit, consisting of one or more computers and associated software, that uses common storage for all or part of a program and also for all or part of the data necessary for the execution of the program. A computer system can be a stand-alone unit, or it can consist of multiple connected units.

**T****terabyte**

In decimal notation, 1 099 511 628 000 bytes.

**thinly provisioned volume**

See *space-efficient virtual disk*.

**topology**

The logical layout of the components of a computer system or network and their interconnections. Topology deals with questions of what components are directly connected to other components from the standpoint of being able to communicate. It does not deal with questions of physical location of components or interconnecting cables. (S)

**trigger**

To initiate or reinitiate copying between a pair of virtual disks (VDisks) that have a copy relationship.

**U**

**UID** See *unique identifier*.

**unconfigured mode**

A mode in which I/O operations cannot be performed. See also *image mode* and *managed space mode*.

**uninterruptible power supply**

A device that is connected between a computer and its power source that protects the computer against blackouts, brownouts, and power surges. The uninterruptible power supply contains a power sensor to monitor the supply and a battery to provide power until an orderly shutdown of the system can be performed.

**unique identifier (UID)**

An identifier that is assigned to storage system logical units when they are created. It is used to identify the logical unit regardless of the logical unit number (LUN), status of the logical unit, or whether alternate paths exist to the same device. Typically, a UID is only used once.

**unmanaged**

An access mode that pertains to a managed disk (MDisk) that is not used by the cluster.

**V****valid configuration**

A configuration that is supported.

**VDisk** See *virtual disk (VDisk)*.

**VDisk copy**

See *virtual disk copy*.

**virtual capacity**

The amount of storage that is available to a server on a virtual disk (VDisk) copy. In a space-efficient virtual disk, the virtual capacity can be different from the real capacity. In a standard virtual disk, the virtual capacity and real capacity are the same.

**virtual disk copy**

A physical copy of the data that is stored on a virtual disk (VDisk). Mirrored VDIsks have two such copies. Nonmirrored VDIsks have one copy.

**virtual disk (VDisk)**

A device that host systems in a storage area network (SAN) recognize as a Small Computer System Interface (SCSI) disk.

**virtualization**

In the storage industry, a concept in which a pool of storage is created that contains several disk subsystems. The subsystems can be from various vendors. The pool can be split into virtual disks that are visible to the host systems that use them.

**virtualized storage**

Physical storage that has virtualization techniques applied to it by a virtualization engine.

**virtual storage area network (VSAN)**

A fabric within the SAN.

**vital product data (VPD)**

Information that uniquely defines system, hardware, software, and microcode elements of a processing system.

**VLUN** See *managed disk*.

**VPD** See *vital product data*.

**VSAN** See *virtual storage area network*.

**W****WBEM**

See *Web-Based Enterprise Management*.

**Web-Based Enterprise Management (WBEM)**

A tiered, enterprise-management architecture that was developed by the Distributed Management Task Force (DMTF). This architecture provides the management design framework that consists of devices, device providers, the object manager, and the messaging protocol for the communication between client applications and the object manager.

**worldwide node name (WWNN)**

An identifier for an object that is globally unique. WWNNs are used by Fibre Channel and other standards.

**worldwide port name (WWPN)**

A unique 64-bit identifier that is associated with a fibre-channel adapter port. The WWPN is assigned in an implementation- and protocol-independent manner.

**WWNN**

See *worldwide node name*.

**WWPN**

See *worldwide port name*.

**Z****zoning**

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.





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SAN Volume Controller Software Installation and  
Configuration Guide

Version 4.3.1