Disk Management Utility User Guide V2

QX and QXS

6-68387-01 Rev A

QX and QXS Disk Management Utility User Guide V2, 6-68387-01 Rev A, March 2016, Product of USA.

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Preface

The Disk Management Utility User Guide (V2) provides information about managing QX and QXS systems by using its web interface.

The following QX and QXS systems are supported:

- QXS-312/412 Hybrid
- QXS-324/424 Hybrid
- QXS-448/648 Hybrid
- QXS-456/656 Hybrid
- StorNext QXS-1200/2400
- StorNext QXS-5600
- StorNext QX-1200/2400

Note: Some functions and/or screens may or may not be supported on your system (depending on firmware version).

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About This Guide

The Disk Management Utility User Guide (V2) provides information about managing QX and QXS storage systems by using its web interface, WBI.

Intended Audience

This guide is intended for storage system administrators.

Prerequisites

Prerequisites for using this product include knowledge of:

- Network administration
- Storage system configuration
- SAN management and DAS
- FC, SAS, and Ethernet protocols

Related Documentation

For information about	See
Web links to download Quantum QX and QXS Storage guides listed below, but not shipped with the product	*QX and QXS Documentation Sheet**
Enhancements, known issues, and late-breaking information not included in product documentation	*QX or QXS Release Notes*
Product overview and overview of setup tasks	*QX and QXS Getting Started Guide*

For information about	See
Regulatory compliance and safety and disposal information	*QX and QXS Series Product Regulatory Compliance and Safety **
Using a 12- and 24-drive rackmount bracket kit to install an enclosure into a rack	*QX/QXS 12- and 24-Drive Rackmount Bracket Kit Installation Guide*
Using a 48-drive rackmount bracket kit to install an enclosure into a rack	*QXS 48-Drive Rackmount Bracket Kit Installation Guide*
Using a 56-drive rackmount bracket kit to install an enclosure into a rack	*QXS 56-Drive Rackmount Bracket Kit Installation Guide*
Installing the front bezel on a QX and QXS system	*QX and QXS Bezel Installation Guide*
Product hardware setup and related troubleshooting	*QX and QXS Setup Guide*
Using the CLI to configure and manage the product	*QX and QXS CLI Reference Guide*
Identifying and installing or replacing CRUs	*QX & QXS CRU Installation and Replacement Guide*
Events that the QX and QXS Series may report, and recommended actions to take in response to those events	*QX and QXS Event Descriptions Reference Guide*
Managing a QXS system by using its primary web interface (V3), the Disk Management Utility	*QXS Disk Management Utility User Guide V3*
Managing a QX and QXS system by using its secondary web interface (V2), the Disk Management Utility	*QX and QXS Disk Management Utility User Guide V2*

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Document Conventions and Symbols

Table 1: Document conventions

Convention	Element
Blue text	Cross-reference links and e-mail addresses
Blue, underlined text	Web site addresses

Convention	Element
Bold text	• Key names • Text typed into a GUI element, such as into a box • GUI elements that are clicked or selected, such as menu and list items, buttons, and check boxes
Italic text	Text emphasis
`Monospace text`	• File and directory names • System output • Code • Text typed at the command-line
`Monospace, italic text`	• Code variables • Command-line variables
`Monospace, bold text`	Emphasis of file and directory names, system output, code, and text typed at the command-line

ⓘ **Note:** Note emphasizes important information related to the main topic.

⚠ **Caution:** Caution indicates potential hazards to equipment or data.

⚡ **WARNING:** Warning indicates potential hazards to personal safety.

Chapter 1: Getting Started

This chapter contains the following topics:

Getting Started

The Disk Management Utility (V2) is a web-based application for configuring, monitoring, and managing the storage system.

Each controller module in the storage system contains a web server, which is accessed when you sign in to the Disk Management Utility (V2). In a dual-controller system, you can access all functions from either controller. If one controller becomes unavailable, you can continue to manage the storage system from the partner controller.

The Disk Management Utility (V2) is also a web-browser interface (WBI).

Note: This guide uses "disk" throughout the document. You must understand that the word and/or usage of "disk" can be a hard disk drive (HDD) or a solid state drive (SSD). HDDs and SSDs can be used in any RAID type and/or vdisk (as long as the correct number of drives are available to create the RAID type and/or vdisk).

Caution: When creating a particular RAID type and/or vdisk, if there are not enough available HDDs or SSDs, the process will fail.

There are two user interfaces available for the Disk Management Utility (V2). The Disk Management Utility (V2) is the legacy interface for managing linear storage that you are currently viewing. The Disk Management Utility (V3) is the new interface for managing virtual storage. For new installations, the Disk Management Utility (V3)is the default management mode. For upgrades, the Disk Management Utility (V2) is the default management mode. You can change the default management mode or switch to the other mode for the session.

To switch to the user interface that manages linear storage for the session: In the URL, replace `v3` with `v2`.

Note: The Disk Management Utility (V3) may or may not be supported on your system (depending on firmware version).

Configuring and Provisioning a New Storage System

To configure and provision a storage system for the first time:

1. Configure your web browser to access the Disk Management Utility (V2) and sign in, as described in Browser Setup on the next page and Signing In and Signing Out on the next page.
2. Set the system date and time, as described in Changing the System Date and Time on page 57.
3. Use the Configuration Wizard to configure other system settings, as described in Using the Configuration Wizard on page 41.
4. Use the Provisioning Wizard to create a virtual disk (*vdisk*) containing storage volumes, and optionally to map the volumes to hosts, as described in Using the Provisioning Wizard on page 80.
5. Use the Replication Setup Wizard to configure replication for a primary volume to a remote system, as described in Using the Replication Setup Wizard on page 179.
6. If you mapped volumes to hosts, verify the mappings by mounting/presenting the volumes from each host and performing simple read/write tests to the volumes.
7. Verify that controller modules and expansion modules have the latest firmware, as described in Viewing Information About the System on page 126 and Updating Firmware on page 109.

You can make additional configuration and provisioning changes and view system status, as described in later chapters of this guide.

Browser Setup

- Supported browser versions: Mozilla Firefox 11 and newer; Microsoft Internet Explorer 10 and 11; Google Chrome 17 and newer; Apple Safari 5.1 and newer.
- Do not use Internet Explorer compatibility mode.
- To see the help window, you must enable pop-up windows.
- To optimize the display, use a color monitor and set its color quality to the highest setting.
- To navigate beyond the Sign In page (with a valid user account):
  - For Internet Explorer, set the browser's local-intranet security option to medium or medium-low.
  - Verify that the browser is set to allow cookies at least for the IP addresses of the storage-system network ports.
  - For Internet Explorer, add each controller's network IP address as a trusted site.
  - If the Disk Management Utility (V2) is configured to use HTTPS, ensure that Internet Explorer is set to use either TLS 1.0, TLS 1.1 or TLS 1.2.

Signing In and Signing Out

Multiple users can be signed in to each controller simultaneously.

For each active Disk Management Utility (V2) session, an identifier is stored in the browser. Depending on how your browser treats this session identifier, you might be able to run multiple independent sessions simultaneously. For example, each instance of Internet Explorer can run a separate Disk Management Utility (V2) session, but all instances of Firefox, Chrome, and Safari share the same Disk Management Utility (V2) session.

To sign in:

1. In the web browser's address field, type the IP address of a controller network port and press **Enter**. The Disk Management Utility (V2) Sign In page is displayed. If the Sign In page does not display, verify that you have entered the correct IP address.
2. On the Sign In page, enter the name and password of a configured user. The default user name and password are `manage` and `!manage`. To display the interface in a language other than the user setting, select the language from the Language list.

   Language preferences can be configured for the system and for individual users.
3. Click **Sign In**. If the system is available, the System Overview page is displayed. Otherwise, a message indicates that the system is unavailable.

When you are ready to end your session, sign out as described below. Do not simply close the browser window.

To sign out:

1. Click **Sign Out** near the top of the Disk Management Utility (V2) window.
2. In the confirmation panel, click **Sign Out**.

Tips For Signing In and Signing Out

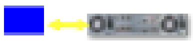
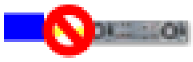
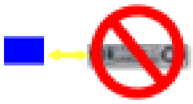
- Do not include a leading zero in an IP address. For example, enter 10.1.4.33 not 10.1.4.**0**33.
- To switch to the user interface that manages linear storage for the session, when the Sign In page opens, perform one of the following action:
  - If the v3 version of the Sign In page appears, in the URL, replace v3 with v2.
- Multiple users can be signed in to each controller simultaneously.
- For each active Disk Management Utility (V2) session an identifier is stored in the browser. Depending on how your browser treats this session identifier, you might be able to run multiple independent sessions simultaneously. Each instance of Internet Explorer can run a separate Disk Management Utility (V2) session. However, all instances of Firefox, Chrome, and Safari share the same session.
- End a Disk Management Utility (V2) session by clicking the Sign Out link near the top of the Disk Management Utility (V2) window. Do not simply close the browser window.

Tips For Using the Main Window

- The Configuration View panel displays logical and physical components of the storage system. To perform a task, select the component to act on and then either:
  - Right-click to display a context menu and select the task to perform. This is the method that help topics describe.
  - Click a task category in the main panel and select the task to perform.
- The System Status panel shows the system time and how many events of each severity have occurred. To view event details, click a severity icon. For more information see Viewing the System Event Log on page 135.
- Many tables can be sorted by a specific column. To do so, click the column heading to sort low to high. Click again to sort high to low. In tables that allow a task to be performed on multiple items, you can select up to
  100 items or clear all selections by toggling the check box in the table’s heading row.
- Do not use the browser’s Back, Forward, Reload, or Refresh buttons. The Disk Management Utility (V2) has a single page whose content changes as you perform tasks and automatically updates to show current data.
- A red asterisk (*) identifies a required setting.

- The icon in the upper right corner of the main window shows the status of communication between the Disk Management Utility (V2), the Management Controller (MC), and the Storage Controller (SC), as described in the following table.

Table 2: Disk Management Utility (V2) communication status icons

Icon	Meaning
	The Disk Management Utility (V2) can communicate with the Management Controller, which can communicate with the Storage Controller.
	The Disk Management Utility (V2) *cannot* communicate with the Management Controller.
	The Disk Management Utility (V2) can communicate with the Management Controller, which *cannot* communicate with the Storage Controller.

- Below the communication status icon, a timer shows how long the session can be idle until you are automatically signed out. This timer resets after each action you perform. One minute before automatic sign-out you are prompted to continue using the Disk Management Utility (V2).
- If a Disk Management Utility (V2) session is active on a controller and the controller is power cycled or is forced offline by the partner controller or certain other events occur, the session might hang. The Disk Management Utility (V2) might indicate that it is “Connecting” but stop responding, or the page may become blank with the browser status “Done.” After the controller comes back online, the session will not restart. To continue using the Disk Management Utility (V2), close and reopen the browser and start a new Disk Management Utility (V2) session.
- Colors that identify how storage space is used are described in About Storage-space Color Codes on page 23.
- Icons shown in the Configuration View panel are described in About Configuration View Icons on page 23.

Tips for using the help window

- To display help for a component in the Configuration View panel, right-click the component and select Help. To display help for the content in the main panel, click either Help in the menu bar or the help icon ? in the upper right corner of the panel.
- In the help window, click the table of contents icon ☰ to show or hide the Contents pane.
- As the context in the main panel is changed, the corresponding help topic is displayed in the help window. To prevent this automatic context-switching, click the pin icon 📌. When a help window is

pinned (📌), you can still browse to other topics within the help window and you can open a new help window. You cannot unpin a help window. You can only close it.

- If you have viewed more than one help topic, you can click the arrow icons to display the previous or next topic.

System Concepts

About User Accounts

The system provides three default user accounts and allows a maximum of 12 user accounts to be configured. Any account can be modified or removed except you cannot remove the user you are signed in as.

The default user accounts are for general users that can access the Disk Management Utility (V3) (WBI), CLI, FTP, or SMI-S interfaces. You can also create SNMPv3 user accounts that can access the Management Information Base (MIB) or receive trap notifications. SNMPv3 user accounts support SNMPv3 security features such as authentication and encryption. For information about configuring trap notifications, see Configuring SNMP notification on page 52. For information about the MIB, see SNMP Reference on page 199.

General user accounts have these options:

- User Name.
- Password.
- User Roles. Either: Monitor, which lets the user view system settings; or Manage, which lets the user view and change system settings.
- User Type. Identifies the user’s experience level: Standard, Advanced, or Diagnostic. This option is informational only and does not affect access to the commands.
- WBI Access. Allows access to the Disk Management Utility (V3).
- CLI Access. Allows access to the command-line management interface.
- FTP Access. Allows access to the FTP interface, which can be used instead of the Disk Management Utility (V3) to install firmware updates and download logs.
- SMI-S Access. Allows access to the Storage Management Initiative Specification (SMI-S) interface, used for management of the system through your network.
- Base Preference. The base for entry and display of storage-space sizes. In base 2, sizes are shown as powers of 2, using 1024 as a divisor for each magnitude. In base 10, sizes are shown as powers of 10, using 1000 as a divisor for each magnitude. Operating systems usually show volume size in base 2. Disk drives usually show size in base 10. Memory (RAM and ROM) size is always shown in base 2.
- Precision Preference. The number of decimal places (1–10) for display of storage-space sizes.

- Unit Preference. The unit for display of storage-space sizes: Auto, TB, GB, MB. The Auto option lets the system determine the proper unit for a size. Based on the precision setting, if the selected unit is too large to meaningfully display a size, the system uses a smaller unit for that size. For example, if the unit is set to TB, precision is set to 1, and base is set to 10, the size 0.11709 TB is shown as 117.1 GB.
- Temperature Preference. The scale for display of temperature values: Celsius or Fahrenheit.
- Auto Sign Out (minutes). The amount of time that the user's session can be idle before the user is automatically signed out (2–720 minutes).
- Locale. The user's preferred display language, which overrides the system's default display language. Installed language sets include Arabic, Chinese-Simplified, Chinese-Traditional, Dutch, English, French, German, Italian, Japanese, Korean, Portuguese, Russian, and Spanish.

SNMPv3 user accounts have these options:

- User Name.
- Password.
- SNMP User Type. Either: User Access, which allows the user to view the SNMP MIB; or Trap Target, which allows the user to receive SNMP trap notifications. Trap Target uses the IP address set with the Trap Host Address option.
- Authentication Type. Either: MD5 authentication; SHA (Secure Hash Algorithm) authentication; or no authentication. Authentication uses the password set with the Password option.
- Privacy Type. Either: DES (Data Encryption Standard) encryption; AES (Advanced Encryption Standard) encryption; or no encryption. Encryption uses the password set with the Privacy Password option.
- Privacy Password. The encryption password.
- Trap Host Address. The IP address of the host system that will receive SNMP traps.

Table 3: Settings for default users (v2)

Name	Password	Roles	Type	Interfaces enabled	Base	Prec.	Units	Temp.	Auto Sign Out	Locale
monitor	!monitor	Monitor	Standard	WBI, CLI	10	1	Auto	Celsius	30 min.	English
manage	!manage	Monitor, Manage		WBI, CLI, FTP, SMI-S						
ftp	!ftp	Monitor, Manage		FTP						

Note: To secure the storage system, set a new password for each default user.

About vdisks

A *vdisk* is a virtual disk that is composed of one or more disks, and has the combined capacity of those disks. The number of disks that a vdisk can contain is determined by its RAID level. All disks in a vdisk must be the same type. A maximum of 64 vdisks per system can exist.

A vdisk can contain different models of disks, and disks with different capacities and sector formats. If you mix disks with different capacities, the smallest disk determines the logical capacity of all other disks in the vdisk, regardless of RAID level. For example, the capacity of a vdisk composed of one 500-GB disk and one 750-GB disk is equivalent to a vdisk composed of two 500-GB disks. To maximize capacity, use disks of similar size. For greatest reliability, use disks of the same size and rotational speed.

Each disk has metadata that identifies whether the disk is a member of a vdisk, and identifies other members of that vdisk. This enables disks to be moved to different slots in a system; an entire vdisk to be moved to a different system; and a vdisk to be quarantined if disks are detected missing.

Sector Format

The system supports 512-byte native sector size disks, 512-byte emulated sector size disks, or a mix of these sector formats. The system identifies the sector format used by a disk or vdisk as follows.

- *512n*. All disks use the 512-byte native sector size. Each logical block and physical block is 512 bytes.
- *512e*. All disks use a 512-byte emulated sector size. Each logical block is 512 bytes and each physical block is 4096 bytes. Eight logical blocks will be stored sequentially in each physical block. Logical blocks may or may not be aligned with physical block boundaries.
- *Mixed*. The vdisk contains a mix of 512n and 512e disks. For consistent and predictable performance, do not mix disks of different rotational speed or sector size types (512n, 512e).

⚠ **Caution:** The emulation for 512e disks supports backward-compatibility for many applications and legacy operating systems that do not support 4K native disks. However, older versions of application software, such as virtualization software that resides between the operating system and your storage firmware, may not fully support 512e disk emulation. If not, performance degradation might result. Ensure that you have upgraded to the most recent version of any software that might be affected, and see its documentation for further information.

In a single-controller system, all vdisks are owned by that controller. In a dual-controller system, when a vdisk is created the system automatically assigns the owner to balance the number of vdisks each controller owns; or, you can select the owner. Typically it does not matter which controller owns a vdisk.

In a dual-controller system, when a controller fails, the partner controller assumes temporary ownership of the failed controller’s vdisks and resources. If a fault-tolerant cabling configuration is used to connect the controllers to drive enclosures and hosts, both controllers’ LUNs are accessible through the partner.

Chunk Size

When you create a vdisk you can use the default chunk size or one that better suits your application. The chunk size is the amount of contiguous data that is written to a disk before moving to the next disk. After a vdisk is created its chunk size cannot be changed. For example, if the host is writing data in 16-KB transfers, that size would be a good choice for random transfers because one host read would generate the read of exactly one disk in the volume. That means if the requests are random-like, then the requests would be spread evenly over all of the disks, which is good for performance. If you have 16-KB accesses from the host and a 64-KB block size, then some of the hosts accesses would hit the same disk. Each chunk contains four possible 16-KB groups of data that the host might want to read, which is not an optimal solution. Alternatively, if the host accesses were 128 KB, then each host read would have to access two disks in the vdisk. For random patterns, that ties up twice as many disks.

Volumes

When you create a vdisk you can also create volumes within it. A volume is a logical subdivision of a vdisk, and can be mapped to controller host ports for access by hosts. The storage system presents only volumes, not vdisks, to hosts.

You can create vdisks with or without volumes by using the Provisioning Wizard, or you can create vdisks manually.

Note: Best practices for creating vdisks include:

- To maximize capacity, use disks of similar size.
- For greatest reliability, use disks of the same size and rotational speed.
- For storage configurations using many disks, create a few vdisks each containing many disks instead of many vdisks each containing a few disks.
- To maximize capacity and disk usage (but not performance), you can create vdisks larger than 2 TB and divide them into multiple volumes each having a capacity of 2 TB or less. This increases the usable capacity of storage configurations by reducing the total number of parity disks required when using parity-protected RAID levels. This differs from using a *volume* larger than 2 TB, which requires specific support by the host operating system, I/O adapter, and application.
- For maximum use of a dual-controller system’s resources, each controller should own a similar number of vdisks.
- Set the chunk size to match the transfer block size of the host application.

About Spares

A controller automatically reconstructs a fault-tolerant vdisk (RAID 1, 3, 5, 6, 10, 50) when one or more of its disks fails and a compatible spare disk is available. A compatible disk has enough capacity to replace the failed disk and is the same type.

There are three types of spares:

- *Dedicated spare*. Reserved for use by a specific vdisk to replace a failed disk. Most secure way to provide spares for vdisks but expensive to reserve a spare for each vdisk.
- *Global spare*. Reserved for use by any fault-tolerant vdisk to replace a failed disk.
- *Dynamic spare*. An available compatible disk that is automatically assigned to replace a failed disk in a fault-tolerant vdisk.

When a disk fails, the system looks for a dedicated spare first. If it does not find a dedicated spare, it looks for a global spare. If it does not find a compatible global spare and the dynamic spares option is enabled, it takes any available compatible disk. If no compatible disk is available, reconstruction cannot start.

ⓘ **Note:** A best practice is to designate spares for use if disks fail. Dedicating spares to vdisks is the most secure method, but it is also expensive to reserve spares for each vdisk. Alternatively, you can enable dynamic spares or assign global spares.

Sparing rules for heterogeneous vdisks

If you upgraded from an earlier release that did not distinguish between enterprise and midline SAS disks, you might have vdisks that contain both types of disks. These are called heterogeneous or mixed vdisks. In the Configuration View panel, the vdisk's RAID-level label includes the suffix `-MIXED`.

For heterogeneous vdisks, the system uses the following logic for global sparing and dynamic sparing. If a vdisk has more than one type of disk in it, the system will look for disks of all types contained in the vdisk. In an effort to migrate heterogeneous vdisks to homogeneous vdisks, the disk type that is most prominent (has the highest number of disks) will be preferred. If all the disk types in a vdisk have the same number of disks, the type that has the smallest capacity disk will be used. If both types have the same capacity disks, enterprise SAS will be the preferred type. Dedicated spares are considered part of a vdisk, so they do not use this logic to choose a preferred disk type since using either type will not change the makeup of the vdisk.

The precedence of spares is as follows:

- Dedicated spares of any type.
- Global spares of preferred type.
- Global spares of non-preferred type.
- Dynamic spares of preferred type (if dynamic sparing is enabled).
- Dynamic spares of non-preferred type (if dynamic sparing is enabled).

About Volumes

A *volume* is a logical subdivision of a vdisk, and can be mapped to controller host ports for access by hosts. A mapped volume provides the storage for a file system partition you create with your operating system or third-party tools. The storage system presents only volumes, not vdisks, to hosts. A maximum of 128 mappable volumes per vdisk can exist.

You can create a vdisk that has one volume or multiple volumes.

- Single-volume vdisks work well in environments that need one large, fault-tolerant storage space for data on one host. A large database accessed by users on a single host that is used only for that application is an example.
- Multiple-volume vdisks work well when you have very large disks and you want to make the most efficient use of disk space for fault tolerance (parity and spares). For example, you could create one 10-TB RAID-5 vdisk and dedicate one spare to the vdisk. This minimizes the amount of disk space allocated to parity and spares compared to the space required if you created five 2-TB RAID-5 vdisks. However, I/O to multiple volumes in the same vdisk can slow system performance.

When you create volumes you can specify their sizes. If the total size of a vdisk's volumes equals the size of the vdisk, you will not have any free space. Without free space, you cannot add or expand volumes. If you need to add or expand a volume in a vdisk without free space, you can delete a volume to create free space. Or, you can expand the vdisk and then either add a volume or expand a volume to use the new free space.

Volume sizes are aligned to 4-MB boundaries. When a volume is created or expanded, if the resulting size would be less than 4 MB it will be increased to 4 MB. If the resulting size would be greater than 4 MB it will be decreased to the nearest 4-MB boundary. The minimum volume size is 4 MB.

You can use a volume's default name or change it to identify the volume's purpose. For example, a volume used to store payroll information can be named Payroll.

You can create vdisks with volumes by using the Provisioning Wizard, or you can create volumes manually.

About Hosts

A *host* identifies an external port that the storage system is attached to. The external port may be a port in an I/O adapter (such as an FC HBA) in a server.

The controllers automatically discover hosts that have sent an `inquiry` command or a `report luns` command to the storage system. Hosts typically do this when they boot up or rescan for devices. When the command from the host occurs, the system saves the host ID. The ID for an FC or SAS host is its WWPN. The ID for an iSCSI host is typically, but not limited to, its IQN. You can also manually create entries for hosts.

You can assign a name to a host to make it easy to recognize for volume mapping. A maximum of 64 names can be assigned.

The Configuration View panel lists hosts by name, or if they are unnamed, by ID.

A storage system with iSCSI ports can be protected from unauthorized access via iSCSI by enabling Challenge Handshake Authentication Protocol (CHAP). CHAP authentication occurs during an attempt by a host to login to the system. This authentication requires an identifier for the host and a shared secret between the host and the system. Optionally, the storage system can also be required to authenticate itself to the host. This is called mutual CHAP. Steps involved in enabling CHAP include:

- Decide on host node names (identifiers) and secrets. The host node name is typically, but not limited to, its IQN. A secret must have 12–16 characters.
- Define CHAP entries in the storage system. If the node name is a host name, then it may be useful to display the hosts that are known to the system.
- Enable CHAP on the storage system. Note that this applies to all iSCSI hosts, in order to avoid security exposures. Any current host connections will be terminated when CHAP is enabled and will need to be re-established using a CHAP login.
- Define the CHAP secret(s) in the host iSCSI initiator.
- Establish a new connection to the storage system using CHAP. The host should be able to be displayed by the system, as well as the ports through which connections were made.

If it becomes necessary to add more hosts after CHAP is enabled, additional CHAP node names and secrets can be added. If a host attempts to login to the storage system, it will become visible to the system, even if the full login is not successful due to incompatible CHAP definitions. This information may be useful in configuring CHAP entries for new hosts. This information becomes visible when an iSCSI discovery session is established, because the storage system does not require discovery sessions to be authenticated.

About SAS cabling (for QXS-312 and QXS-324 only)

For systems with a 2-port SAS controller module, host ports can be configured through the WBI or CLI to use fan-out cables or standard cables. A standard cable can connect one port on a SAS host to one controller port, using four PHY lanes per port. A fan-out cable can connect one port on each of two SAS hosts to one controller port, using two PHY lanes per port. Using fan-out cables instead of standard cables doubles the number of hosts that can be attached to a single system. It will also halve the maximum bandwidth available to each host, but overall bandwidth available to all hosts is unchanged. Configuration must be the same for all ports on both controllers, so a mix of standard cables and fan-out cables cannot be used on one system.

Once you have switched the configuration through the firmware, you can disconnect the existing cables and switch to the other type of cables. For information on how to connect and disconnect cables, refer to your product's Setup Guide.

If you connect a cable that does not match the cable type for the configuration, an event will be logged that indicates a mismatch has occurred. Also, while I/O will occur, half of the PHY lanes for each port will be disabled. The host port properties table accessed through the Rear Graphical tab of the Enclosure Overview panel will reflect that the port is in a degraded state. If a cable mismatch occurs, change the port mode of the system using the Configure Host Interface panel or connect cables of the appropriate type for the configuration.

For more information on checking port properties through the Enclosure Overview panel, see Viewing Information About an Enclosure on page 154.

When configuring the host-interface settings for a 2-port SAS controller module, the current link speed, number of PHY lanes expected for the SAS port, and number of PHY lanes active for each SAS port are displayed. The number of ports that appear depends on the configuration. Changing the host-interface settings interrupts I/O and restarts the storage controllers. For more information on how to configure host ports for use with SAS fan-out cables, see To change host interface settings for 2-port SAS controller modules (for QXS-312 and QXS-324 only) on page 59

About Volume Mapping

Each volume has default host-access settings that are set when the volume is created. These settings are called the *default mapping*. The default mapping applies to any host that has not been explicitly mapped using different settings. *Explicit mappings* for a volume override its default mapping.

Default mapping enables all attached hosts to see a volume using a specified LUN and access permissions set by the administrator. This means that when the volume is first created, all connected hosts can immediately access the volume using the advertised default mapping settings. This behavior is expected by some operating systems, such as Microsoft Windows, which can immediately discover the volume. The advantage of a default mapping is that all connected hosts can discover the volume with no additional work by the administrator. The disadvantage is that all connected hosts can discover the volume with no restrictions. Therefore, this process is not recommended for specialized volumes that require restricted access.

You can change a volume’s default mapping, and create, modify, or delete explicit mappings. A mapping can specify read-write, read-only, or no access through one or more controller host ports to a volume. When a mapping specifies no access, the volume is *masked*. You can apply access privileges to one or more of the host ports on either controller. To maximize performance, map a volume to at least one host port on the controller that owns it. To sustain I/O in the event of controller failure, map to at least one host port on each controller.

For example, a payroll volume could be mapped with read-write access for the Human Resources host and be masked for all other hosts. An engineering volume could be mapped with read-write access for the Engineering host and read-only access for other departments’ hosts.

A LUN identifies a mapped volume to a host. Both controllers share a set of LUNs, and any unused LUN can be assigned to a mapping. However, each LUN can only be used once per volume as its default LUN. For explicit mappings, the rules differ: LUNs used in default mappings can be reused in explicit mappings for other volumes and other hosts.

Note: When an explicit mapping is deleted, the volume’s default mapping takes effect. Therefore, it is recommended to use the same LUN for explicit mappings as for the default mapping.

Volume mapping settings are stored in disk metadata. If enough of the disks used by a volume are moved into a different enclosure, the volume’s vdisk can be reconstructed and the mapping data is preserved.

The storage system uses Unified LUN Presentation (ULP), which can expose all LUNs through all host ports on both controllers. The interconnect information is managed in the controller firmware. ULP appears to the host as an active-active storage system where the host can choose any available path to access a LUN regardless of vdisk ownership. When ULP is in use, the controllers’ operating/redundancy mode is shown as Active-Active ULP. ULP uses the T10 Technical Committee of INCITS Asymmetric Logical Unit Access (ALUA) extensions, in SPC-3, to negotiate paths with aware host systems. Unaware host systems see all paths as being equal.

About Volume Cache Options

You can set options that optimize reads and writes performed for each volume.

Using write-back or write-through caching

Caution: Only disable write-back caching if you fully understand how the host operating system, application, and adapter move data. If used incorrectly, you might hinder system performance.

You can change a volume’s write-back cache setting. *Write-back* is a cache-writing strategy in which the controller receives the data to be written to disks, stores it in the memory buffer, and immediately sends the host operating system a signal that the write operation is complete, without waiting until the data is actually written to the disk. Write-back cache mirrors all of the data from one controller module cache to the other. Write-back cache improves the performance of write operations and the throughput of the controller.

When write-back cache is disabled, *write-through* becomes the cache-writing strategy. Using write-through cache, the controller writes the data to the disks before signaling the host operating system that the process is complete. Write-through cache has lower write operation and throughput performance than write-back, but it is the safer strategy, with minimum risk of data loss on power failure. However, write-through cache does not mirror the write data because the data is written to the disk before posting command completion and mirroring is not required. You can set conditions that cause the controller to change from write-back caching to write-through caching.

In both caching strategies, active-active failover of the controllers is enabled.

You can enable and disable the write-back cache for each volume. By default, volume write-back cache is enabled. Because controller cache is backed by super-capacitor technology, if the system loses power, data is not lost. For most applications, this is the preferred setting.

If you are doing random access to this volume, leave the write-back cache enabled.

Note: The best practice for a fault-tolerant configuration is to use write-back caching.

Cache optimization mode

Caution: Changing the cache optimization setting while I/O is active can cause data corruption or loss. Before changing this setting, quiesce I/O from all initiators.

You can also change the optimization mode.

- **Standard**. This controller cache mode of operation is optimized for sequential and random I/O and is the optimization of choice for most workloads. In this mode, the cache is kept coherent with the partner controller. This mode gives you high performance and high redundancy. This is the default.
- **No-mirror**. In this mode of operation, the controller cache performs the same as the standard mode with the exception that the cache metadata is not mirrored to the partner. While this improves the response time of write I/O, it comes at the cost of redundancy. If this option is used, the user can expect higher write performance but is exposed to data loss if a controller fails.

Optimizing read-ahead caching

Caution: Only change read-ahead cache settings if you fully understand how the host operating system, application, and adapter move data so that you can adjust the settings accordingly.

You can optimize a volume for sequential reads or streaming data by changing its read-ahead cache settings. Read ahead can be forward (that is, increasing LBAs) or reverse (that is, decreasing LBAs). Increasing the read-ahead cache size can greatly improve performance for multiple sequential read streams. However, increasing read-ahead size will likely decrease random read performance.

- Adaptive. This option works well for most applications: it enables adaptive read-ahead, which allows the controller to dynamically calculate the optimum read-ahead size for the current workload. This is the default.
- Stripe. This option sets the read-ahead size to one stripe. The controllers treat non-RAID and RAID-1 vdisks internally as if they have a stripe size of 512 KB, even though they are not striped.
- Specific size options. These options let you select an amount of data for all accesses.
- Disabled. This option turns off read-ahead cache. This is useful if the host is triggering read ahead for what are random accesses. This can happen if the host breaks up the random I/O into two smaller reads, triggering read ahead.

About Managing Remote Systems

You can add a management object to obtain information from a remote storage system. This allows a local system to track remote systems by their network-port IP addresses and cache their login credentials — the user name and password for a user with the Manage role on that system. The IP address can then be used in commands that need to interact with the remote system.

After a remote system has been added, you can check the connectivity of host ports in the local system to host ports in that remote system. A port in the local system can only link to ports with the same host interface, such as Fibre Channel (FC), in a remote system.

Communication between local and remote systems is an essential part of the remote replication feature.

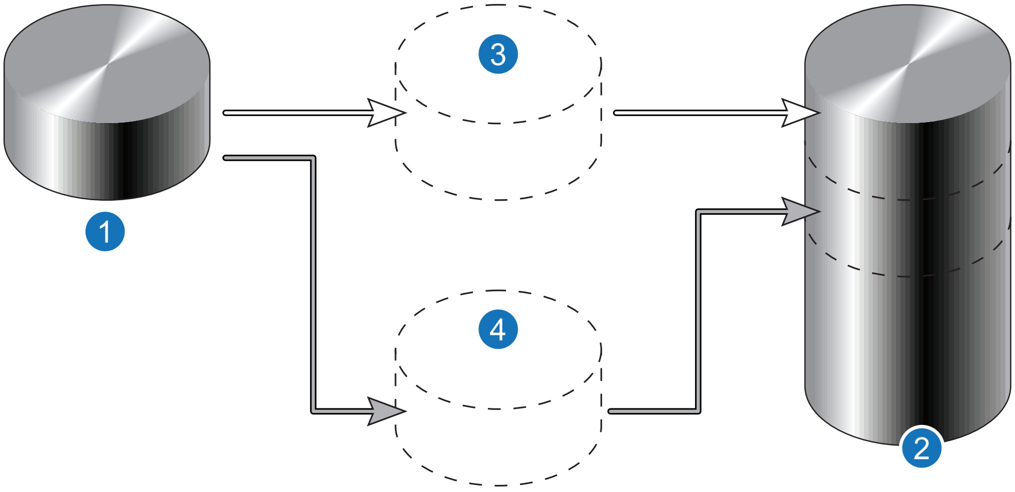
About the Snapshot Feature

Snapshot (AssuredSnap™) is a licensed feature that provides data protection by enabling you to create and save snapshots of a volume. Each snapshot preserves the source volume's data state at the point in time when the snapshot was created. Snapshots can be created manually or by using the task scheduler.

When the first snapshot is taken of a standard volume, the system automatically converts the volume into a *master volume* and reserves additional space for snapshot data. This reserved space, called a *snap pool*, stores pointers to the source volume's data. Each master volume has its own snap pool. The system treats a snapshot like any other volume. The snapshot can be mapped to hosts with read-only access, read-write access, or no access, depending on the snapshot's purpose. Any additional unique data written to a snapshot is also stored in the snap pool.

The following figure shows how the data state of a master volume is preserved in the snap pool by two snapshots taken at different points in time. The dotted line used for the snapshot borders indicates that snapshots are logical volumes, not physical volumes as are master volumes and snap pools.

Figure 1: Relationship between a master volume and its snapshots and snap pool



1. **MasterVolume-1**
2. **Snap Pool-1**
3. **Snapshot-1 (Monday)**
4. **Snapshot-2 (Tuesday)**

The snapshot feature uses the single copy-on-write method to capture only data that has changed. That is, if a block is to be overwritten on the master volume, and a snapshot depends on the existing data in the block being overwritten, the data is copied from the master volume to the snap pool before the data is changed. All snapshots that depend on the older data are able to access it from the same location in the snap pool. This reduces the impact of snapshots when writing to a master volume. In addition, only a single copy-on-write operation is performed on the master volume.

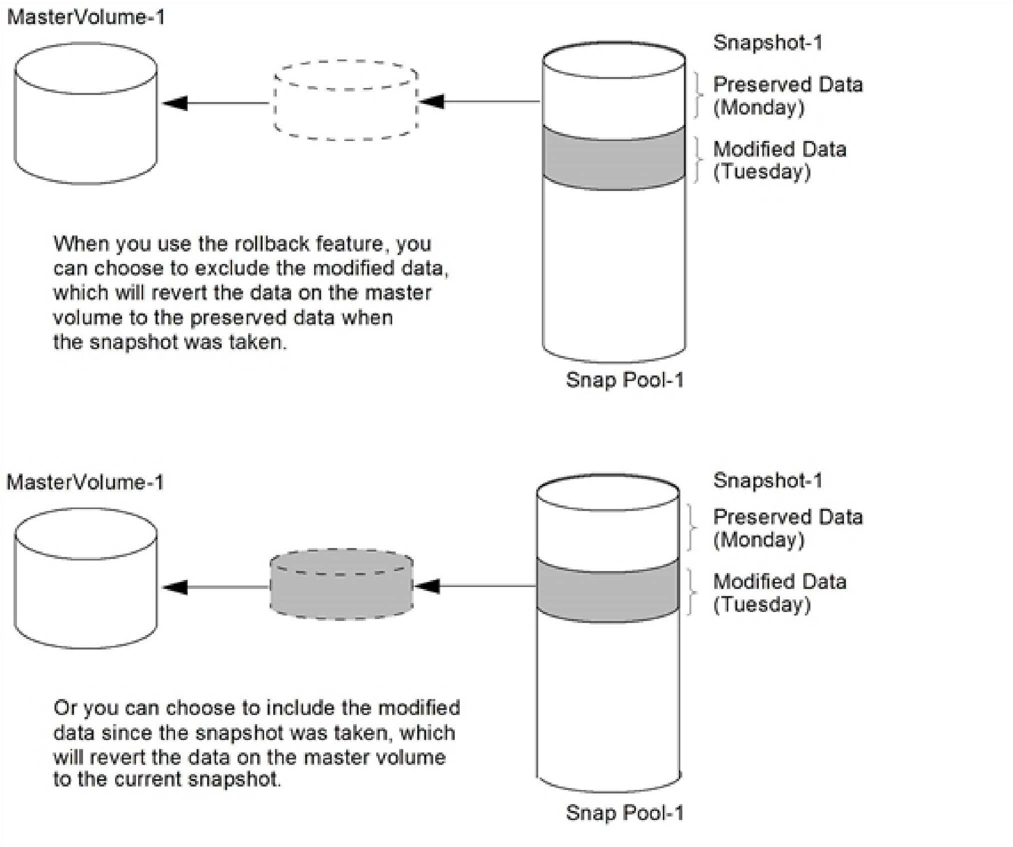
The storage system allows a maximum number of snapshots to be retained, as determined by an installed license. For example, if your license allows four snapshots, when the fifth snapshot is taken an error message informs you that you have reached the maximum number of snapshots allowed on your system. Before you can create a new snapshot you must either delete an existing snapshot, or purchase and install a license that increases the maximum number of snapshots.

The snapshot service has two features for reverting data back to original data:

- Deleting only modified data on a snapshot. For snapshots that have been made accessible as read-write, you can delete just the modified (write) data that was written directly to a snapshot. When the modified data is deleted, the snapshot data reverts to the original data that was snapped. This feature is useful for testing an application, for example. You might want to test some code, which writes data to the snapshot. Rather than having to take another snapshot, you can just delete any write data and start again.
- Rolling back the data in a source volume. The rollback feature enables you to revert the data in a source volume to the data that existed when a specified snapshot was created (preserved data). Alternatively, the rollback can include data that has been modified (write data) on the snapshot since the snapshot was taken. For example, you might want to take a snapshot, mount/present/map that snapshot for read/write, and then install new software on that snapshot for test purposes. If the software installation is successful, you can rollback the master volume to the contents of the modified snapshot (preserved data plus the write data).

The following figure shows the difference between rolling back the master volume to the data that existed when a specified snapshot was created (preserved), and rolling back preserved and modified data.

Figure 2: Rolling back a master volume


MasterVolume-1
Snapshot-1
Preserved Data (Monday)
Modified Data (Tuesday)
When you use the rollback feature, you can choose to exclude the modified data, which will revert the data on the master volume to the preserved data when the snapshot was taken.
Snap Pool-1
MasterVolume-1
Snapshot-1
Preserved Data (Monday)
Modified Data (Tuesday)
Or you can choose to include the modified data since the snapshot was taken, which will revert the data on the master volume to the current snapshot.
Snap Pool-1

Snapshot operations are I/O-intensive. Every write to a unique location in a master volume after a snapshot is taken will cause an internal read and write operation to occur in order to preserve the snapshot data. If you intend to create snapshots or copies of volumes in a vdisk, ensure that the vdisk contains no more than four master volumes, snap pools, or both.If you intend to create snapshots of, create volume copies of, or replicate volumes in a vdisk, ensure that the vdisk contains no more than four master volumes, snap pools, or both. For example: 2 master volumes and 2 snap pools; 3 master volumes and 1 snap pool; 4 master volumes and 0 snap pools.

About the Volume Copy Feature

Volume Copy (AssuredCopy™) is a licensed feature that enables you to copy a volume or a snapshot to a new standard volume.

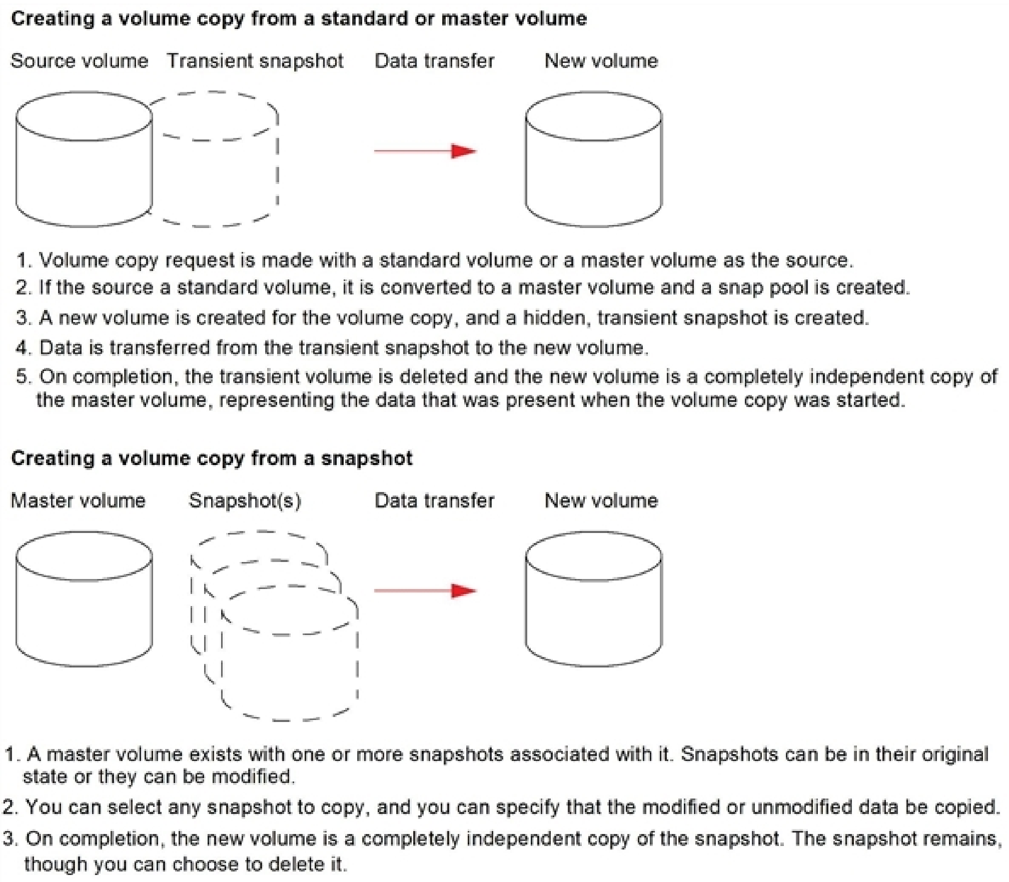
While a snapshot is a point-in-time logical copy of a volume, the volume copy service creates a complete “physical” copy of a volume within a storage system. It is an exact copy of a source volume as it existed at the time the volume copy operation was initiated, consumes the same amount of space as the source volume, and is independent from an I/O perspective. Volume independence is a key distinction of a volume copy (versus a snapshot, which is a “virtual” copy and dependent on the source volume).

Benefits include:

- Additional data protection. An independent copy of a volume (versus logical copy through snapshot) provides additional data protection against a complete master volume failure. If the source master volume fails, the volume copy can be used to restore the volume to the point in time the volume copy was taken.
- Non-disruptive use of production data. With an independent copy of the volume, resource contention and the potential performance impact on production volumes is mitigated. Data blocks between the source and the copied volumes are independent (versus shared with snapshot) so that I/O is to each set of blocks respectively. Application I/O transactions are not competing with each other when accessing the same data blocks.

The following figure illustrates how volume copies are created.

Figure 3: Creating a volume copy from a master volume or a snapshot



Creating a volume copy from a standard or master volume

1. Volume copy request is made with a standard volume or a master volume as the source.
2. If the source a standard volume, it is converted to a master volume and a snap pool is created.
3. A new volume is created for the volume copy, and a hidden, transient snapshot is created.
4. Data is transferred from the transient snapshot to the new volume.
5. On completion, the transient volume is deleted and the new volume is a completely independent copy of the master volume, representing the data that was present when the volume copy was started.

Creating a volume copy from a snapshot

1. A master volume exists with one or more snapshots associated with it. Snapshots can be in their original state or they can be modified.
2. You can select any snapshot to copy, and you can specify that the modified or unmodified data be copied.
3. On completion, the new volume is a completely independent copy of the snapshot. The snapshot remains, though you can choose to delete it.

Snapshot operations are I/O-intensive. Every write to a unique location in a master volume after a snapshot is taken will cause an internal read and write operation to occur in order to preserve the snapshot data. If you intend to create snapshots of, create volume copies of, or replicate volumes in a vdisk, ensure that the vdisk contains no more than four master volumes, snap pools, or both. For example: 2 master volumes and 2 snap pools; 3 master volumes and
1 snap pool; 4 master volumes and 0 snap pools.

Guidelines to keep in mind when performing a volume copy include:

- The destination vdisk must be owned by the same controller as the source volume.

- The destination vdisk must have free space that is at least as large as the amount of space allocated to the original volume. A new volume will be created using this free space for the volume copy.
- The destination vdisk does not need to have the same attributes (such as disk type, RAID level) as the volume being copied.
- Once the copy is complete, the new volume will no longer have any ties to the original.
- Volume Copy makes a copy from a snapshot of the source volume. Therefore, the snap pool for the source volume must have sufficient space to store snapshot data when performing this copy.

About the AssuredRemote Replication feature

See About the AssuredRemote Replication Feature on page 171.

About the VDS and VSS Hardware Providers

Virtual Disk Service (VDS) enables host-based applications to manage vdisks and volumes. Volume Shadow Copy Service (VSS) enables host-based applications to manage snapshots. A license is required to enable VDS and VSS hardware providers, so hosts can manage vdisks, volumes, and snapshots in the storage system. For more information, see the VDS and VSS hardware provider documentation for your product.

About the Storage Replication Adapter (SRA)

The SRA is a host-software component installed on a Microsoft Windows Server operating system that allows VMware vCenter Site Recovery Manager software to control certain aspects of the replication feature in storage systems. The presence of the SRA allows the disaster recovery software to automatically coordinate virtual-machine failover and failback between a protected data center and a disaster recovery site. A license is required to enable the SRA.

About RAID Levels

The RAID controllers enable you to set up and manage vdisks, the storage for which may be spread across multiple disks. This is accomplished through firmware resident in the RAID controller. RAID refers to vdisks in which part of the storage capacity may be used to achieve fault tolerance by storing redundant data. The redundant data enables the system to reconstruct data if a disk in the vdisk fails.

Hosts see each partition of a vdisk, known as a volume, as a single disk. A volume is actually a portion of the storage space on disks behind a RAID controller. The RAID controller firmware makes each volume appear as one very large disk. Depending on the RAID level used for a vdisk, the disk presented to hosts has advantages in fault-tolerance, cost, performance, or a combination of these.

Note: Choosing the right RAID level for your application improves performance.

The following tables:

- Provide examples of appropriate RAID levels for different applications
- Compare the features of different RAID levels
- Describe the expansion capability for different RAID levels

Note: To create an NRAID, RAID-0, or RAID-3 vdisk, you must use the CLI `create vdisk` command. For more information on this command, see the CLI Reference Guide.

Table 4: Example applications and RAID levels (v2)

Application	RAID level
Testing multiple operating systems or software development (where redundancy is not an issue)	NRAID
Fast temporary storage or scratch disks for graphics, page layout, and image rendering	0
Workgroup servers	1 or 10
Video editing and production	3
Network operating system, databases, high availability applications, workgroup servers	5
Very large databases, web server, video on demand	50
Mission-critical environments that demand high availability and use large sequential workloads	6

Table 5: RAID level comparison(v2)

RAID level	Min. disks	Description	Strengths	Weaknesses
NRAID	1	Non-RAID, nonstriped mapping to a single disk	Ability to use a single disk to store additional data	Not protected, lower performance (not striped)
0	2	Data striping without redundancy	Highest performance	No data protection: if one disk fails all data is lost
1	2	Disk mirroring	Very high performance and data protection; minimal penalty on write performance; protects against single disk failure	High redundancy cost overhead: because all data is duplicated, twice the storage capacity is required

RAID level	Min. disks	Description	Strengths	Weaknesses
3	3	Block-level data striping with dedicated parity disk	Excellent performance for large, sequential data requests (fast read); protects against single disk failure	Not well-suited for transaction-oriented network applications; write performance is lower on short writes (less than 1 stripe)
5	3	Block-level data striping with distributed parity	Best cost/performance for transaction-oriented networks; very high performance and data protection; supports multiple simultaneous reads and writes; can also be optimized for large, sequential requests; protects against single disk failure	Write performance is slower than RAID 0 or RAID 1
6	4	Block-level data striping with double distributed parity	Best suited for large sequential workloads; non-sequential read and sequential read/write performance is comparable to RAID 5; protects against dual disk failure	Higher redundancy cost than RAID 5 because the parity overhead is twice that of RAID 5; not well-suited for transaction-oriented network applications; non-sequential write performance is slower than RAID 5
10 (1+0)	4	Stripes data across multiple RAID-1 sub-vdisks	Highest performance and data protection (protects against multiple disk failures)	High redundancy cost overhead: because all data is duplicated, twice the storage capacity is required; requires minimum of four disks
50 (5+0)	6	Stripes data across multiple RAID-5 sub-vdisks	Better random read and write performance and data protection than RAID 5; supports more disks than RAID 5; protects against multiple disk failures	Lower storage capacity than RAID 5

Table 6: Vdisk expansion by RAID level (v2)

RAID level	Expansion capability	Maximum disks
NRAID	Cannot expand.	1
0, 3, 5, 6	You can add 1–4 disks at a time.	16
1	Cannot expand.	2

RAID level	Expansion capability	Maximum disks
10	You can add 2 or 4 disks at a time.	16
50	You can add one sub-vdisk at a time. The added sub-vdisk must contain the same number of disks as each of the existing sub-vdisks.	32

About Size Representations

Parameters such as names of users and volumes have a maximum length in bytes. When encoded in UTF-8, a single character can occupy multiple bytes. Standard US-ASCII characters require 1 byte; most Latin (Western European), Cyrillic, and Arabic characters are encoded with 2 bytes; most Asian characters are 3 bytes.

Operating systems usually show volume size in base 2. Disk drives usually show size in base 10. Memory (RAM and ROM) size is always shown in base 2. In the Disk Management Utility (V2), the base for entry and display of storage-space sizes can be set per user or per session. When entering storage-space sizes only, either base-2 or base-10 units can be specified.

Table 7: Size representations in base 2 and base 10 (v2)

Base 2		Base 10	
Unit	Size in bytes	Unit	Size in bytes
KiB (kibibyte)	1,024	KB (kilobyte)	1,000
MiB (mebibyte)	$1,024^2$	MB (megabyte)	$1,000^2$
GiB (gibibyte)	$1,024^3$	GB (gigabyte)	$1,000^3$
TiB (tebibyte)	$1,024^4$	TB (terabyte)	$1,000^4$
PiB (pebibyte)	$1,024^5$	PB (petabyte)	$1,000^5$
EiB (exbibyte)	$1,024^6$	EB (exabyte)	$1,000^6$

The locale setting determines the character used for the decimal (radix) point, as shown below.

Table 8: Decimal (radix) point character by locale (v2)

Language	Character	Examples
Arabic, English, Chinese, Japanese, Korean, Russian	Period (.)	146.81 GB 3.0 Gbit/s
Dutch, French, German, Italian, Portuguese, Spanish	Comma (,)	146,81 GB 3,0 Gbit/s

About the System Date and Time

You can change the storage system's date and time, which are displayed in the System Status panel. It is important to set the date and time so that entries in system logs and event-notification email messages have correct time stamps.

You can set the date and time manually or configure the system to use Network Time Protocol (NTP) to obtain them from a network-attached server. When NTP is enabled, and if an NTP server is available, the system time and date can be obtained from the NTP server. This allows multiple storage devices, hosts, log files, and so forth to be synchronized. If NTP is enabled but no NTP server is present, the date and time are maintained as if NTP was not enabled.

NTP server time is provided in Coordinated Universal Time (UTC), which provides several options:

- If you want to synchronize the times and logs between storage devices installed in multiple time zones, set all the storage devices to use UTC.
- If you want to use the local time for a storage device, set its time zone offset.
- If a time server can provide local time rather than UTC, configure the storage devices to use that time server, with no further time adjustment.

Whether NTP is enabled or disabled, the storage system does not automatically make time adjustments, such as for U.S. daylight savings time. You must make such adjustments manually.

About Storage-space Color Codes

The Disk Management Utility (V2) panels use the following color codes to identify how storage space is used.

Table 9: Storage-space color codes (v2)

Area	Color	Meaning
Overview panels	🟦	Total space
	🟩	Available/free space
	🟦	Used space
	🟪	Reserved/overhead space, used for parity and snap pools, for example
Vdisk panels	🟧	Space used by spares
	🟪	Wasted space, due to use of mixed disk sizes

About Configuration View Icons

The Configuration View panel uses the following icons to let you view physical and logical components of the storage system.

Table 10: Configuration View icons (v2)

Icon	Meaning	Icon	Meaning
++	Show all subcomponents		Snapshot
--	Hide all subcomponents		Snap pool
⊞	Show the component's subcomponents		Replication-prepared volume
⊟	Hide the component's subcomponents		Local primary volume
	Storage system		Local secondary volume
	Enclosure		Local replication image
	Host/initiator		Remote primary volume
	Vdisk		Remote secondary volume
	Standard or master volume		Remote replication image

About Disk Failure and vdisk Reconstruction

Vdisk reconstruction does not require I/O to be stopped, so the vdisk can continue to be used while the Reconstruct utility runs. Vdisk reconstruction starts automatically when all of the following are true:

- One or more disks fail in a fault-tolerant vdisk (RAID 1, 3, 5, 6, 10, or 50)
- The vdisk is still operational
- Compatible spares are available

The storage system automatically uses the spares to reconstruct the vdisk. A compatible spare has a capacity equal to or greater than the smallest disk in the vdisk, has enough capacity to replace a failed disk, and is the same type (SASSSD for AssuredSAN 4004 only, enterprise SAS, or midline SAS) as those disks. If no compatible spares are available, reconstruction does not start automatically. To start reconstruction manually, replace each failed disk and then do one of the following:

- Add each new disk as either a dedicated spare or a global spare. Remember that a global spare might be taken by a different critical vdisk than the one you intended. When a global spare replaces a disk in a vdisk, the global spare's icon in the enclosure view changes to match the other disks in that vdisk.
- Enable the Dynamic Spare Capability option to use the new disks without designating them as spares.
- Change a dedicated spare from a different vdisk to either a global spare or a dedicated spare for the degraded vdisk.

RAID-6 reconstruction behaves as follows:

- During online initialization, if one disk fails, initialization continues and the resulting vdisk will be degraded (FTDN status). After initialization completes, the system can use a compatible spare to reconstruct the vdisk.
- During online initialization, if two disks fail, initialization stops (CRIT status). The system can use two compatible spares to reconstruct the vdisk.
- During vdisk operation, if one disk fails and a compatible spare is available, the system begins to use that spare to reconstruct the vdisk. If a second disk fails during reconstruction, reconstruction continues until it is complete, regardless of whether a second spare is available. If the spare fails during reconstruction, reconstruction stops.
- During vdisk operation, if two disks fail and only one compatible spare is available, the system waits five minutes for a second spare to become available. After five minutes, the system begins to use that spare to reconstruct one disk in the vdisk (referred to as “fail 2, fix 1” mode). If the spare fails during reconstruction, reconstruction stops.
- During vdisk operation, if two disks fail and two compatible spares are available, the system uses both spares to reconstruct the vdisk. If one of the spares fails during reconstruction, reconstruction proceeds in “fail 2, fix 1” mode. If the second spare fails during reconstruction, reconstruction stops.

When a disk fails, its fault LED is illuminated. When a spare is used as a reconstruction target, its activity LED is illuminated. During reconstruction, the fault LED and activity LEDs for all disks in the disk group blink. For details about LED states, see your product’s Setup Guide.

ℹ **Note:** Reconstruction can take hours or days to complete, depending on the vdisk RAID level and size, disk speed, utility priority, and other processes running on the storage system. You can stop reconstruction only by deleting the vdisk.

About Data Protection in a Single-controller Storage System

The storage system can operate with a single controller module. Because single-controller mode is not a redundant configuration, this section presents some considerations concerning data protection.

A volume’s default caching mode is write back, as opposed to write through. In write-back mode, data is held in controller cache until it is written to disk. In write-through mode, data is written directly to disk.

If the controller fails while in write-back mode, unwritten cache data likely exists. The same is true if the controller enclosure or the target volume’s enclosure is powered off without a proper shut down. Data remains in the controller’s cache and associated volumes will be missing that data. This can result in data loss or in some cases volume loss.

If the controller can be brought back online long enough to perform a proper shut down, the controller should be able to write its cache to disk without causing data loss.

To avoid the possibility of data loss in case the controller fails you can change a volume’s caching mode to write through. While this will cause significant performance degradation, this configuration guards against data loss. While write-back mode is much faster, this mode is not guaranteed against data loss in the case of a controller failure. If data protection is more important, use write-through caching. If performance is more important, use write-back caching.

For details about caching modes see About Volume Cache Options on page 13. To change a volume's caching mode, see Changing a Volume's Cache Settings on page 77.

About Managed Logs

As the storage system operates, it records diagnostic data in several types of log files. The size of any log file is limited, so over time and during periods of high activity, these logs can fill up and begin overwriting their oldest data. The managed logs feature allows log data to be transferred to a log-collection system before any data is lost. The transfer does not remove any data from the logs in the storage system. This feature is disabled by default.

The *log-collection system* is a host computer that is designated to receive the log data transferred from the storage system. Because log data is transferred incrementally, the log-collection system is responsible for integrating the log data for display and analysis.

The managed logs feature can be configured to operate in push mode or *pull mode*:

- In push mode, when log data has accumulated to a significant size, the storage system sends notifications with attached log files via email to the log-collection system. The notification will specify the storage-system name, location, contact, and IP address, and will contain a single log segment in a compressed zip file. The log segment will be uniquely named to indicate the log-file type, the date/time of creation, and the storage system. This information will also be in the email subject line. The file name format is `logtype_yyyy_mm_dd__hh_mm_ss.zip`.
- In pull mode, when log data has accumulated to a significant size, the system sends notifications via email, SNMP, or SMI-S to the log-collection system, which can then use FTP to transfer the appropriate logs from the storage system. The notification will specify the storage-system name, location, contact, and IP address and the log-file type (region) that needs to be transferred.

The managed logs feature monitors the following controller-specific log files:

- Expander Controller (EC) log, which includes EC debug data, EC revisions, and PHY statistics
- Storage Controller (SC) debug log and controller event log
- SC crash logs, which include the SC boot log
- Management Controller (MC) log

Each log-file type also contains system-configuration information. The capacity status of each log file is maintained, as well as the status of what data has already been transferred. Three capacity-status levels are defined for each log file:

- Need to transfer: The log file has filled to the threshold at which content needs to be transferred. This threshold varies for different log files. When this level is reached:
  - In push mode, informational event 400 and all untransferred data is sent to the log-collection system.
  - In pull mode, informational event 400 is sent to the log-collection system, which can then request the untransferred log data. The log-collection system can pull log files individually, by controller.
- Warning: The log file is nearly full of untransferred data. When this level is reached, warning event 401 is sent to the log-collection system.

- Wrapped: The log file has filled with untransferred data and has started to overwrite its oldest data. When this level is reached, informational event 402 is sent to the log-collection system.

Following the transfer of a log's data in push or pull mode, the log's capacity status is reset to zero to indicate that there is no untransferred data.

Note: In push mode, if one controller is offline its partner will send the logs from both controllers.

Alternative methods for obtaining log data are to use the Disk Management Utility (V2)'s Save Logs panel or the FTP interface's `get logs` command. These methods will transfer the entire contents of a log file without changing its capacity-status level. Use of Save Logs or `get logs` is expected as part of providing information for a technical support request. For information about using the Save Logs panel, see Saving Logs on page 113. For information about using the FTP interface, see Using FTP on page 217.

About Performance Monitoring

The storage system samples disk-performance statistics every quarter hour and retains performance data for 6 months. You can view these historical performance statistics to identify disks that are experiencing errors or are performing poorly.

The Disk Management Utility (V2) displays historical performance statistics in graphs for ease of analysis. You can view historical performance statistics either for a single disk or for all disks in a vdisk. By default, the graphs will show the latest 50 data samples, but you can specify the time period to display. If the specified time period includes more than 50 samples, their data will be aggregated into 50 samples. The graphs show a maximum of 50 samples. Data shown will be up-to-date as of the time it is requested for display, and summary statistics will be updated when a new sample is taken.

Disk-performance graphs include:

- Data Transferred
- Data Throughput
- I/O
- IOPS
- Average Response Time
- Average I/O Size
- Disk Error Counters
- Average Queue Depth

Vdisk-performance graphs include:

- Data Transferred
- Data Throughput
- Average Response Time

You can save historical statistics in CSV format to a file for import into a spreadsheet or other third-party application. You can also reset historical statistics, which clears the retained data and continues to gather new samples.

Note: The Disk Management Utility (V2) does not show live statistics. For information about viewing live statistics, see the CLI Reference Guide.

About Firmware Update

Controller modules, expansion modules, drawers, and disk drives contain firmware that operate them. As newer firmware versions become available, they may be installed at the factory or at a customer maintenance depot or they may be installed by storage-system administrators at customer sites. The controller-module firmware-update algorithm supports the following scenarios for a dual-controller system:

- The administrator installs a new firmware version in one controller and wants that version to be transferred to the partner controller.
- In a system that has been qualified with a specific firmware version, the administrator replaces one controller module and wants the firmware version in the remaining controller to be transferred to the new controller (which might contain older or newer firmware).

When a controller module is installed into an enclosure at the factory, the enclosure midplane serial number and firmware-update timestamp are recorded for each firmware component in controller flash memory, and will not be erased when the configuration is changed or is reset to defaults. These two pieces of data are not present in controller modules that are not factory-installed and are used as replacements.

When you update controller firmware, the Partner Firmware Update (PFU) option, which is enabled by default, ensures that the same firmware version is installed in both controller modules. PFU uses the following algorithm to determine which controller module will update its partner:

- If both controllers are running the same firmware version, no change is made.
- If the firmware in only one controller has the proper midplane serial number then the firmware, midplane serial number, and attributes of that controller are transferred to the partner controller. After, the firmware update behavior for both controllers depends on the system settings.
- If the firmware in both controllers has the proper midplane serial number then the firmware having the latest firmware-update timestamp is transferred to the partner controller.
- If the firmware in neither controller has the proper midplane serial number then the newer firmware version in either controller is transferred to the other controller.

For information about the procedures to update firmware in controller modules, expansion modules, drawers, and disk drives, see Updating Firmware on page 109. That topic also describes how to use the activity progress interface to view detailed information about the progress of a firmware-update operation.

About Full Disk Encryption (for QXS-4//6 Series Only)

Full Disk Encryption (FDE) is a method by which you can secure the data residing on the drives. It uses self-encrypting drives (SED), which are also referred to as FDE-capable disks. When secured and removed from a secured system, FDE-capable disks cannot be read by other systems.

The ability to secure a disk and system relies on passphrases and lock keys. A passphrase is a user-created password that allows users to manage lock keys. A lock key is generated by the system and manages the encryption and decryption of data on the disks. A lock key is persisted on the storage system and is not available outside the storage system.

A system and the FDE-capable disks in the system are initially unsecured but can be secured at any point. Until the system is secured, FDE-capable disks function exactly like disks that do not support FDE.

Enabling FDE protection involves setting a passphrase and securing the system. Data that was present on the system before it was secured is accessible in the same way it was when it was unsecured. However, if a disk is transferred to an unsecured system or a system with a different passphrase, the data is not accessible.

Secured disks and systems can be repurposed without needing the correct passphrase. Repurposing erases all data and unsecures the system and disks.

FDE operates on a per-system basis, not a per-vdisk basis. To use FDE, all disks in the system must be FDE-capable.

For information about the procedures to change FDE settings, see Changing FDE settings (for QXS-4/6 Series Only) on page 65.

Chapter 2: Configuring the System

This chapter contains the following topics:

Configuration Processes

You can configure your system by using one of the following methods:

- Using the One Button Configuration Feature: This feature is designed to set up disk/drive profiles that make efficient use of the number of drives in the QXS-1200, QXS-2400, and QXS-5600. It provides a convenient method for creating StorNext volumes. You will select the profile for the desired volume and click a button. The following events are triggered:
- A RAID vdisk is created.
- A volume or volumes are created.
- The logical unit LUN is mapped to the host ports.
- A StorNext label is written to the volume(s).
- Using the Configuration Wizard: The Configuration Wizard helps you create a vdisk with volumes and to map the volumes to hosts.
- Before using this wizard, read documentation for your product to learn about vdisks, volumes, and mapping.
- Then plan the vdisks and volumes you want to create and the default mapping settings you want to use.

Available QXS Systems

Table 11 below provides the available QXS systems, drive types, drive count, and enclosure types supported.

Table 11: Available QXS Systems

System	Drive Types	Drive Count	Enclosure Types
QXS-312/412	LFF HDDs/SSDs	12	RBOD & JBOD
QXS-324/424	SFF HDDs/SSDs	24	RBOD & JBOD
QXS-448/648	SFF HDDs/SSDs	48	RBOD & JBOD
QXS-456/656	LFF HDDs/SSDs	56	RBOD & JBOD
QXS-1200	LFF HDDs only	12	RBOD & JBOD
QXS-2400	SFF HDDs only	24	RBOD & JBOD
QXS-5600	LFF HDDs only	56	RBOD & JBOD

Using the One Button Configuration Feature

This section includes the following topics:

- One Button Configuration Overview
- StorNext Labels
- Using the One Button Configuration

One Button Configuration Overview

The One-Button Configuration is a feature that provides a:

- User-initiated one-button configuration for Quantum's QXS disk arrays
- Quick customer-initiated set-up of volumes
- Quantum-exclusive feature
- WBI to be used with the QXS systems
- All default profiles are StorNext profiles, but the default profiles can be replaced as needed.

Table 12 below provides the One Button Configuration storage profiles:

Table 12: Storage Profiles

Profile	Vdisk	Chunk Size	12-Drive	24-Drive	48-Drive	56-Drive
StorNext Metadata 1+1	RAID1	N/A	Yes	Yes	Yes	Yes
StorNext Data 10+2	RAID6	256k	Yes	Yes	Yes	Yes
StorNext Data 12+2	RAID6	256k	No	No	No	Yes
StorNext Data 5+2	RAID6	256k	Yes	Yes	Yes	Yes
StorNext Data 8+2	RAID6	128k	Yes	Yes	Yes	Yes
MultiVolume 10+2	RAID6	256k	Yes	Yes	Yes	Yes
StorNext MultiVolume 12+2	RAID6	128k	No	No	No	Yes
StorNext MultiVolume 10+2	RAID6	256k	Yes	Yes	Yes	Yes

Note: The QXS system can use the eight pre-defined profiles if the correct number of drives are installed to support the RAID type.

StorNext Labels

The StorNext label is dependent on the name of the array system name being set up. See the section Setting system information. The array system name must be unique among all StorNext arrays on the SAN.

It is suggested that the array system name be a component of the array's hostnames on the network. For example, if the array name is qx1, the network hostname of the management port on controller A would be qx1a and the hostname of the management port for controller B would be qx1b. Thus the array system name must follow naming conventions for hostnames.

Note: Only upper and lower case letters, numbers, and hyphens are allowed. As the array system name will be a component of the StorNext label, short but descriptive names are recommended.

For example, if we choose the button to create a StorNext Data 10+2 volume on the array named qx1, we will create a StorNext label on the volume that looks something like snfs_data_qx1_L2.

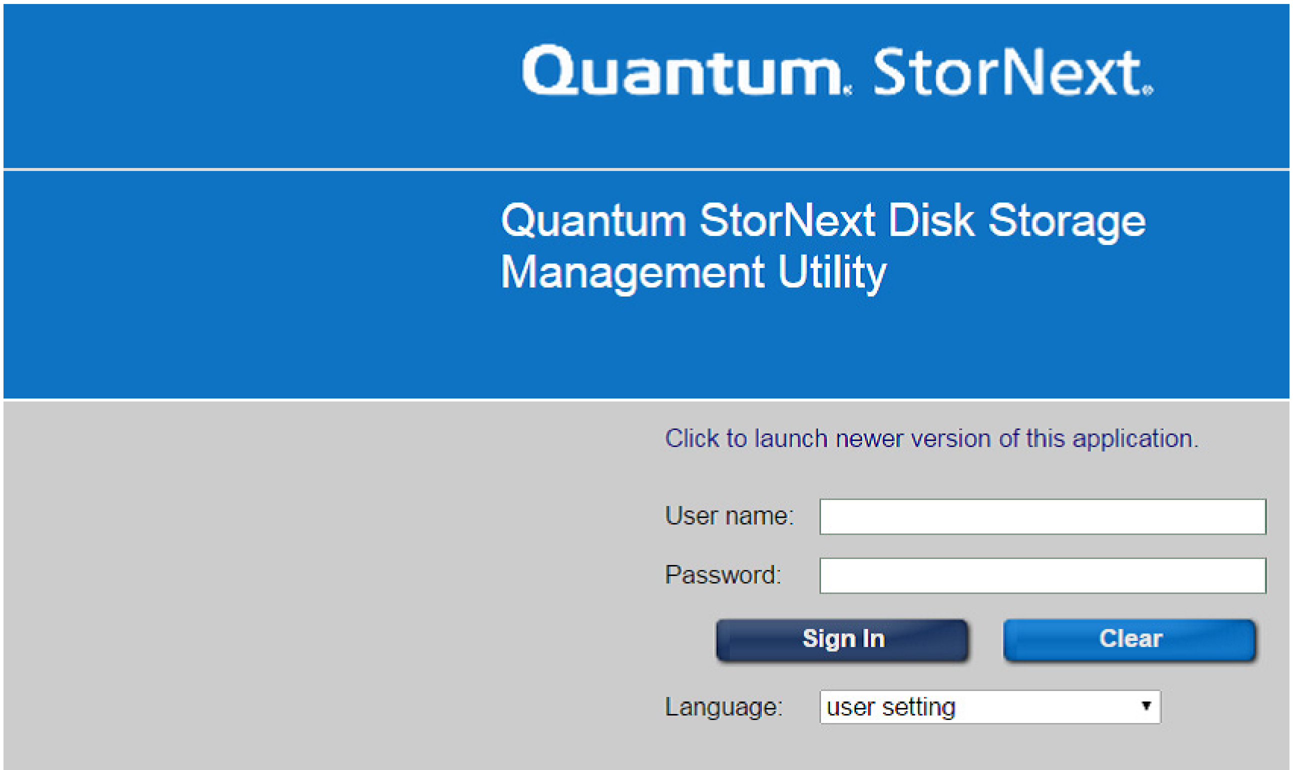
The L2 signifies the volume is mapped to LUN 2 on the array. The array system name and the LUN provide a unique identifier for the StorNext volume in the SAN.

Using the One Button Configuration

To create StorNext volumes:

1. Login to the WBI (Disk Storage Management Utility, V2).

Figure 4: Login Screen



Quantum StorNext Disk Storage Management Utility

Click to launch newer version of this application.

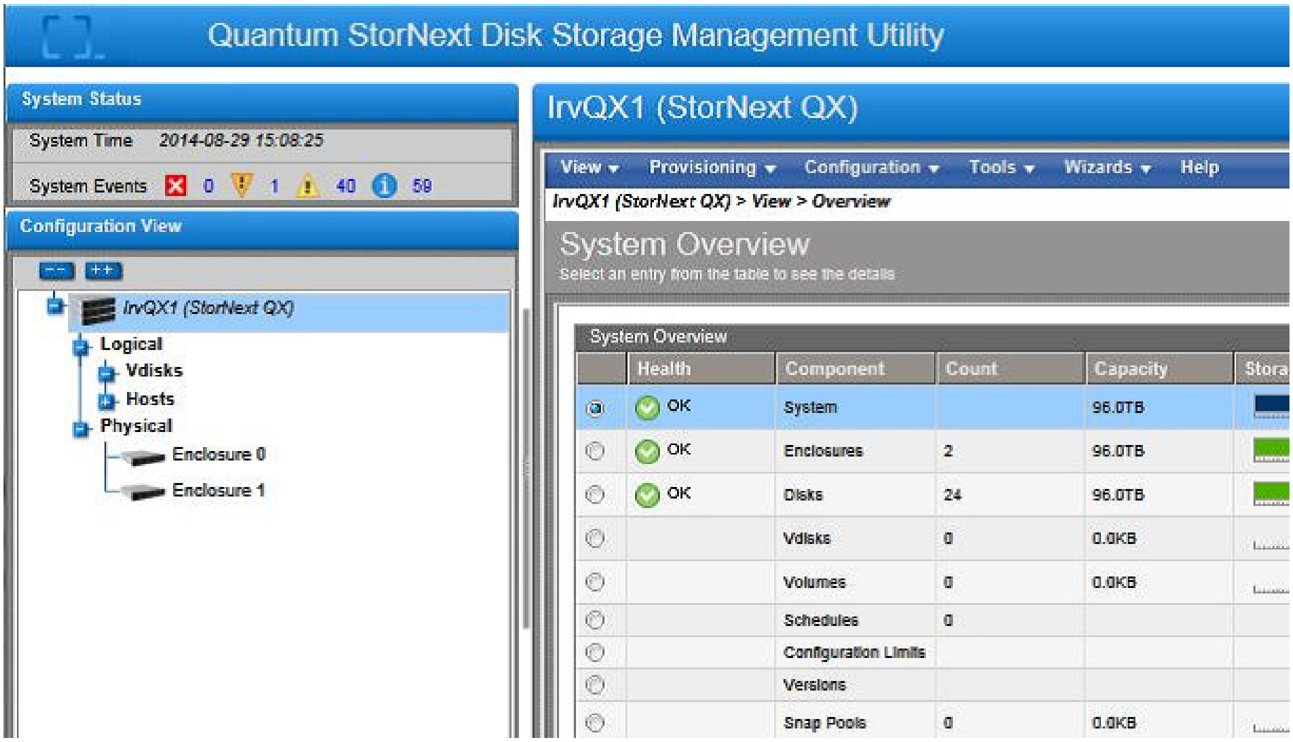
User name:

Password:

Language: user setting

2. In the System Overview panel, click on the Provisioning menu.

Figure 5: Provisioning Tab



System Time 2014-08-29 15:08:25

System Events ☒ 0 1 40 59

IrvQX1 (StorNext QX)

IrvQX1 (StorNext QX) > View > Overview

System Overview

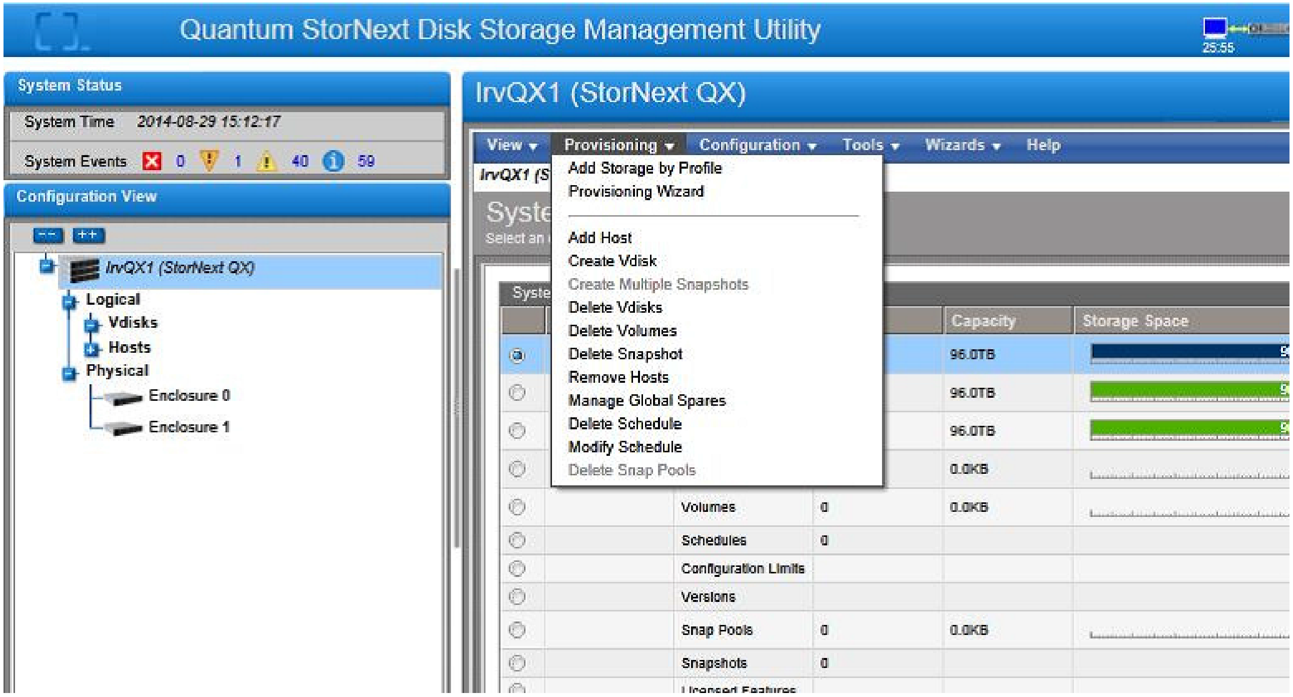
Select an entry from the table to see the details

System Overview

	Health	Component	Count	Capacity	Stora
●	✓ OK	System		96.0TB	
○	✓ OK	Enclosures	2	96.0TB	
○	✓ OK	Disks	24	96.0TB	
○		Vdisks	0	0.0KB	
○		Volumes	0	0.0KB	
○		Schedules	0		
○		Configuration Limits			
○		Versions			
○		Snap Pools	0	0.0KB	

3. In the Provisioning menu, select "Add Storage by Profile."

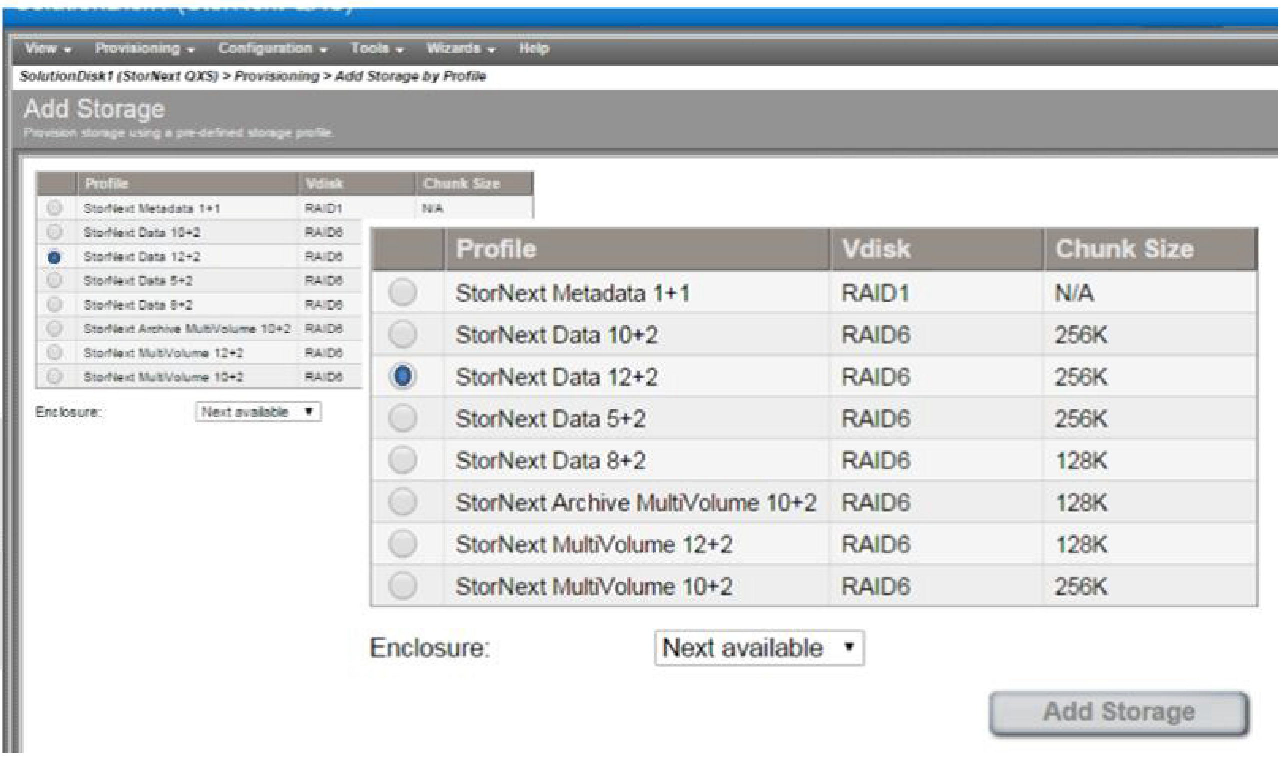
Figure 6: Add Storage by Profile



4. In the Add Storage panel, select the type of RAID and enclosure you will use.

Note: Any of the eight RAID types can be selected for the QXS-5600. Refer to Table 12 on page 32 for the RAID types available for the QXS systems.

Figure 7: Selecting RAID Type



SolutionDisk1 (StorNext QXS) > Provisioning > Add Storage by Profile

Add Storage

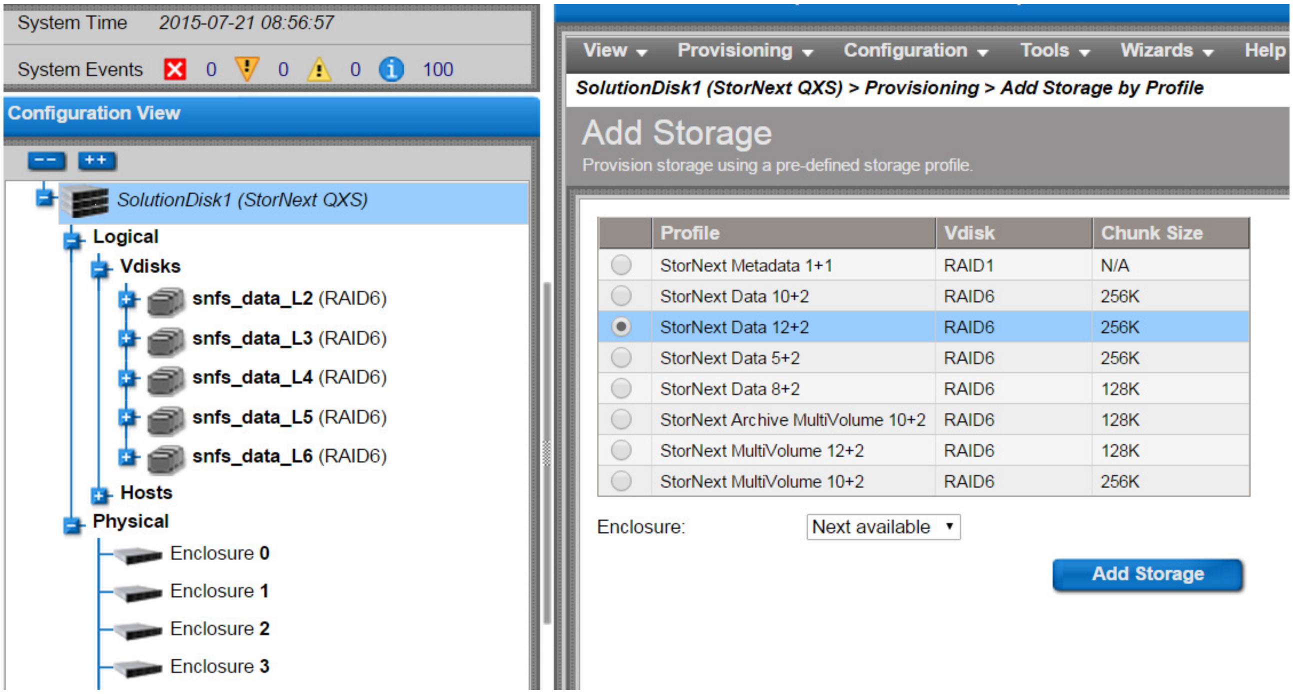
Provision storage using a pre-defined storage profile.

	Profile	Vdisk	Chunk Size
○	StorNext Metadata 1+1	RAID1	N/A
○	StorNext Data 10+2	RAID6	256K
●	StorNext Data 12+2	RAID6	256K
○	StorNext Data 5+2	RAID6	256K
○	StorNext Data 8+2	RAID6	128K
○	StorNext Archive MultiVolume 10+2	RAID6	128K
○	StorNext MultiVolume 12+2	RAID6	128K
○	StorNext MultiVolume 10+2	RAID6	256K

Enclosure: Next available ▾

5. After selecting the RAID type and enclosure in the Add Storage panel, click on the “Add Storage” button.

Figure 8: Add Storage Button



SolutionDisk1 (StorNext QXS) > Provisioning > Add Storage by Profile

Add Storage

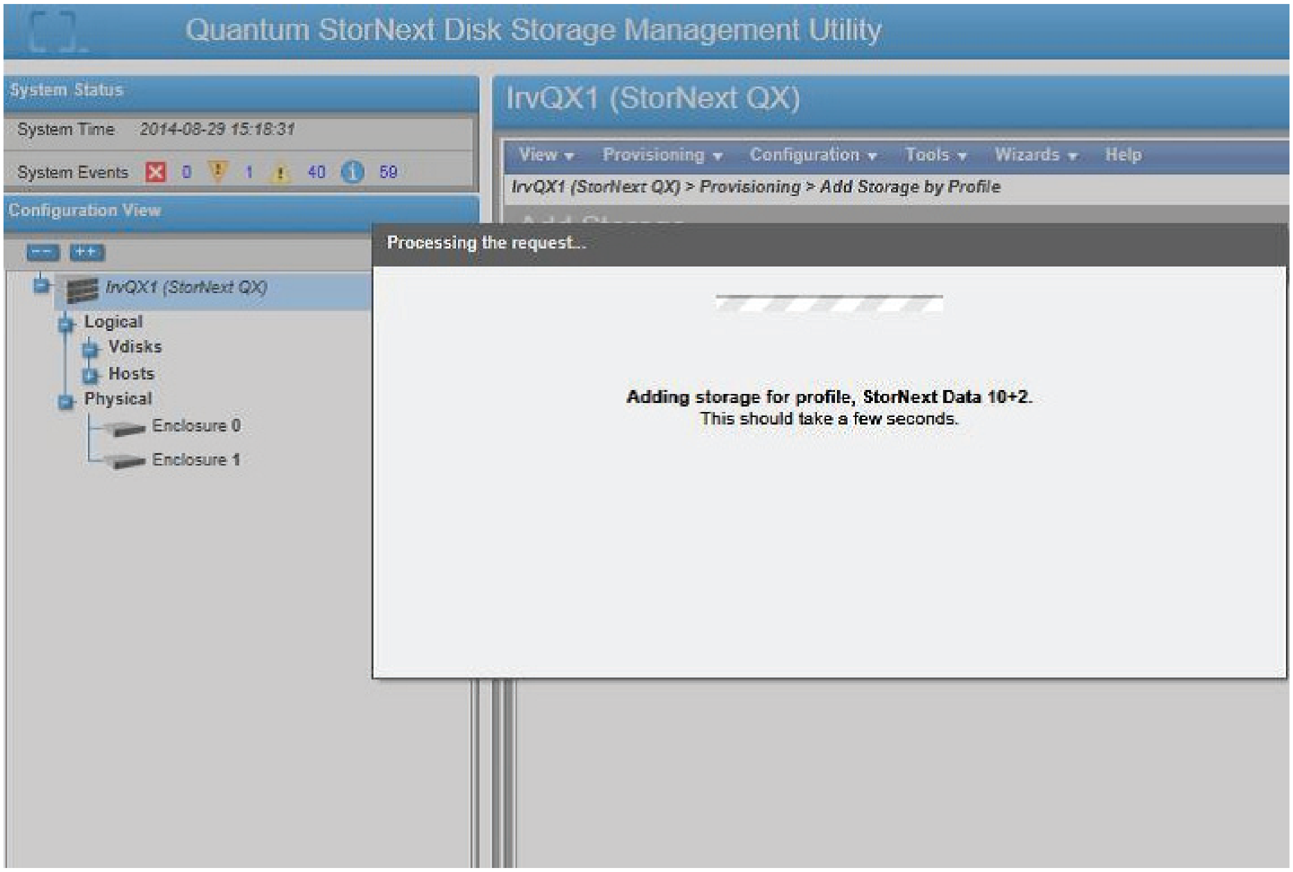
Provision storage using a pre-defined storage profile.

	Profile	Vdisk	Chunk Size
○	StorNext Metadata 1+1	RAID1	N/A
○	StorNext Data 10+2	RAID6	256K
●	StorNext Data 12+2	RAID6	256K
○	StorNext Data 5+2	RAID6	256K
○	StorNext Data 8+2	RAID6	128K
○	StorNext Archive MultiVolume 10+2	RAID6	128K
○	StorNext MultiVolume 12+2	RAID6	128K
○	StorNext MultiVolume 10+2	RAID6	256K

Enclosure: Next available

6. When the process begins, you will see a message stating “Adding storage for profile”.

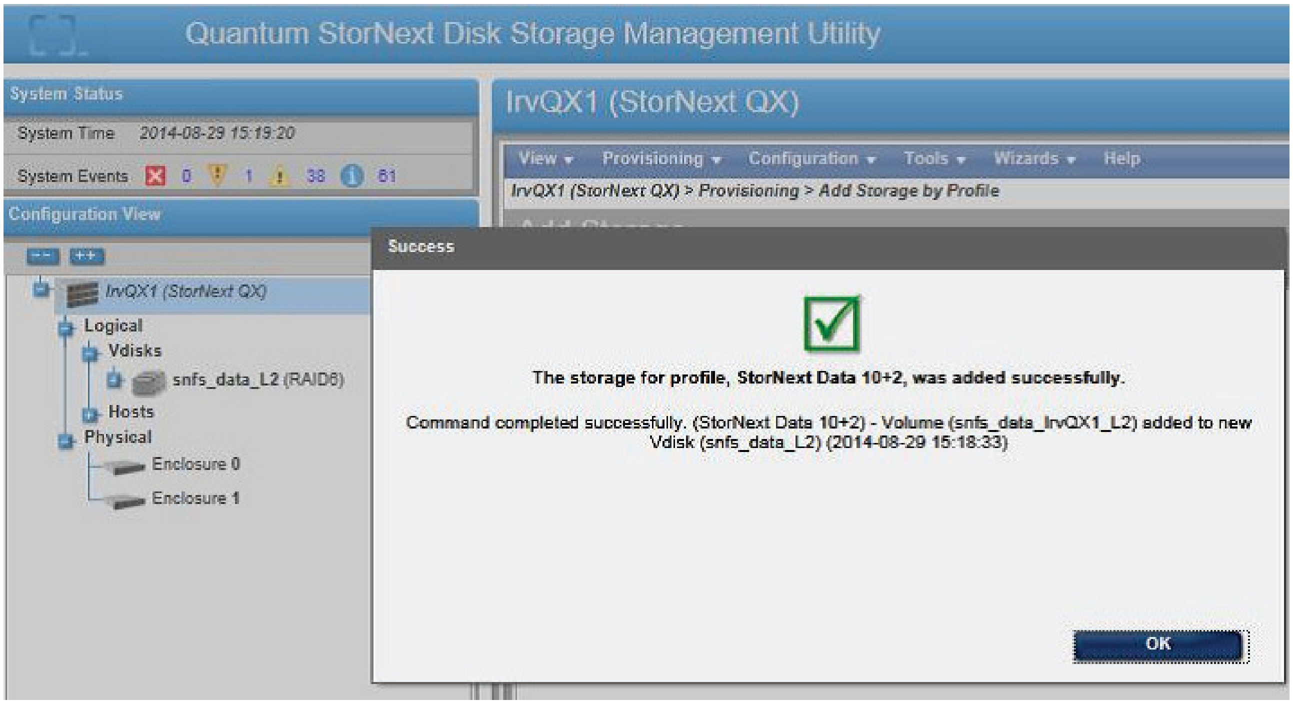
Figure 9: Adding storage for profile



Adding storage for profile, StorNext Data 10+2.
This should take a few seconds.

7. When the adding storage process completes, you will see a message stating that the “The Storage for profile, StorNext Data 12+2 (or the RAID type selected), was added successfully.”

Figure 10: Storage for profile added successfully pop-up



Quantum StorNext Disk Storage Management Utility
System Status
System Time 2014-08-29 15:19:20
System Events 0 1 38 61
Configuration View
-- ++
IrvQX1 (StorNext QX)
Logical
Vdisks
snfs_data_L2 (RAID6)
Hosts
Physical
Enclosure 0
Enclosure 1
IrvQX1 (StorNext QX)
View Provisioning Configuration Tools Wizards Help
IrvQX1 (StorNext QX) > Provisioning > Add Storage by Profile
Success
OK

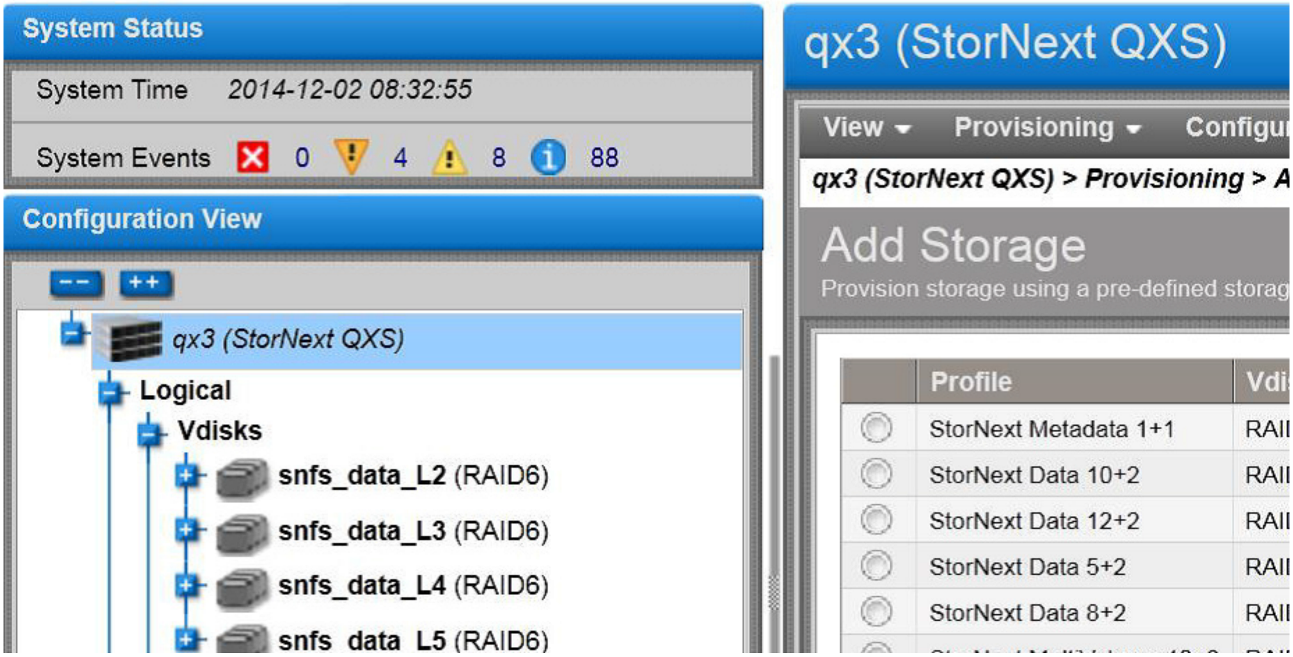
The storage for profile, StorNext Data 10+2, was added successfully.

Command completed successfully. (StorNext Data 10+2) - Volume (snfs_data_IrvQX1_L2) added to new Vdisk (snfs_data_L2) (2014-08-29 15:18:33)

8. Click “OK” to close the dialog popup.
9. In the Configuration View you will see the Vdisk that was just added.

   Example: snfs_data_L2(RAID6)

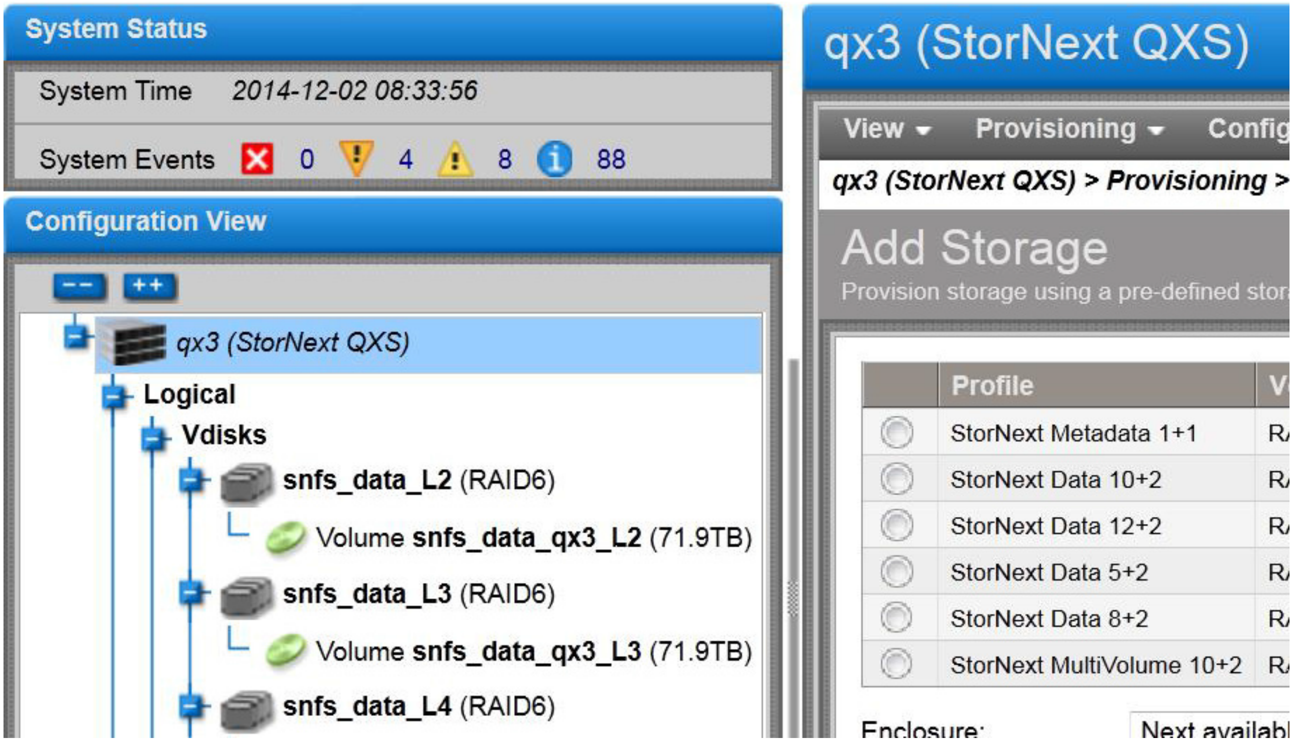
Figure 11: Verifying Vdisk was added



10. In the Configuration View, click on the + sign on the left side of the Vdisk you added and you will see that a volume was created.

    Example: Volume snfs_data_qx3_L2(71.9TB)

Figure 12: Verifying a Volume was created



System Status

System Time 2014-12-02 08:33:56

System Events 0 4 8 88

Configuration View

- qx3 (StorNext QXS)
  - Logical
    - Vdisks
      - snfs_data_L2 (RAID6)
        - Volume snfs_data_qx3_L2 (71.9TB)
      - snfs_data_L3 (RAID6)
        - Volume snfs_data_qx3_L3 (71.9TB)
      - snfs_data_L4 (RAID6)

qx3 (StorNext QXS)

qx3 (StorNext QXS) > Provisioning >

Add Storage

Provision storage using a pre-defined stor

	Profile	V
○	StorNext Metadata 1+1	R
○	StorNext Data 10+2	R
○	StorNext Data 12+2	R
○	StorNext Data 5+2	R
○	StorNext Data 8+2	R
○	StorNext MultiVolume 10+2	R

Enclosure: Next availabl

Repeat steps 4-10 to use the One Button Configuration to add additional RAID storage by profile.

Using the Configuration Wizard

The Configuration Wizard helps you initially configure the system or change system configuration settings.

The wizard guides you through the following steps. For each step you can view help by clicking the help icon ? in the wizard panel. As you complete steps they are highlighted at the bottom of the panel. If you cancel the wizard at any point, no changes are made.

- Change passwords for the default users, providing they still exist
- Configure each controller’s network port
- Enable or disable system-management services
- Enter information to identify the system
- Configure event notification

- Configure controller host ports
- Confirm changes and apply them

When you complete this wizard you are given the option to start the Provisioning Wizard to provision storage.

Step 1: Starting the wizard

1. In the Configuration View panel, right-click the system and select either **Configuration > Configuration Wizard** or **Wizards > Configuration Wizard**. The wizard panel appears.
2. Click **Next** to continue.

Step 2: Changing default passwords

The system provides the default users `manage` and `monitor`.

1. To secure the storage system, set a new password for each default user. A password is case sensitive and can have 8–32 characters. If the password contains only printable ASCII characters, then it must contain at least one uppercase character, one lowercase character, and one non-alphabetic character. A password can include printable UTF-8 characters except for the following: a space or ' " , < > \
2. Click **Next** to continue.

Step 3: Configuring network ports

You can configure addressing parameters for each controller’s network port. You can set static IP values or use DHCP.

In DHCP mode, network port IP address, subnet mask, and gateway values are obtained from a DHCP server if one is available. If a DHCP server is unavailable, current addressing is unchanged. You must have some means of determining what addresses have been assigned, such as the list of bindings on the DHCP server.

Each controller has the following factory-default IP settings:

- Controller A IP address: 10.0.0.2
- Controller B IP address: 10.0.0.3
- IP subnet mask: 255.255.255.0
- Gateway IP address: 10.0.0.1

When DHCP is enabled, the following initial values are set and remain set until the system is able to contact a DHCP server for new addresses:

- Controller IP addresses: 169.254.`x.x` (where the value of `x.x` is the lowest 16 bits of the controller serial number)

- IP subnet mask: 255.255.0.0
- Gateway IP address: 0.0.0.0

169.254.x.x addresses (including gateway 169.254.0.1) are on a private subnet that is reserved for unconfigured systems and the addresses are not routable. This prevents the DHCP server from reassigning the addresses and possibly causing a conflict where two controllers have the same IP address. As soon as possible, change these IP values to proper values for your network.

⚠ **Caution:** Changing IP settings can cause management hosts to lose access to the storage system.

To use DHCP to obtain IP values for network ports

1. Set the IP address source to **DHCP**.
2. Click **Next** to continue.

To set static IP values for network ports

1. Determine the IP address, subnet mask, and gateway values to use for each controller.
2. Set the IP address source to **manual**.
3. Set the values for each controller. You must set a unique IP address for each network port.

   ⓘ **Note:** The following IP addresses are reserved for internal use by the storage system: 192.168.200.253, 192.168.200.254, 172.22.255.253, 172.22.255.254, and 127.0.0.1

4. Click **Next** to continue.

Step 4: Enabling system-management services

You can enable or disable management interfaces to limit the ways in which users and host-based management applications can access the storage system. Network management interfaces operate out-of-band and do not affect host I/O to the system. The network options are:

- Web Browser Interface (WBI). The primary interface for managing the system.
  - You can enable use of HTTPS, HTTP (if lesser security is acceptable), or both. Also, if you choose to disable the Disk Management Utility (V2), the change does not take effect until the Configuration Wizard has finished and you have logged in again. If you disable both, you will lose access to this interface.
  - Default Management Mode. The default version of the Disk Management Utility (V2) interface that is launched when you point your browser to the address of a controller module network port. Select **v2** for the legacy interface to manage linear storage, or **v3** for the new interface to manage linear and virtual storage.
- Command Line Interface (CLI). An advanced user interface for managing the system. . You can enable use of SSH (secure shell) for increased security, Telnet, or both.
- Storage Management Initiative Specification (SMI-S). Used for management of the system through your network. You can enable use of secure (encrypted) or unsecure (unencrypted) SMI-S:

- **Encrypted**. Additionally selecting this option allows SMI-S clients to communicate with each controller's embedded SMI-S provider via HTTPS port 5989. HTTPS port 5989 and HTTP port 5988 cannot be enabled at the same time, so enabling this option will disable port 5988.
- **Unencrypted**. This option allows SMI-S clients to communicate with each controller's embedded SMI-S provider via HTTP port 5988. HTTP port 5988 and HTTPS port 5989 cannot be enabled at the same time, so enabling this option will disable port 5989.

The Storage Management Initiative Specification (SMI-S) is a Storage Networking Industry Association (SNIA) standard that enables interoperable management for storage networks and storage devices. SMI-S replaces multiple disparate managed object models, protocols, and transports with a single object-oriented model for each type of component in a storage network. The specification was created by SNIA to standardize storage management solutions. SMI-S enables management applications to support storage devices from multiple vendors quickly and reliably because they are no longer proprietary. SMI-S detects and manages storage elements by type, not by vendor.

- File Transfer Protocol (FTP). A secondary interface for installing firmware updates, downloading logs, and installing a license.
- Simple Network Management Protocol (SNMP). Used for monitoring of the system through your network.
- Service Debug. Used for technical support only. Enables or disables debug capabilities, including Telnet debug ports and privileged diagnostic user IDs.
- Activity Progress Reporting. Provides access to the activity progress interface via HTTP port 8081. This mechanism reports whether a firmware update or partner firmware update operation is active and shows the progress through each step of the operation. In addition, when the update operation completes, status is presented indicating either the successful completion, or an error indication if the operation failed.

In-band management interfaces operate through the data path and can slightly reduce I/O performance. The in-band option is:

- In-band SES Capability. Used for in-band monitoring of system status based on SCSI Enclosure Services (SES) data.

If a service is disabled, it cannot be accessed. To allow specific users to access the Disk Management Utility (V2), CLI, FTP or SMI-S, see About User Accounts on page 6.

To change management interface settings

1. Enable the options that you want to use to manage the storage system, and disable the others. If desired, choose a different default version of the Disk Management Utility (V2) by selecting a different option.
2. Click **Next** to continue.

Step 5: Setting system information

Set the System Name, System Contact person, System Location, and System Information (description) values. Each value can include a maximum of 79 bytes and use any characters except the following: " < > \

The name is shown in the browser title bar or tab. The name, location, and contact are included in event notifications. All four values are recorded in system debug logs for reference by service personnel.

Click **Next** to continue.

Step 6: Configuring event notification

Configure email addresses and SNMP trap hosts to receive event notifications, and configure the managed logs feature.

1. In the Event Notifications section, set the options:
   - Notification Level. Select the minimum severity for which the system should send notifications: **Critical** (only); **Error** (and Critical); **Warning** (and Error and Critical); **Informational** (all); or **none (Disabled)**.
   - SMTP Server address. The IP address of the SMTP mail server to use for the email messages. If the mail server is not on the local network, make sure that the gateway IP address was set in the network configuration step.
   - Sender Name. The sender name that is joined with an `@` symbol to the domain name to form the “from” address for notification. This name provides a way to identify the system that is sending the notification. The sender name can have a maximum of 64 bytes. Because this name is used as part of an email address, do not include spaces. For example: `Storage-1`. If no sender name is set, a default name is created.
   - Sender Domain. The domain name that is joined with an `@` symbol to the sender name to form the “from” address for notification. The domain name can have a maximum of 255 bytes. Because this name is used as part of an email address, do not include spaces. For example: `MyDomain.com`. If the domain name is not valid, some email servers will not process the mail.
   - Email Address fields. Up to three email addresses that the system should send notifications to. Email addresses must use the format *user-name@domain-name*. Each email address can have a maximum of 320 bytes. For example: `Admin@MyDomain.com` or `IT-team@MyDomain.com`.
2. In the SNMP Configuration section, set the options:
   - Notification Level. Select the minimum severity for which the system should send notifications: **Critical** (only); **Error** (and Critical); **Warning** (and Error and Critical); **Informational** (all); or **none (Disabled)**, which disables SNMP notification. However, Critical events and managed-logs events are sent regardless of the notification setting.
   - Read Community. The SNMP read password for your network. This password is also included in traps that are sent. The value is case sensitive and can have a maximum of 31 bytes. It can include any character except the following: " < >
   - Write Community. The SNMP write password for your network. The value is case sensitive and can have a maximum of 31 bytes. It can include any character except the following: " < >
   - Trap Host Address fields. IP addresses of up to three host systems that are configured to receive SNMP traps.
3. In the Managed Logs Notifications section, set the options:

- Log Destination. The email address of the log-collection system. The email addresses must use the format `user-name@domain-name` and can have a maximum of 320 bytes. For example: `LogCollector@MyDomain.com`.
- **Include Logs**. When the managed logs feature is enabled, this option activates "push" mode, which automatically attaches system log files to managed-logs email notifications that are sent to the log-collection system.

Note: These options configure the managed logs feature but do not enable it, which is done on the Configuration > Advanced Settings > System Utilities panel.

4. Click **Next** to continue.

Step 7: Configuring host ports

To enable the system to communicate with hosts or with remote systems having FC or iSCSI interfaces, you can configure the system's host-interface options. If the current settings are correct, port configuration is optional.

For QXS-4/6 Series: Host ports can be configured as a combination of FC or iSCSI ports. For a 4-port SAS controller module, there are no host-interface configuration options.

For QXS-312/324: Host ports can only be configured as either FC or iSCSI ports. For a 2-port SAS controller module, host ports can be configured to use fan-out cables or standard cables through the Configure Host Interfaces panel. See Changing Host Interface Settings on page 58 for more information.

Note: For information about setting advanced host-port parameters, such as FC port topology, see the CLI Reference Guide.

To change FC host interface settings

1. **For QXS-4/6 Series:** Set the Speed option to the proper value to communicate with the host. The speed can be set to **auto**, which auto-negotiates the proper link speed with the host, or to **4Gb**, **8Gb**, or **16Gb** (Gbit/s). Because a speed mismatch prevents communication between the port and host, set a speed only if you need to force the port to use a known speed.

   For QXS-312/324: Set the Speed option to the proper value to communicate with the host. The speed can be set to **auto**, which auto-negotiates the proper link speed with the host, or to **4Gb**, **8Gb** or **16Gb** (Gbit/s). Because a speed mismatch prevents communication between the port and host, set a speed only if you need to force the port to use a known speed.
2. The FC Connection Mode can be point-to-point or auto:
   - point-to-point: Fibre Channel point-to-point.
   - auto: Automatically sets the mode based on the detected connection type.
3. Click **Next** to continue.

To change iSCSI host interface settings

1. In the upper section of the panel, set the port-specific options:

- IP Address. For IPv4 or IPv6, the port IP address. For corresponding ports in each controller, assign one port to one subnet and the other port to a second subnet. Ensure that each iSCSI host port in the storage system is assigned a different IP address. For example, in a system using IPv4:
  - Controller A port 2: 10.10.10.100
  - Controller A port 3: 10.11.10.120
  - Controller B port 2: 10.10.10.110
  - Controller B port 3: 10.11.10.130
- Netmask. For IPv4, subnet mask for assigned port IP address.
- Gateway. For IPv4, gateway IP address for assigned port IP address.
- Default Router. For IPv6, default router for assigned port IP address.
- Link-Local Address. For IPv6, the link-local address that is automatically generated from the MAC address and assigned to the port.

⚠ **Caution:** Changing IP settings can cause data hosts to lose access to the storage system.

2. In the Common Settings for iSCSI section of the panel, set the options that apply to all iSCSI ports:
   - Authentication (CHAP). Enables or disables use of Challenge Handshake Authentication Protocol.

   ℹ **Note:** CHAP records for iSCSI login authentication must be defined if CHAP is enabled. To create CHAP records, see Configuring CHAP on page 104.

   - Jumbo Frames. Enables or disables support for jumbo frames. Allowing for 100 bytes of overhead, a normal frame can contain 1400 bytes whereas a jumbo frame can contain a maximum of 8900 bytes for larger data transfers.

   ℹ **Note:** Use of jumbo frames can succeed only if jumbo-frame support is enabled on all network components in the data path.

   - iSCSI IP Version. Specifies whether IP values use Internet Protocol version 4 (IPv4) or version 6 (IPv6) format. IPv4 uses 32-bit addresses. IPv6 uses 128-bit addresses.
   - iSNS. Enables or disables registration with a specified Internet Storage Name Service server, which provides name-to-IP-address mapping.
   - iSNS Address. Specifies the IP address of an iSNS server.
   - Alternate iSNS Address. Specifies the IP address of an alternate iSNS server, which can be on a different subnet.
3. Click **Next** to continue.

Step 8: Confirming configuration changes

Confirm that the values listed in the wizard panel are correct.

- If they are not correct, click **Previous** to return to previous steps and make necessary changes.
- If they are correct, click **Finish** to apply the setting changes and finish the wizard.

Installing a License

A license is required to use Snapshots, Volume Copy, Replication, VDS, VSS, and the Storage Replication Adapter (SRA). The license is specific to a controller enclosure serial number and firmware version.

If a permanent license is not installed and you want to try these features before buying a permanent license, you can create a one-time temporary license. A temporary license will expire 60 days from the time it is created. After creating a temporary license, each time you sign in to the Disk Management Utility (V2), a message specifies the number of remaining days for the temporary license. If you do not install a permanent license before the temporary license expires, you cannot create new items with these features. However, you can continue to use existing snapshots.

After a temporary license is created or a permanent license is installed, the option to create a temporary license is no longer displayed.

To view information about system licenses

In the Configuration View panel, right-click the system and select **Tools > Install License**.

The System Licenses table shows the following information about licensed features:

- Feature. The name of the licensed feature.
- Base. Either:
  - The number of components that users can create without a license.
  - `N/A`. Not applicable.
- License. Either:
  - The number of user-created components that the installed license supports.
  - `Enabled` or `Disabled`.
- In Use. Either:
  - The number of user-created components that exist.
  - `N/A`. Not applicable.
- Max Licensable. Either:
  - The number of user-created components that the maximum license supports.
  - `N/A`. Not applicable.
- Expiration. One of the following:
  - `Never`. License is purchased and doesn’t expire.
  - Number of days remaining for a temporary license.
  - `Expired`. Temporary license has expired and cannot be renewed.
  - `Expired/Renewable`. Temporary license has expired and can be renewed.
  - `N/A`. No license installed.

The panel also shows the licensing serial number (controller enclosure serial number) and licensing version number (controller firmware version), for which a license file must be generated in order to successfully install.

To create a temporary license

1. In the Configuration View panel, right-click the system and select **Tools > Install License**. If the option to create a temporary license is available, the End User License Agreement appears in the lower portion of the license panel.
2. Read the license agreement.
3. If you accept the terms of the license agreement, select the check box. A confirmation dialog appears.
4. Click **Yes** to start the trial period. The feature’s Expiration value shows the number of days remaining in the trial period. The trial period will expire on the last day. When the trial period expires, the value changes to Expired or Expired/Renewable.

To install a permanent license

1. Ensure that:
   - The license file is saved to a network location that you can access from the Disk Management Utility (V2).
   - You are signed into the controller enclosure that the file was generated for.
2. In the Configuration View panel, right-click the system and select **Tools > Install License**.
3. Click **Browse** to locate and select the license file.
4. Click **Install License File**. If installation succeeds, the System Licenses table is updated. The licensing change takes effect immediately. The feature’s Expiration value shows `Never` for permanent licenses, and displays the number of days remaining for temporary licenses

Configuring System Services

Changing Management Interface Settings

You can enable or disable management interfaces to limit the ways in which users and host-based management applications can access the storage system. Network management interfaces operate out-of-band and do not affect host I/O to the system. The network options are:

- Web Browser Interface (WBI). The primary interface for managing the system.
  - You can enable use of HTTP, of HTTPS for increased security, or both. If you disable both, you will lose access to this interface.
  - Default Management Mode. The default version of the Disk Management Utility (V2) that opens when you access it. Select v2 for the interface that manages legacy linear storage, or v3 for the new interface that manages virtual storage.

- Command Line Interface (CLI). An advanced user interface for managing the system. You can enable use of Telnet, of SSH (secure shell) for increased security, or both.
- Storage Management Initiative Specification (SMI-S). Used for management of the system through your network. You can enable use of unencrypted or encrypted SMI-S:
  - Enable. Selecting this option allows SMI-S clients to communicate with each controller's embedded SMI-S provider via HTTP port 5988. HTTP port 5988 and HTTPS port 5989 cannot be enabled at the same time, so enabling this option will disable port 5989.
  - Encrypted. Additionally selecting this option allows SMI-S clients to communicate with each controller's embedded SMI-S provider via HTTPS port 5989. HTTPS port 5989 and HTTP port 5988 cannot be enabled at the same time, so enabling this option will disable port 5988.
- Storage Management Initiative Specification (SMI-S). Used for management of the system through your network. You can enable use of secure (encrypted) or unsecure (unencrypted) SMI-S:
  - Encrypted. This option allows SMI-S clients to communicate with each controller's embedded SMI-S provider via HTTPS port 5989. HTTPS port 5989 and HTTP port 5988 cannot be enabled at the same time, so enabling this option will disable port 5988. This is the default.
  - Unencrypted. This option allows SMI-S clients to communicate with each controller's embedded SMI-S provider via HTTP port 5988. HTTP port 5988 and HTTPS port 5989 cannot be enabled at the same time, so enabling this option will disable port 5989
- File Transfer Protocol (FTP). A secondary interface for installing firmware updates, downloading logs, and installing a license.
- Simple Network Management Protocol (SNMP). Used for remote monitoring of the system through your network.
- Service Debug. Used for technical support only. Enables or disables debug capabilities, including Telnet debug ports and privileged diagnostic user IDs.
- Activity Progress Reporting. Provides access to the activity progress interface via HTTP port 8081. This mechanism reports whether a firmware update or partner firmware update operation is active and shows the progress through each step of the operation. In addition, when the update operation completes, status is presented indicating either the successful completion, or an error indication if the operation failed.

In-band management interfaces operate through the data path and can slightly reduce I/O performance. The in-band option is:

- In-band SES Capability. Used for in-band monitoring of system status based on SCSI Enclosure Services (SES) data.

If a service is disabled, it cannot be accessed. To allow specific users to access the Disk Management Utility (V2), CLI, FTP, or SMI-S, see About User Accounts on page 6.

To change management interface settings

1. In the Configuration View panel, right-click the system and select **Configuration > Services > Management**.
2. Enable the options that you want to use to manage the storage system, and disable the others.
3. Click **Apply**. If you disabled any options or changed your default management mode setting, a confirmation dialog appears.

4. Click **Yes** to continue. Otherwise, click **No**. If you clicked **Yes**, a processing dialog appears. When processing is complete a success dialog appears.
5. Click **OK**.

Configuring Email Notification

You can configure email-notification settings for events and managed logs. For an overview of the managed logs feature, see About Managed Logs on page 26.

To configure email notification for events

1. In the Configuration View panel, right-click the system and select **Configuration > Services > Email Notification**.
2. In the main panel, set the options:
   - Notification Level. Select the minimum severity for which the system should send notifications: **Critical** (only); **Error** (and Critical); **Warning** (and Error and Critical); **Informational** (all); or **none (Disabled)**. The default is **none**, which disables email notification.
   - SMTP Server address. The IP address of the SMTP mail server to use for the email messages. If the mail server is not on the local network, make sure that the gateway IP address is set in **System Settings > Network Interfaces**.
   - Sender Name. The sender name that is joined with an @ symbol to the domain name to form the "from" address for notification. This name provides a way to identify the system that is sending the notification. The sender name can have a maximum of 64 bytes. The name cannot include a space or: " , < > \\

     For example: `Storage-1`. If no sender name is set, a default name is created.
   - Sender Domain. The domain name that is joined with an @ symbol to the sender name to form the "from" address for notification. The domain name can have a maximum of 255 bytes. Because this name is used as part of an email address, do not include spaces. For example: `MyDomain.com`. If the domain name is not valid, some email servers will not process the mail.
   - Email Address fields. Up to three email addresses that the system should send notifications to. Email addresses must use the format *user-name@domain-name*. Each email address can have a maximum of 320 bytes. For example: `Admin@MyDomain.com` or `IT-team@MyDomain.com`.
3. Click **Apply**.
4. Send a test message to the configured destinations as described on Testing Notifications on page 118.

To configure email notification for managed logs

1. In the Configuration View panel, right-click the system and select **Configuration > Services > Email Notification**.
2. In the main panel, set the options:
   - Log Destination. The email address of the log-collection system. The email addresses must use the format `user-name@domain-name` and can have a maximum of 320 bytes. For example: `LogCollector@MyDomain.com`.

- **Include Logs**. When the managed logs feature is enabled, this option activates “push” mode, which automatically attaches system log files to managed-logs email notifications that are sent to the log-collection system.

3. Click **Apply**.
4. Enable log management as described on Enabling/disabling managed logs on page 72.
5. Send a test message to the configured destination as described on Testing Notifications on page 118.

Configuring SNMP notification

To configure SNMP notification of events

1. In the Configuration View panel, right-click the system and select **Configuration > Services > SNMP Notification**.
2. In the main panel, set the options:
   - Notification Level. Select the minimum severity for which the system should send notifications: **Critical** (only); **Error** (and Critical); **Warning** (and Error and Critical); **Informational** (all); or **none** (**Disabled**). However, Critical events and managed-logs events are sent regardless of the notification setting.
   - Read Community. The SNMP read password for your network. This password is also included in traps that are sent. The value is case sensitive and can have a maximum of 31 bytes. It can include any character except the following: " < >
     Write Community. The SNMP write password for your network. The value is case sensitive and can have a maximum of 31 bytes. It can include any character except the following: " < >
     Trap Host Address fields. IP addresses of up to three host systems that are configured to receive SNMP traps.
3. Click **Apply**.
4. Optionally, send a test message to the configured destinations as described on Testing Notifications on page 118.

Configuring syslog notification

You can set remote syslog notification options to allow events to be logged by the syslog of a specified host computer. Syslog is a protocol for sending event messages across an IP network to a logging server.

To configure syslog notification of events

1. In the Configuration View panel, right-click the system and select **Configuration > Services > Syslog Notification**.
2. In the main panel, set the options:
   - **Notification Level**. Select the minimum severity for which the system should send notifications: **Critical** (only); **Error** (and Critical); **Warning** (and Error and Critical); **Informational** (all); or **none** (**Disabled**), which disables syslog notification.

- **Syslog Server IP Address**. IP address of the syslog host system.
- **Syslog Server Port Number**. Port number of the syslog host system.

3. Click **Apply**.
4. Optionally, send a test message to the configured destinations as described in Testing Notifications on page 118.

Configuring User Accounts

Adding Users

You can create either a general user that can access the Disk Management Utility (V2), CLI, FTP or SMI-S interfaces, or an SNMPv3 user that can access the MIB or receive trap notifications. SNMPv3 user accounts support SNMPv3 security features such as authentication and encryption.

To add a general user

1. In the Configuration View panel, right-click the system and select **Configuration > Users > Add New User**.
2. In the main panel, set the options:
   - User Name. A user name is case sensitive and can have a maximum of 29 bytes. It cannot already exist in the system or include the following: a space or ' " , < > \
   - Password. A password is case sensitive and must contain 8–32 characters. If the password contains only printable ASCII characters, then it must contain at least one uppercase character, one lowercase character, and one non-alphabetic character. A password can include printable UTF-8 characters except for the following: a space or ' " , < \
   - Select **Standard User**.
   - User Roles. Select **Monitor** to let the user view system settings, or **Manage** to let the user view and change system settings. You cannot change the roles of user `manage`.
   - User Type. Select an option to identify the user’s experience level: **Standard**, **Advanced**, or **Diagnostic**. This option is informational only and does not affect access to commands.
   - **WBI Access**. Allows access to the Disk Management Utility (V2).
   - **CLI Access**. Allows access to the command-line management interface.
   - **FTP Access**. Allows access to the FTP interface, which can be used instead of the Disk Management Utility (V2) to install firmware updates and download logs.
   - **SMI-S Access**. Allows access to the SMI-S interface, used for management of the system through your network.

- Base Preference. Select the base for entry and display of storage-space sizes, either **Base 10** or **Base 2**. In base 2, sizes are shown as powers of 2, using 1024 as a divisor for each magnitude. In base 10, sizes are shown as powers of 10, using 1000 as a divisor for each magnitude. Operating systems usually show volume size in base 2. Disk drives usually show size in base 10. Memory (RAM and ROM) size is always shown in base 2.
- Precision Preference. Select the number of decimal places (1–10) for display of storage-space sizes.
- Unit Preference. Select a unit for display of storage-space sizes: **Auto**, **TB**, **GB**, **MB**. The Auto option lets the system determine the proper unit for a size. Based on the precision setting, if the selected unit is too large to meaningfully display a size, the system uses a smaller unit for that size. For example, if the unit is set to TB, precision is set to 1, and base is set to 10, the size 0.11709 TB is shown as 117.1 GB.
- Temperature Preference. Specifies the scale to use for temperature values: **Celsius** or **Fahrenheit**.
- Auto Sign Out (minutes). Select the amount of time that the user's session can be idle before the user is automatically signed out (2–720 minutes).
- Locale. The user's preferred display language, which overrides the system's default display language. Installed language sets include Arabic, Chinese-Simplified, Chinese-Traditional, Dutch, English, French, German, Italian, Japanese, Korean, Portuguese, Russian, and Spanish.

3. Click **Add User**.

To add an SNMPv3 user

1. In the Configuration View panel, right-click the system and select **Configuration > Users > Add New User**.
2. In the main panel, set the options:
   - User Name. A user name is case sensitive and can have a maximum of 29 bytes. It cannot already exist in the system or include the following: a space or ' " , < > \
   - Password. A password is case sensitive and must contain 8–32 characters. If the password contains only printable ASCII characters, then it must contain at least one uppercase character, one lowercase character, and one non-alphabetic character. A password can include printable UTF-8 characters except for the following: a space or ' " , < > \
     If the Authentication Type option is set to use authentication, this password is the authentication password and must include at least 8 characters.
   - Select **SNMPv3 User**.
   - SNMP User Type. Select User **Access** to enable the user to view the SNMP MIB, or Trap Target to enable the user to receive SNMP trap notifications. If you select **Trap Target** you must set the Trap Host Address option.
   - Authentication Type. Select whether to use **MD5** or **SHA** authentication, or no authentication (**None**). Authentication uses the user password.
   - Privacy Type. Select whether to use **DES** or **AES** encryption, or no encryption (**none**). To use encryption you must also set the Privacy Password and Authentication Type options.
   - Privacy Password. If the Privacy Type option is set to use encryption, specify an encryption password. A password is case sensitive; can have a maximum of 32 bytes; and must include at least 8 characters. It cannot include the following: ' " , < > \

- Trap Host Address. If you set the user type to **Trap Target**, specify the IP address of the host system that will receive SNMP traps.

3. Click **Add User**.

Modifying Users

You can change settings either for a general user that can access the Disk Management Utility (V2), CLI, FTP, or SMI-S interfaces, or for an SNMPv3 user.

The system requires at least one CLI user with the Manage role to exist.

To modify a general user

1. In the Configuration View panel, right-click the system and select **Configuration > Users > Modify User**. A table displays details for each user. For each interface a user can access, a check mark appears in the WBI, CLI, SNMP, FTP, and SMI-S columns.
2. In the main panel, select the user to modify.
3. Set the options:
   - Password. A password is case sensitive and must contain 8–32 characters. If the password contains only printable ASCII characters, then it must contain at least one uppercase character, one lowercase character, and one non-alphabetic character. A password can include printable UTF-8 characters except for the following: a space or ' " , < > \
   - User Roles. Select **Monitor** to let the user view system settings, or **Manage** to let the user view and change system settings.
   - User Type. Select an option to identify the user’s experience level: **Standard**, **Advanced**, or **Diagnostic**. This option is informational only and does not affect access to commands.
   - **WBI Access**. Allows access to the Disk Management Utility (V2).
   - **CLI Access**. Allows access to the command-line management interface.
   - **FTP Access**. Allows access to the FTP interface, which can be used instead of the Disk Management Utility (V2) to install firmware updates and download logs.
   - **SMI-S Access**. Allows access to the SMI-S interface, used for management of the system through your network.
   - Base Preference. Select the base for entry and display of storage-space sizes, either **Base 10** or **Base 2**. In base 2, sizes are shown as powers of 2, using 1024 as a divisor for each magnitude. In base 10, sizes are shown as powers of 10, using 1000 as a divisor for each magnitude. Operating systems usually show volume size in base 2. Disk drives usually show size in base 10. Memory (RAM and ROM) size is always shown in base 2.
   - Precision Preference. Select the number of decimal places (1–10) for display of storage-space sizes.
   - Unit Preference. Select a unit for display of storage-space sizes: **Auto**, **TB**, **GB**, **MB**. The Auto option lets the system determine the proper unit for a size. Based on the precision setting, if the selected unit is too large to meaningfully display a size, the system uses a smaller unit for that size.

For example, if the unit is set to TB, precision is set to 1, and base is set to 10, the size 0.11709 TB is shown as 117.1 GB.

- Temperature Preference. Specifies the scale to use for temperature values: **Celsius** or **Fahrenheit**.
- Auto Sign Out (minutes). Select the amount of time that the user's session can be idle before the user is automatically signed out (2–720 minutes).
- Locale. The user's preferred display language, which overrides the system's default display language. Installed language sets include Arabic, Chinese-Simplified, Chinese-Traditional, Dutch, English, French, German, Italian, Japanese, Korean, Portuguese, Russian, and Spanish.

4. Click **Modify User**.

   User changes take effect when the user next signs in.

To modify an SNMPv3 user

1. In the Configuration View panel, right-click the system and select **Configuration > Users > Modify User**. A table displays details for each user. SNMPv3 users can only access the SNMP interface. The other columns are not applicable.
2. In the main panel, select the user to modify.
3. Set the options:
   - Password. A password is case sensitive and must contain 8–32 characters. If the password contains only printable ASCII characters, then it must contain at least one uppercase character, one lowercase character, and one non-alphabetic character. A password can include printable UTF-8 characters except for the following: a space or ' " , < > \
     If the Authentication Type option is set to use authentication, this password is the authentication password and must include at least 8 characters.
   - SNMP User Type. Select **User Access** to enable the user to view the SNMP MIB, or Trap Target to enable the user to receive SNMP trap notifications. If you select **Trap Target** you must set the Trap Host Address option.
   - Authentication Type. Select whether to use **MD5** or **SHA** authentication, or no authentication (**None**). Authentication uses the user password.
   - Privacy Type. Select whether to use **DES** or **AES** encryption, or no encryption (**none**). To use encryption you must also set the Privacy Password and Authentication Type options.
   - Privacy Password. If the Privacy Type option is set to use encryption, specify an encryption password. This password is case sensitive and can have 8–32 characters. If the password contains only printable ASCII characters, then it must contain at least one uppercase character, one lowercase character, and one non-alphabetic character. A password can include printable UTF-8 characters except for the following: a space or ' " , < > \
   - Trap Host Address. If you set the user type to **Trap Target**, specify the IP address of the host system that will receive SNMP traps.
4. Click **Modify User**.

   User changes take effect when the user next signs in.

Removing Users

You can remove any user, including the default users. However, the system requires at least one CLI user with the `manage` role to exist. When a user is deleted, any sessions associated with that user name are terminated.

To remove a user

1. In the Configuration View panel, right-click the system and select **Configuration > Users > Remove User**.
2. In the main panel, select the user to remove.
3. Click **Remove User**. A confirmation dialog appears.
4. Click **Remove** to continue. Otherwise, click **Cancel**. If you clicked **Remove**, a processing dialog appears. When processing is complete, the user is removed from the table.
5. Click **OK**.

Configuring System Settings

Changing the System Date and Time

You can enter values manually for the system date and time, or you can set the system to use NTP as explained in About the System Date and Time on page 23.

To use manual date and time settings

1. In the Configuration View panel, right-click the system and select **Configuration > System Settings > Date, Time**. The date and time options appear.
2. Set the options:
   - Time. Enter the time in the format *hh*:*mm*:*ss*, where *hh* is the hour (0–23), *mm* is the minutes (0–59), and *ss* is the seconds (0–59).
   - Month. Select the month.
   - Day. Enter the day number.
   - Year. Enter the year using four digits.
   - Network Time Protocol (NTP). Select **Disabled**.
3. Click **Apply**.

To obtain the date and time from an NTP server

1. In the Configuration View panel, right-click the system and select **Configuration > System Settings > Date, Time**. The date and time options appear.

2. Set the options:
   - Network Time Protocol (NTP). Select **Enabled**.
   - NTP Time Zone Offset. Optional. The system's time zone as an offset in hours (-12 through +14) and optionally minutes (0–59) from Coordinated Universal Time (UTC). To specify a positive offset, the '+' is optional. To specify a negative offset, the '-' is required. The hour value can have one or two digits and can omit a leading zero. If the minutes value is specified it must have two digits. If it is omitted, the minutes value is set to 00.
   - NTP Server Address. Optional. If the system should retrieve time values from a specific NTP server, enter the address of an NTP server. If no IP server address is set, the system listens for time messages sent by an NTP server in broadcast mode.
3. Click **Apply**.

Changing Host Interface Settings

You can configure controller host-interface settings for ports. To enable the system to communicate with hosts or with remote systems, you must configure the system's host-interface options.

For QXS-4/6 Series : Host ports can be configured as a combination of FC or iSCSI ports. For a system with a 4-port SAS controller module, there are no host-interface configuration options.

For QXS-312/324 : Host ports can only be configured as either FC or iSCSI ports. For a system with a 2-port SAS controller module, host ports can be configured to use fan-out cables or standard cables.

Note: For information about setting advanced host-port parameters, such as FC port topology, see the CLI Reference Guide.

To change FC host interface settings

1. In the Configuration View panel, right-click the system and select **Configuration > System Settings > Host Interfaces**.
2. **For QXS-4/6 Series** : Set the Speed option to the proper value to communicate with the host. The speed can be set to **auto**, which auto-negotiates the proper link speed with the host, or to **4Gb**, **8Gb**, or **16Gb** (Gbit/s). Because a speed mismatch prevents communication between the port and host, set a speed only if you need to force the port to use a known speed.

   For QXS-312/324 : Set the Speed option to the proper value to communicate with the host. The speed can be set to **auto**, which auto-negotiates the proper link speed with the host, or to **4Gb** or **8Gb**, or **16Gb** (Gbit/s). Because a speed mismatch prevents communication between the port and host, set a speed only if you need to force the port to use a known speed.
3. The FC Connection Mode can be point-to-point or auto:
   - point-to-point: Fibre Channel point-to-point.
   - auto: Automatically sets the mode based on the detected connection type.
4. Click **Apply**.

To change iSCSI host interface settings

1. In the Configuration View panel, right-click the system and select **Configuration > System Settings > Host Interfaces**.
2. In the upper section of the panel, set the port-specific options:
   - IP Address. For IPv4 or IPv6, the port IP address. For corresponding ports in each controller, assign one port to one subnet and the other port to a second subnet. Ensure that each iSCSI host port in the storage system is assigned a different IP address. For example, in a system using IPv4:
     - Controller A port 2: 10.10.10.100
     - Controller A port 3: 10.11.10.120
     - Controller B port 2: 10.10.10.110
     - Controller B port 3: 10.11.10.130
   - Netmask. For IPv4, subnet mask for assigned port IP address.
   - Gateway. For IPv4, gateway IP address for assigned port IP address.
   - Default Router. For IPv6, default router for assigned port IP address.
   - Link-Local Address. For IPv6, the link-local address that is automatically generated from the MAC address and assigned to the port.

⚠ **Caution:** Changing IP settings can cause data hosts to lose access to the storage system.

3. In the Common Settings for iSCSI section of the panel, set the options that apply to all iSCSI ports:
   - Authentication (CHAP). Enables or disables use of Challenge Handshake Authentication Protocol.

   ⓘ **Note:** CHAP records for iSCSI login authentication must be defined if CHAP is enabled. To create CHAP records, see Configuring CHAP on page 104.

   - Jumbo Frames. Enables or disables support for jumbo frames. Allowing for 100 bytes of overhead, a normal frame can contain 1400 bytes whereas a jumbo frame can contain a maximum 8900 byte payload for larger data transfers.

   ⓘ **Note:** Use of jumbo frames can succeed only if jumbo-frame support is enabled on all network components in the data path.

   - iSCSI IP Version. Specifies whether IP values use Internet Protocol version 4 (IPv4) or version 6 (IPv6) format. IPv4 uses 32-bit addresses. IPv6 uses 128-bit addresses.
   - iSNS. Enables or disables registration with a specified Internet Storage Name Service server, which provides name-to-IP-address mapping.
   - iSNS Address. Specifies the IP address of an iSNS server.
   - Alternate iSNS Address. Specifies the IP address of an alternate iSNS server, which can be on a different subnet.
4. Click **Apply**.

To change host interface settings for 2-port SAS controller modules (for QXS-312 and QXS-324 only)

A fan-out cable can connect one port on each of two SAS hosts to one controller port, using two PHY lanes per port. A standard cable can connect one port on a SAS host to one controller port, using four PHY lanes per port. When configuring the host-interface settings for a 2-port SAS controller module, the Configure Host Interface panel displays the current link speed, cable type, number of PHY lanes expected for the SAS port, and number of PHY lanes active for each SAS port. The number of ports that display depends on the configuration.

Note: Using fan-out instead of standard cables doubles the number of hosts that can be attached to a single system. It will also halve the maximum bandwidth available to each host, but overall bandwidth available to all hosts is unchanged.

Caution: Changing the fan-out setting will change the logical numbering of controller host ports, which will cause port IDs in mappings between volumes and initiators to be incorrect. Therefore, before changing the fan-out setting, unmap all mappings. After you have changed the fan-out setting and connected the appropriate cables, you can re-create the mappings.

1. In the Configuration View panel, right-click the system and select **Configuration > System Settings > Host Interfaces**.
2. To switch to fan-out cables, select the **Use fan-out cables** check box. To switch to standard cables, clear the **Use fan-out cables** check box.
3. Click **Apply**.
4. Click **Apply** to continue. Otherwise, click **Cancel**. If you clicked Apply and the task succeeds:
   a. A processing dialog appears and quickly exits.
   b. A message displays that the controllers are restarting.
   c. The Sign In page appears after the controllers have restarted.
5. Disconnect the existing cables from the controller module SAS ports and host SAS HBA ports.
6. Switch to the standard or fan-out cables by connecting the new cables to the controller module SAS ports and host SAS HBA ports.
7. Login in if you have not already done so.
8. In the Configuration View panel, right-click an enclosure and select **View > Overview > Rear Graphical**.
   - If fan-out cables are connected to SAS ports that are configured to use them, fan-out cable icons Ⓨ appear between the depicted SAS ports.
   - If standard cables are connected to SAS ports that are configured to use them, no icons appear.

Changing Network Interface Settings

You can configure addressing parameters for each controller's network port. You can set static IP values or use DHCP.

In DHCP mode, network port IP address, subnet mask, and gateway values are obtained from a DHCP server if one is available. If a DHCP server is unavailable, current addressing is unchanged. You must have some means of determining what addresses have been assigned, such as the list of bindings on the DHCP server.

Each controller has the following factory-default IP settings:

- DHCP: disabled
- Controller A IP address: 10.0.0.2
- Controller B IP address: 10.0.0.3
- IP subnet mask: 255.255.255.0
- Gateway IP address: 10.0.0.1

When DHCP is enabled, the following initial values are set and remain set until the system is able to contact a DHCP server for new addresses:

- Controller IP addresses: 169.254.x.x (where the value of x.x is the lowest 16 bits of the controller serial number)
- IP subnet mask: 255.255.0.0
- Gateway IP address: 0.0.0.0

169.254.x.x addresses (including gateway 169.254.0.1) are on a private subnet that is reserved for unconfigured systems and the addresses are not routable. This prevents the DHCP server from reassigning the addresses and possibly causing a conflict where two controllers have the same IP address. As soon as possible, change these IP values to proper values for your network.

⚠ **Caution:** Changing IP settings can cause management hosts to lose access to the storage system.

To use DHCP to obtain IP values for network ports

1. In the Configuration View panel, right-click the system and select **Configuration > System Settings > Network Interfaces**.
2. Set the IP address source to **DHCP**.
3. Click **Apply**. If the controllers successfully obtain IP values from the DHCP server, the new IP values are displayed.
4. Record the new addresses.
5. Sign out and access the Disk Management Utility (V2) using the new IP addresses.

To set static IP values for network ports

1. Determine the IP address, subnet mask, and gateway values to use for each controller.
2. In the Configuration View panel, right-click the system and select **Configuration > System Settings > Network Interfaces**.
3. Set the IP address source to **manual**.
4. Set the values for each controller. You must set a unique IP address for each network port.

   ⓘ **Note:** The following IP addresses are reserved for internal use by the storage system: 192.168.200.253, 192.168.200.254, 172.22.255.253, 172.22.255.254, and 127.0.0.1

5. Record the IP values you assign.
6. Click **Apply**.
7. Sign out and access the Disk Management Utility (V2) using the new IP addresses.

Setting System Information

To set system information

1. In the Configuration View panel, right-click the system and select **Configuration > System Settings > System Information**.
2. In the main panel, set the System Name, System Contact person, System Location, and System Information (description) values. The name is shown in the browser title bar or tab. The name, location, and contact are included in event notifications. All four values are recorded in system debug logs for reference by service personnel. Each value can include a maximum of 79 bytes, using all characters except the following: ' " < > \
3. Click **Apply**.

Configuring Advanced Settings

Changing disk settings

Configuring SMART

Self-Monitoring Analysis and Reporting Technology (SMART) provides data that enables you to monitor disks and analyze why a disk failed. When SMART is enabled, the system checks for SMART events one minute after a restart and every five minutes thereafter. SMART events are recorded in the event log.

To change the SMART setting

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings** > **Disk**.
2. Set the SMART Configuration option to one of the following:
   - **Don’t Modify**. Allows current disks to retain their individual SMART settings and does not change the setting for new disks added to the system.
   - **Enabled**. Enables SMART for all current disks after the next rescan and automatically enables SMART for new disks added to the system.
   - **Disabled**. Disables SMART for all current disks after the next rescan and automatically disables SMART for new disks added to the system.
3. Click **Apply**.

Configuring dynamic spares

The dynamic spares feature lets you use all of your disks in fault-tolerant vdisks without designating a disk as a spare. With dynamic spares enabled, if a disk fails and you replace it with a compatible disk, the storage system rescans the bus, finds the new disk, automatically designates it a spare, and starts reconstructing the vdisk. A compatible disk has enough capacity to replace the failed disk and is the same type. If a dedicated spare, global spare, or available compatible disk is already present, the dynamic spares feature uses that disk to start the reconstruction and the replacement disk can be used for another purpose.

To change the dynamic spares setting

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Disk**.
2. Either select (enable) or clear (disable) the **Dynamic Spare Capability** option.
3. Click **Apply**.

Configuring drive spin down for available disks and global spares

The drive spin down (DSD) feature monitors disk activity within system enclosures and spins down inactive disks to conserve energy. You can enable or disable DSD for available disks and global spares, and set the period of inactivity after which available disks and global spares automatically spin down.

To configure a time period to suspend and resume DSD for all disks, see Scheduling drive spin down for all disks below. To configure DSD for a vdisk, see Configuring Drive Spin Down For a vdisk on page 76.

DSD affects disk operations as follows:

- Spun-down disks are not polled for SMART events.
- Operations requiring access to disks may be delayed while the disks are spinning back up.

To configure DSD for available disks and global spares

1. In the Configuration View panel, right-click the local system and select **Configuration > Advanced Settings > Disk**.
2. Set the options:
   - Either select (enable) or clear (disable) the **Available and Spare Drive Spin Down Capability** option. If you are enabling DSD, a warning prompt appears. To use DSD, click **Yes**. To leave DSD disabled, click **No**.
   - Set the Drive Spin Down Delay (minutes) option, which is the period of inactivity after which available disks and global spares automatically spin down, from 1–360 minutes.
3. Click **Apply**. When processing is complete a success dialog appears.
4. Click **OK**.

Scheduling drive spin down for all disks

For all disks that are configured to use drive spin down (DSD), you can configure a time period to suspend and resume DSD so that disks remain spun-up during hours of frequent activity.

To configure DSD for a vdisk, see Configuring Drive Spin Down For a vdisk on page 76. To configure DSD for available disks and global spares, see Configuring drive spin down for available disks and global spares on the previous page.

DSD affects disk operations as follows:

- Spun-down disks are not polled for SMART events.
- Operations requiring access to disks may be delayed while the disks are spinning back up.
- If a suspend period is configured and it starts while a disk has started spinning down, the disk spins up again.

To schedule DSD for all disks

1. In the Configuration View panel, right-click the local system and select **Configuration > Advanced Settings > Disk**.
2. Set the options:
   - Select the **Drive Spin Down Suspend Period** option.
   - Set the Time to Suspend and Time to Resume options. For each, enter hour and minutes values and select either AM, PM, or 24H (24-hour clock).
   - If you want the schedule to apply only Monday through Friday, select the **Exclude Weekend Days from Suspend Period** option.
3. Click **Apply**. When processing is complete a success dialog appears.
4. Click **OK**.

Configuring the EMP polling rate

You can change the frequency interval at which the storage system polls each attached enclosure's EMP for status changes. Typically you can use the default setting.

- Increasing the interval might slightly improve processing efficiency, but changes in device status are communicated less frequently. For example, this increases the amount of time before LEDs are updated to reflect status changes.
- Decreasing the interval slightly decreases processing efficiency, but changes in device status are communicated more frequently. For example, this decreases the amount of time before LEDs are updated to reflect status changes.

To change the EMP polling rate

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Disk**.
2. Set the EMP Polling Rate interval. The options are 5, 10, or 30 seconds; or 1, 5, 10, 15, 20, 25, 30, 45, or 60 minutes.
3. Click **Apply**.

Changing FDE settings (for QXS-4/6 Series Only)

In the Full Disk Encryption Settings panel you can change settings for these options:

- FDE general configuration
  - Set the passphrase
  - Clear lock keys
  - Secure the system
- Repurpose the system
- Repurpose disks
- FDE import lock key IDs

Changing FDE general configuration

⚠ **Caution:** Do not change FDE configuration settings while running I/O. Temporary data unavailability may result. Also, the intended configuration change might not take effect.

Setting the passphrase

You can set the FDE passphrase the system uses to write to and read from FDE-capable disks. From the passphrase, the system generates the lock key ID that is used to secure the FDE-capable disks. If the passphrase for a system is different from the passphrase associated with a disk, the system cannot access data on the disks.

⚠ **Caution:** Be sure to record the passphrase as it cannot be recovered if lost.

To set or change the passphrase

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Full Disk Encryption** and select the **FDE General Configuration** tab.
2. Enter a passphrase in the **Passphrase** field. A passphrase is case sensitive and can include 8–32 printable UTF-8 characters. It cannot include the following: ' " , < > \
3. Re-enter the passphrase.
4. Click **Set**. A dialog box will confirm the passphrase was changed successfully.

Clearing lock keys

Lock keys are generated from the passphrase and manage locking and unlocking the FDE-capable disks in the system. Clearing the lock keys and power cycling the system denies access to data on the disks. Use this procedure when the system will not be under your physical control.

If the lock keys are cleared while the system is secured, the system will enter the FDE lock-ready state, in preparation for the system being powered down and transported. The disks will still be in the secured, unlocked state. Once the system has been transported and powered back up, the system and disks will both be in the secured, locked state. Set the system's lock key to restore access to data.

To clear lock keys

Note: The FDE panels are dynamic, and the Clear All FDE Keys option is not available until the current passphrase is entered in the **Current Passphrase** field. If there is no passphrase, set one using the procedure in Setting the passphrase on the previous page.

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Full Disk Encryption** and select the **FDE General Configuration** tab.
2. Enter the passphrase in the **Current Passphrase** field.
3. Click **Clear**. A dialog box appears.
4. Do one of the following:
   - To clear the keys, click **Yes**.
   - To cancel the request, click **No**.

Securing the system

An FDE-capable system must be secured to enable FDE protection.

To secure the system

Note: The FDE panels are dynamic, and the Secure option is not available until the current passphrase is entered in the **Current Passphrase** field. If there is no passphrase, set one using the procedure in Setting the passphrase on the previous page.

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Full Disk Encryption** and select the **FDE General Configuration** tab.
2. Enter the passphrase in the **Current Passphrase** field.
3. Click **Secure**.
4. Do one of the following:
   - To secure the system, click **Yes**.
   - To cancel the request, click **No**.

Repurposing the System (for QXS-4/6 Series Only)

You can repurpose a system to erase all data on the system and return its FDE state to unsecure.

Caution: Repurposing a system erases all disks in the system and restores the FDE state to unsecure.

Note: If you want to repurpose more than one disk and the drive spin down (DSD) feature is enabled, disable DSD before repurposing the disks. You can re-enable it after the disks are repurposed. For information about disabling and enabling DSD, see Configuring drive spin down for available disks and global spares on page 63.

To repurpose the system

Note: The FDE panels are dynamic, and the Repurpose System option is not available until the system is secure and all vdisks have been removed from the system.

1. Delete all vdisks in the system. To delete vdisks, see Deleting vdisks on page 85. Deleting vdisks effectively deletes all data on the disks but does not secure erase them.
2. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Full Disk Encryption** and select the **FDE General Configuration** tab.
3. Click **Repurpose**. A dialog box displays.
4. Do one of the following:
   - To repurpose the system, click **Yes**.
   - To cancel the request, click **No**.

Repurposing Disks (for QXS-4/6 Series Only)

You can repurpose a disk that is no longer part of a vdisk. Repurposing a disk resets the encryption key on the disk, effectively deleting all data on the disk. After a disk is repurposed in a secured system, the disk is secured using the system lock key ID and the new encryption key on the disk, making the disk usable to the system.

Caution: Repurposing a disk changes the encryption key on the disk and effectively deletes all data on the disk. Repurpose a disk only if you no longer need the data on the disk.

To repurpose a disk

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Full Disk Encryption** and select the **Repurpose Disks** tab.
2. Select the disk to repurpose.
3. Click **Repurpose**. A dialog box displays.
4. Do one of the following:
   - To repurpose the selected disk, click **Yes**.
   - To cancel the request, click **No**.

Setting FDE import lock key IDs(for QXS-4/6 Series Only)

You can set the passphrase associated with an import lock key to unlock FDE-secured disks that are inserted into the system from a different secure system. If the correct passphrase is not entered, the system cannot access data on the disk.

After importing disks into the system, the disks will now be associated with the system lock key ID and data will no longer be accessible using the import lock key. This effectively transfers security to the local system passphrase.

To set or change the import passphrase

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Full Disk Encryption** and select the **Set Import Lock Key ID** tab.
2. In the **Passphrase** field, enter the passphrase associated with the displayed lock key.
3. Re-enter the passphrase.
4. Click **Import Passphrase**. A dialog box will confirm the passphrase was changed successfully.

Changing system cache settings

Changing the synchronize-cache mode

You can control how the storage system handles the `SCSI SYNCHRONIZE CACHE` command. Typically you can use the default setting. However, if the system has performance problems or problems writing to databases or other applications, contact technical support to determine if you should change this option.

To change the synchronize-cache mode

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Cache**.
2. Set the Sync Cache Mode option to either:
   - **Immediate**. Good status is returned immediately and cache content is unchanged.
   - **Flush to Disk**. Good status is returned only after all write-back data for the specified volume is flushed to disk.
3. Click **Apply**.

Changing the missing LUN response

Some operating systems do not look beyond LUN 0 if they do not find a LUN 0 or cannot handle noncontiguous LUNs. The Missing LUN Response option handles these situations by enabling the host drivers to continue probing for LUNs until they reach the LUN to which they have access.

This option controls the SCSI sense data returned for volumes that are not accessible because they don’t exist or have been hidden through volume mapping (this does not apply to volumes of offline vdisks). Use Not Ready unless the system is used in a VMware environment or a service technician asks you to change it to work around a host driver problem.

To change the missing LUN response

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Cache**.
2. Set the Missing LUN Response option to either:
   - **Not Ready**. Sends a reply that there is a LUN where a gap has been created but that it’s “not ready.” Sense data returned is a Sense Key of `2h` and an ASC/ASCQ of `04/03`.

- **Illegal Request**. Sends a reply that there is a LUN but that the request is “illegal.” Sense data returned is a Sense Key of `5h` and an ASC/ASCQ of `25/00`. If the system is used in a VMware environment, use this option.

3. Click **Apply**.

Controlling host access to the system’s write-back cache setting

You can prevent hosts from using `SCSI MODE SELECT` commands to change the system’s write-back cache setting. Some operating systems disable write cache. If host control of write-back cache is disabled, the host cannot modify the cache setting.

This option is useful in some environments where the host disables the system’s write-back cache, resulting in degraded performance.

To change host access to the write-back cache setting

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Cache**.
2. Either select (enable) or clear (disable) the **Host Control of Write-Back Cache** option.
3. Click **Apply**.

Changing the controllers’ cache redundancy mode

In a dual-controller system’s default redundancy/operating mode, Active-Active ULP, data for volumes configured to use write-back cache is automatically mirrored between the two controllers. Cache redundancy has a slight impact on performance but provides fault tolerance. You can disable cache redundancy, which permits independent cache operation for each controller. This is called independent cache performance mode (ICPM).

The advantage of ICPM is that the two controllers can achieve very high write bandwidth and still use write-back caching. User data is still safely stored in nonvolatile RAM, with backup power provided by super-capacitors should a power failure occur. This feature is useful for high-performance applications that do not require a fault-tolerant environment for operation. That is, where speed is more important than the possibility of data loss due to a drive fault prior to a write completion.

The disadvantage of ICPM is that if a controller fails, the other controller will not be able to fail over (that is, take over I/O processing for the failed controller). If a controller experiences a complete hardware failure, and needs to be replaced, then user data in its write-back cache will be lost.

⚠ **Caution:** Data might be compromised if a RAID controller failure occurs after it has accepted write data, but before that data has reached the disk drives. Do not use ICPM in an environment that requires fault tolerance.

ℹ **Note:** You cannot enable ICPM if the Partner Firmware Update (PFU) feature or single-controller mode is enabled.

To change the controllers’ cache redundancy mode

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Cache**.

2. Either select (enable) or clear (disable) the **Independent Cache Performance Mode** option. In Single Controller mode this option is grayed out.
3. Click **Apply**. For the change to take effect, you must restart both Storage Controllers.

Changing auto-write-through cache triggers and behaviors

You can set conditions that cause ("trigger") a controller to change the cache mode from write-back to write-through, as described in About Volume Cache Options on page 13. You can also specify actions for the system to take when write-through caching is triggered.

To change auto-write-through cache triggers and behaviors

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Cache**.
2. In the Auto-Write Through Cache Trigger Conditions section, either select (enable) or clear (disable) the options:
   - **Controller Failure**. Changes to write-through if a controller fails. In Single Controller mode this option is grayed out.
   - **Cache Power**. Changes to write-through if cache backup power is not fully charged or fails.
   - **CompactFlash**. Changes to write-through if CompactFlash memory is not detected during POST, fails during POST, or fails while the controller is under operation.
   - **Power Supply Failure**. Changes to write-through if a power supply unit fails.
   - **Fan Failure**. Changes to write-through if a cooling fan fails.
   - **Overtemperature Failure**. Forces a controller shutdown if a temperature is detected that exceeds system threshold limits.
3. In the Auto-Write Through Cache Behaviors section, either select (enable) or clear (disable) the options:
   - **Revert when Trigger Condition Clears**. Changes back to write-back caching after the trigger condition is cleared.
   - **Notify Other Controller**. Notifies the partner controller that a trigger condition occurred. Enable this option to have the partner also change to write-through mode for better data protection. Disable this option to allow the partner continue using its current caching mode for better performance. In Single Controller mode this option is grayed out.
4. Click **Apply**.

Configuring partner firmware update

In a dual-controller system in which partner firmware update is enabled, when you update firmware on one controller, the system automatically updates the partner controller. Disable partner firmware update only if requested by a service technician.

To change the partner firmware update setting

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > Firmware**.
2. Either select (enable) or clear (disable) the **Partner Firmware Update** option.
3. Click **Apply**.

Configuring system utilities

Configuring background scrub for vdisks

You can enable or disable whether the system continuously analyzes disks in vdisks to find and fix disk errors. This command will fix parity mismatches for RAID 3, 5, 6, and 50; mirror mismatches for RAID 1 and 10; and media errors for all RAID levels.

You can use a vdisk while it is being scrubbed. Background vdisk scrub runs at background utility priority, which reduces to no activity if processor usage is above a certain percentage or if I/O is occurring on the vdisk being scrubbed. A vdisk scrub may be in process on multiple vdisks at once. A new vdisk will first be scrubbed 20 minutes after creation. After a vdisk is scrubbed, scrub will start again after the interval specified by the Vdisk Scrub Interval (hours) option.

When a scrub is complete, event 207 is logged and specifies whether errors were found and whether user action is required.

Enabling background vdisk scrub is recommended.

Note: If you choose to disable background vdisk scrub, you can still scrub a selected vdisk by using **Tools > Media Scrub Vdisk** (Scrubbing a vdisk on page 120).

To configure background scrub for vdisks

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > System Utilities**.
2. Set the options:
   - Either select (enable) or clear (disable) the **Vdisk Scrub** option.
   - Set the Vdisk Scrub Interval (hours) option, which is the interval between background vdisk scrub finishing and starting again, from 0–360 hours.
3. Click **Apply**.

Configuring background scrub for disks not in vdisks

You can enable or disable whether the system continuously analyzes disks that are not in vdisks to find and fix disk errors. The interval between background disk scrub finishing and starting again is 72 hours. The first time you enable this option, background disk scrub will start with minimal delay. If you disable and then re-enable this option, background disk scrub will start 72 hours after the last background disk scrub completed.

Enabling background disk scrub is recommended.

To configure background scrub for disks not in vdisks

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > System Utilities**.
2. Either select (enable) or clear (disable) the **Disk Scrub** option.
3. Click **Apply**.

Configuring utility priority

You can change the priority at which the Verify, Reconstruct, Expand, and Initialize utilities run when there are active I/O operations competing for the system's controllers.

To change the utility priority

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > System Utilities**.
2. Set the Utility Priority option to either:
    - **High**. Use when your highest priority is to get the system back to a fully fault-tolerant state. This causes heavy I/O with the host to be slower than normal.
    - **Medium**. Use when you want to balance data streaming with data redundancy.
    - **Low**. Use when streaming data without interruption, such as for a web server, is more important than data redundancy. This enables a utility such as Reconstruct to run at a slower rate with minimal effect on host I/O.
3. Click **Apply**.

Enabling/disabling managed logs

You can enable or disable the managed logs feature, which allows log files to be transferred from the storage system to a log-collection system to avoid losing diagnostic data. For an overview of the managed logs feature, including how to configure and test it, see About Managed Logs on page 26.

To enable or disable managed logs

1. In the Configuration View panel, right-click the system and select **Configuration > Advanced Settings > System Utilities**.
2. Either select (enable) or clear (disable) the **Managed Logs** option.
3. Click **Apply**.

Configuring remote systems

Adding a remote system

You can add a management object to obtain information from a remote storage system. This allows a local system to track remote systems by their network-port IP addresses and cache their login credentials. The IP address can then be used in commands that need to interact with the remote system.

To add a remote system

1. In the Configuration View panel, either:
   - Right-click the local system and select **Configuration > Remote System > Add Remote System**.
   - Right-click a remote system and select **Configuration > Add Remote System**.
2. In the main panel set the options:
   - IP address. IP address of a network port on the remote system.
   - User Name. User name of a user with a Manage role on the remote system.
   - Password. Password for that user.
3. Click **Create Remote System**. If the task succeeds, the new remote system appears in the Configuration View panel.

Deleting remote systems

You can delete the management objects for remote systems.

After establishing replication to a remote system, if you choose to delete the remote system you can safely do so without affecting replications. However, because the remote system’s name and IP address will no longer appear in user interfaces, record this information before deleting the remote system so that you can access it at a later time, such as to delete old replication images or for disaster recovery.

To delete remote systems

1. In the Configuration View panel, either:
   - Right-click the local system and select **Configuration > Remote System > Delete Remote System**.
   - Right-click a remote system and select **Configuration > Delete Remote System**.
2. In the main panel, select the remote systems to remove. To select or clear all remote systems, toggle the check box in the heading row.
3. Click **Delete Remote System(s)**. A confirmation dialog appears.

4. Click **Delete** to continue. Otherwise, click **Cancel**. If you clicked **Delete**, a processing dialog appears. If the task succeeds, the System Overview panel and a success dialog appear.
5. Click **OK**. As processing completes, the deleted items are removed from the Configuration View panel.

Configuring a vdisk

Managing Dedicated Spares

You can assign a maximum of four available disks to a fault-tolerant vdisk (RAID 1, 3, 5, 6, 10, 50) for use as spares by that vdisk only. A spare must be the same type as other disks in the vdisk, and have sufficient capacity to replace the smallest disk in the vdisk.

Vdisks support a mix of 512n and 512e disks. However, for consistent and predictable performance, do not mix disks of different rotational speed or sector size types (512n, 512e). To identify the sector format for a disk, in the Configuration View panel, right-click an enclosure and select **View > Overview**. Select a disk and click the **Properties** tab to view the disk properties, including its sector format (512n or 512e).

Note: If you upgraded from an earlier release that did not distinguish between enterprise and midline SAS disks, you might have vdisks that contain both types of disks. For such a vdisk, whose RAID-level label has the suffix `-MIXED` in the Configuration View panel, you can designate either or both types of disks to be spares.

If a disk in the vdisk fails, a dedicated spare is automatically used to reconstruct the vdisk. A fault-tolerant vdisk other than RAID-6 becomes Critical when one disk fails. A RAID-6 vdisk becomes Degraded when one disk fails and Critical when two disks fail. After the vdisk's parity or mirror data is completely written to the spare, the vdisk returns to fault-tolerant status. For RAID-50 vdisks, if more than one sub-vdisk becomes critical, reconstruction and use of assigned spares occur in the order sub-vdisks are numbered.

To change a vdisk's spares

1. In the Configuration View panel, right-click a vdisk and select **Configuration > Manage Dedicated Spares**. The main panel shows information about the selected vdisk, its spares, and all disks in the system. Existing spares are labeled SPARE.
   - In the Disk Sets table, the number of white slots in the Disks column of the SPARE row shows how many spares you can add to the vdisk.
   - In the Graphical or Tabular view, only existing spares and suitable available disks are selectable.
2. Select spares to remove, disks to add as spares, or both. To add a spare, select its check box. To remove a spare, clear its check box.
3. Click **Modify Spares**. If the vdisk and spares contain a mix of 512n and 512e disks, a dialog box displays.
4. Perform one of the following:
   - To change the vdisk's spares, click **Yes**.

- To cancel the request, click **No**.

If the task succeeds, the panel is updated to show which disks are now spares for the vdisk.

Changing a vdisk’s name

To change a vdisk’s name

1. In the Configuration View panel, right-click a vdisk and select **Configuration > Modify Vdisk Name**. The main panel shows the vdisk’s name.
2. Enter a new name. A vdisk name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in the system or include the following: ' " , < > \
3. Click **Modify Name**. The new name appears in the Configuration View panel.

Changing a vdisk’s owner

Each vdisk is owned by one of the controllers, A or B, known as the *preferred owner*. Typically, you should not need to change vdisk ownership.

When a controller fails, the partner controller assumes temporary ownership of the failed controller’s vdisks and resources, becoming the *current owner*. If the system uses a fault-tolerant cabling configuration, both controllers’ LUNs are accessible through the partner.

Caution:
-Before changing the owning controller for a vdisk, you must stop host I/O to the vdisk’s volumes.
-Because a volume and its snap pool must be in vdisks owned by the same controller, if an ownership change will cause volumes and their snap pools to be owned by different controllers, the volumes will not be able to access their snap pools.

Changing the owner of a vdisk does not affect the mappings volumes in that vdisk.

To change a vdisk’s owner

1. In the Configuration View panel, right-click a vdisk and select **Configuration > Modify Vdisk Owner**. The main panel shows the vdisk’s owner.
2. Select a new owner.
3. Click **Modify Owner**. A confirmation dialog appears.
4. Click **Yes** to continue. Otherwise, click **No**. If you clicked Yes, a processing dialog appears. When processing is complete a success dialog appears.
5. Click **OK**.

Configuring Drive Spin Down For a vdisk

The drive spin down (DSD) feature monitors disk activity within system enclosures and spins down inactive disks to conserve energy. For a specific vdisk, you can enable or disable DSD and set the period of inactivity after which the vdisk's disks and dedicated spares automatically spin down.

To configure a time period to suspend and resume DSD for all vdisks, see Scheduling drive spin down for all disks on page 63. To configure DSD for available disks and global spares, see Configuring drive spin down for available disks and global spares on page 63.

DSD affects disk operations as follows:

- Spun-down disks are not polled for SMART events.
- Operations requiring access to disks may be delayed while the disks are spinning back up.
- If a suspend period is configured and it starts while a vdisk has started spinning down, the vdisk spins up again.

To configure DSD for a vdisk

1. In the Configuration View panel, right-click a vdisk and select **Configuration > Configure Vdisk Drive Spin Down**.
2. Set the options:
   - Either select (enable) or clear (disable) the **Enable Drive Spin Down** option.
   - Set the Drive Spin Down Delay (minutes) option, which is the period of inactivity after which the vdisk's disks and dedicated spares automatically spin down, from 1–360 minutes.
3. Click **Apply**. When processing is complete a success dialog appears.
4. Click **OK**.

Changing a vdisk's Scrub Duration Goal

For use when vdisk scrub is enabled, you can set the requested duration of a vdisk scrub operation. To enable vdisk scrub for all vdisks, see Configuring background scrub for vdisks on page 71.

To change a vdisk's scrub duration goal

1. In the Configuration View panel, right-click a vdisk and select **Configuration> <Modify Vdisk Scrub Duration Goal**.
2. Enter a new value for the requested duration of a vdisk scrub operation, in hours. A value of 0 indicates that the scrub duration is not intended to be controlled, and the scrub instead runs at the background priority. A value of 1 to 1080 hours (45 days) will cause the storage system to adjust the resources available to the scrub operation, which could affect other performance. There is no guarantee that this scrub duration goal is achievable, due to such considerations as vdisk size or abnormally high host activity.

3. Click **Set Duration**. The new setting will apply to the next scrub operation to be scheduled for this vdisk.

Configuring a Volume

Changing a Volume's Name

To change a volume's name

1. In the Configuration View panel, right-click a volume and select **Configuration > Modify Volume Name**.
2. Enter a new name. A volume name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in a vdisk or include the following: ' " , < > \
3. Click **Modify Name**. The new name appears in the Configuration View panel.

Changing a Volume's Cache Settings

For explanations of volume cache options, see About Volume Cache Options on page 13.

⚠ **Caution:**
-Only disable write-back caching if you fully understand how the host operating system, application, and adapter move data. If used incorrectly, you might hinder system performance.
-Only change read-ahead cache and cache optimization mode settings if you fully understand how the host operating system, application, and adapter move data so that you can adjust the settings accordingly.

To change a volume's cache settings

1. In the Configuration View panel, right-click a volume and select **Configuration > Modify Volume Cache Settings**.
2. In the main panel, set the volume cache options:
   - Write Policy. Select Write-back or Write-through.
   - Write Optimization. Select Standard or No-mirror.
   - Read Ahead Size. Select Disabled, Adaptive, Stripe, or a specific size (512KB, 1MB, 2MB, 4MB, 8MB, 16MB, or 32MB).
3. Click **Modify Cache Settings**.

Configuring a Snapshot

Changing a Snapshot's Name

To change a snapshot's name

1. In the Configuration View panel, right-click a snapshot and select **Configuration > Modify Snapshot Name**.
2. Enter a new name. A snapshot name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in a vdisk or include the following: ' " , < \
3. Click **Modify Name**. A message indicates whether the task succeeded or failed.
4. Click **OK**. The new name appears in the Configuration View panel.

Configuring a Snap Pool

Changing a Snap Pool's Name

To change a snap pool's name

1. In the Configuration View panel, right-click a snap pool and select **Configuration > Modify Snap Pool Name**.
2. Enter a new name. A snap pool name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in a vdisk or include the following: ' " , < \
3. Click **Modify Name**. The new name appears in the Configuration View panel.

Chapter 3: Provisioning the System

This chapter contains the following topics:

Using the Provisioning Wizard

The Provisioning Wizard helps you create a vdisk with volumes and to map the volumes to hosts. Before using this wizard, read documentation for your product to learn about vdisks, volumes, and mapping. Then plan the vdisks and volumes you want to create and the default mapping settings you want to use.

The wizard guides you through the following steps. For each step you can view help by clicking the help icon ? in the wizard panel. As you complete steps they are highlighted at the bottom of the panel. If you cancel the wizard at any point, no changes are made.

- Specify a name and RAID level for the vdisk
- Select disks to use in the vdisk
- Specify the number and size of volumes to create in the vdisk
- Specify the default mapping for access to the volume by hosts
- Confirm changes and apply them

Note: To create an NRAID, RAID-0, or RAID-3 vdisk, you must use the CLI `create vdisk` command. For more information on this command, see the CLI Reference Guide.

Step 1: Starting the wizard

1. In the Configuration View panel, right-click the system and select either **Provisioning > Provisioning Wizard** or **Wizards > Provisioning Wizard**. The wizard panel appears.
2. Click **Next** to continue.

Step 2: Specifying the vdisk name and RAID level

A *vdisk* is a virtual disk that is composed of one or more disks, and has the combined capacity of those disks. The number of disks that a vdisk can contain is determined by its RAID level. When you create a vdisk, all its disks must be the same type.

A vdisk can contain different models of disks, and disks with different capacities. If you mix disks with different capacities, the smallest disk determines the logical capacity of all other disks in the vdisk, regardless of RAID level. For example, the capacity of a vdisk composed of one 500-GB disk and one 750-GB disk is equivalent to a vdisk composed of two 500-GB disks. To maximize capacity, use disks of similar size. For greatest reliability, use disks of the same size and rotational speed.

In a single-controller system, all vdisks are owned by that controller. In a dual-controller system, when a vdisk is created the system automatically assigns the owner to balance the number of vdisks each controller owns; or, you can select the owner. Typically it doesn’t matter which controller owns a vdisk.

In a dual-controller system, when a controller fails, the partner controller assumes temporary ownership of the failed controller’s vdisks and resources. If the system uses a fault-tolerant cabling configuration, both controllers’ LUNs are accessible through the partner.

When you create a vdisk you can also create volumes within it. A volume is a logical subdivision of a vdisk, and can be mapped to controller host ports for access by hosts. The storage system presents only volumes, not vdisks, to hosts.

To create a vdisk

1. Set the options:
   - Vdisk name. This field is populated with a default name, which you can change. A vdisk name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in the system or include the following: " , < \
   - Assign to. If the system is operating in Active-Active ULP mode, optionally select a controller to be the preferred owner for the vdisk. Auto automatically assigns the owner to load-balance vdisks between controllers. If the system is operating in Single Controller mode, the Assign to setting is ignored and the system automatically load-balances vdisks in anticipation of the insertion of a second controller in the future.
   - RAID level. Select a RAID level for the vdisk. Each RAID level requires a minimum number of disks, so the number of available disks determines which RAID-level options are selectable. The default, with at least three available disks, is RAID 5.
   - Number of sub-vdisks. For a RAID-10 or RAID-50 vdisk, optionally change the number of sub-vdisks that the vdisk should contain.
   - Chunk size. For RAID 5, 6, 10, or 50, optionally set the amount of contiguous data that is written to a vdisk member before moving to the next member of the vdisk. For RAID 50, this option sets the

chunk size of each RAID-5 sub-vdisk. The chunk size of the RAID-50 vdisk is calculated as: *configured-chunk-size* x (*subvdisk-members* - 1). For RAID 1, chunk size has no meaning and is therefore disabled.

2. Click **Next** to continue.

Step 3: Selecting disks

Select disks to include in the vdisk. The Disk Selection Sets table has one row for each sub-vdisk in a RAID-10 or RAID-50 vdisk, or a single row for a vdisk having another RAID level. The table also has a SPARE row where you can assign dedicated spares to the vdisk. In each row, the Disks field shows how many disks you can, and have, assigned. As you select disks, the table shows the amount of storage space in the vdisk. For descriptions of storage-space color codes, see About Storage-space Color Codes on page 23.

The Tabular tab shows all available disks in all enclosures in a table, displaying Health, Name, Type, State, Size, Enclosure, Serial Number, and Status. The Graphical tab shows disk information graphically, displaying the state for each disk (VDISK, AVAIL, SPARE, VIRTUAL POOL). Only available disks can be selected. Disks you select are highlighted and color-coded to match the rows in the Disk Selection Sets table. Based on the type of disk you select first, only available disks of that type become selectable. Disks of different types cannot be mixed in a vdisk.

Note: The VIRTUAL POOL label on disks in the Tabular tab view indicates the state of disks used in the virtual storage system.

To select disks and spares

1. Select disks to populate each vdisk row. When you have selected enough disks, a check mark appears in the table's Complete field.
2. Optionally select up to four dedicated spares for the vdisk.
3. Click **Next** to continue.

Step 4: Defining volumes

A *volume* is a logical subdivision of a vdisk and can be mapped to controller host ports for access by hosts. A mapped volume provides the storage for a file system partition you create with your operating system or third-party tools. The storage system presents only volumes, not vdisks, to hosts.

You can create multiple volumes with the same base name, size, and default mapping settings. If you choose to define volumes in this step, you will define their mapping settings in the next step.

To define volumes

1. Set the options:
   - Number of volumes to create. Specify the number of volumes to create. If you do not want to create volumes, enter **0**. After changing the value, press **Tab**.
   - Volume size. Specify the size of each volume. The default size is the total capacity of the vdisk divided by the number of volumes.

- Base name for volumes. Specify the base name for the volumes. A volume name is case sensitive and can have a maximum of 16 bytes. It cannot already exist in a vdisk or include the following: " , < \

2. Click **Next** to continue.

Step 5: Setting the default mapping

You can optionally specify *default mapping* settings to control whether and how hosts will be able to access the vdisk's volumes. These settings include:

- A logical unit number (LUN), used to identify a mapped volume to hosts. Both controllers share one set of LUNs. Each LUN can be assigned as the default LUN for only one volume in the storage system. For example, if LUN 5 is the default for Volume1, LUN5 cannot be the default LUN for any other volume.
- The level of access — read-write, read-only, or no access — that hosts will have to each volume. When a mapping specifies no access, the volume is *masked*.
- Controller host ports through which hosts will be able to access each volume. To maximize performance, it is recommended to map a volume to at least one host port on the controller that the volume's vdisk is assigned to. To sustain I/O in the event of controller failure, it is recommended to map to at least one host port on each controller.

After a volume is created you can change its default mapping, and create, modify, or delete explicit mappings. An *explicit mapping* overrides the volume's default mapping for a specific host.

ℹ **Note:** When mapping a volume to a host using the Linux ext3 file system, specify read-write access. Otherwise, the file system will be unable to mount/present/map the volume and will report an error such as "unknown partition table."

To specify the default mapping

1. Select **Map**.
2. Set the starting LUN for the volumes. If this LUN is available, it will be assigned to the first volume and the next available LUNs in sequence will be assigned to any remaining volumes.
3. In the enclosure view or list, select controller host ports through which attached hosts can access each volume.
4. Select the access level that hosts will have to each volume: **read-write**, **read-only**, or **no-access** (masked).
5. Click **Next** to continue.

To proceed without specifying a default mapping

1. Do not select **Map**.
2. Click **Next** to continue.

Step 6: Confirming vdisk settings

Confirm that the values listed in the wizard panel are correct.

- If they are not correct, click **Previous** to return to previous steps and make necessary changes.
- If they are correct, click **Finish** to apply the setting changes and finish the wizard.

Creating a vdisk

Before creating a vdisk, consider some basics, such as the RAID level and the type, capacity, and sector format of the disks. When selecting disks for the vdisk, you can view the disk type and capacity. To identify the sector format for a disk, in the Configuration View panel, right-click an enclosure and select **View > Overview**. Select a disk and click the Properties tab to view the disk properties, including its sector format (512n or 512e). Vdisks support a mix of 512n and 512e disks. However, for consistent and predictable performance, do not mix disks of different rotational speed or sector size types (512n, 512e).

ℹ **Note:** To create an NRAID, RAID-0, or RAID-3 vdisk, you must use the CLI `create vdisk` command. For more information on this command, see the CLI Reference Guide.

To create a vdisk

1. In the Configuration View panel, right-click the system or **Vdisks** and then select **Provisioning > Create Vdisk**.
2. In the main panel set the options:
   - Vdisk name. Optionally change the default name for the vdisk. A vdisk name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in the system or include the following: " , < \
   - Assign to. If the system is operating in Active-Active ULP mode, optionally select a controller to be the preferred owner for the vdisk. The default, Auto, automatically assigns the owner to load-balance vdisks between controllers. If the system is operating in Single Controller mode, the Assign to setting is ignored and the system automatically load-balances vdisks in anticipation of the insertion of a second controller in the future.
   - RAID Level. Select a RAID level for the vdisk. Each RAID level requires a minimum number of disks, so the number of available disks determines which RAID-level options are selectable.
   - Number of Sub-vdisks. For a RAID-10 or RAID-50 vdisk, optionally change the number of sub-vdisks that the vdisk should contain.
   - Chunk size. For RAID 5, 6, 10, or 50, optionally set the amount of contiguous data that is written to a vdisk member before moving to the next member of the vdisk. For RAID 50, this option sets the chunk size of each RAID-5 sub-vdisk. The chunk size of the RAID-50 vdisk is calculated as: *configured-chunk-size* x (*subvdisk-members* - 1). For RAID 1, chunk size has no meaning and is therefore disabled. The default size is `512KB`.
   - Online Initialization. If you select (enable) this option, you can use the vdisk while it is initializing but because the verify method is used to initialize the vdisk, initialization takes more time. If you clear (disable) this option, you must wait for initialization to complete before using the vdisk, but initialization takes less time. Online initialization is fault tolerant.
3. Select disks to include in the vdisk. The Disk Selection Sets table has one row for each sub-vdisk in a RAID-10 or RAID-50 vdisk, or a single row for a vdisk having another RAID level. The table also has a

SPARE row where you can assign dedicated spares to the vdisk. In each row, the Disks field shows how many disks you can, and have, assigned. As you select disks, the table shows the amount of storage space in the vdisk. For descriptions of storage-space color codes, see About Storage-space Color Codes on page 23. The Tabular tab shows all available disks in all enclosures in a table, displaying Health, Name, Type, State, Size, Enclosure, Serial Number, and Status. The Graphical tab shows disk information graphically, displaying the state for each disk (VDISK, AVAIL, SPARE). Only available disks can be selected. Disks you select are highlighted and color-coded to match the rows in the Disk Selection Sets table. Based on the type of disk you select first, only available disks of that type become selectable. Disks of different types cannot be mixed in a vdisk.

To select disks and spares:

- Select disks to populate each vdisk row. When you have selected enough disks, a checkmark appears in the table’s Complete field.
- Optionally select up to four dedicated spares for the vdisk.

4. Click **Create Vdisk**. If the task succeeds, the new vdisk appears in the Configuration View panel. If the vdisk contains a mix of 512n and 512e disks, a dialog box displays.
5. Perform one of the following:
   - To create the vdisk, click **Yes**.
   - To cancel the request, click **No**.

   If the task succeeds, the new vdisk appears in the Configuration View panel.

Deleting vdisks

⚠ **Caution:** Deleting a vdisk removes all of its volumes and their data.

To delete vdisks

1. Verify that hosts are not accessing volumes in the vdisks that you want to delete.
2. In the Configuration View panel, either:
   - Right-click the system or **Vdisks** and then select **Provisioning > Delete Vdisks**.
   - Right-click a vdisk and select **Provisioning > Delete Vdisk**.
3. In the main panel, select the vdisks to delete. To select or clear all vdisks, toggle the check box in the heading row.
4. Click **Delete Vdisk(s)**. A confirmation dialog appears.
5. Click **Delete** to continue. Otherwise, click **Cancel**. If you clicked Delete, a processing dialog appears. If the task succeeds, an overview panel and a success dialog appear.
6. Click **OK**. As processing completes, the deleted items are removed from the Configuration View panel.

Managing global spares

You can designate a maximum of 16 global spares for the system. If a disk in any fault-tolerant vdisk (RAID 1, 3, 5, 6, 10, 50) fails, a global spare is automatically used to reconstruct the vdisk. At least one vdisk must exist before you can add a global spare. A spare must have sufficient capacity to replace the smallest disk in an existing vdisk.

The vdisk remains in critical status until the parity or mirror data is completely written to the spare, at which time the vdisk returns to fault-tolerant status. For RAID-50 vdisks, if more than one sub-vdisk becomes critical, reconstruction and use of spares occur in the order sub-vdisks are numbered.

To illuminate a locator LED for a disk, select the disk and click **Turn On LEDs**. To turn off locator LEDs for a disk, click **Turn Off LEDs**.

Note: Vdisks support a mix of 512n and 512e disks. However, for consistent and predictable performance, do not mix disks of different rotational speed or sector size types (512n, 512e). If a global spare has a different sector format than the disks in a vdisk, an event will appear when the system chooses the spare after a disk in the vdisk fails. For more information about vdisks, see About vdisks on page 8.

To change the system's global spares

1. In the Configuration View panel, right-click the system and select **Provisioning > Manage Global Spares**. The main panel shows information about available disks in the system. Existing spares are labeled GLOBAL SP.
   - In the Disk Sets table, the number of white slots in the Disks field shows how many spares you can add.
   - In the Graphical or Tabular view, only existing global spares and suitable available disks are selectable.
2. Select spares to remove, disks to add as spares, or both.
3. Click **Modify Spares**. If the task succeeds, the panel is updated to show which disks are now global spares.

Creating a volume set

In a vdisk that has sufficient free space, you can create multiple volumes with the same base name and size. Optionally, you can specify a default mapping for the volumes. Otherwise, they will be created unmapped.

Volume sizes are aligned to 4-MB boundaries. When a volume is created or expanded, if the resulting size would be less than 4 MB it will be increased to 4 MB. If the resulting size would be greater than 4 MB it will be decreased to the nearest 4-MB boundary.

To create a volume set

1. In the Configuration View panel, right-click a vdisk and select **Provisioning > Create Volume Set**.

2. In the main panel, set the options:
   - Volume Set Base-name. This field is populated with a default base name for the volumes, which you can change. The volume names will consist of the base name and a number that increments from 0000. If a name in the series is already in use, the next name in the series is assigned. For example, for a two-volume set starting with Volume0000, if Volume0001 already exists, the second volume is named Volume0002. A base name is case sensitive and can have a maximum of 16 bytes. It cannot include the following: " , < \
   - Total Volumes. Specify the number of volumes to create. Volumes are created up to the maximum number supported per vdisk.
   - Size. Optionally change the volume size. The default size is the total space divided by the number of volumes.
   - Map. Select this option to specify a default mapping for the volumes:
     - Access. Select the access level that hosts will have to the volumes.
     - LUN. If the access level is set to read-write or read-only, set a LUN for the first volume. The next available LUN is assigned to the next volume mapped through the same ports. If a LUN to be assigned to a volume is already in use, that volume and any subsequent volumes are not mapped.
     - In the enclosure view or list, select controller host ports through which attached hosts can access the volumes.
3. Click **Apply**. If the task succeeds, the new volumes appear in the Configuration View panel.

Creating a volume

You can add a volume to a vdisk that has sufficient free space, and define default mapping settings.

Volume sizes are aligned to 4-MB boundaries. When a volume is created or expanded, if the resulting size would be less than 4 MB it will be increased to 4 MB. If the resulting size would be greater than 4 MB it will be decreased to the nearest 4-MB boundary.

Note: In rare cases, a large amount of I/O can cause a snap pool that is too small to fill quickly. This can result in all snapshots being deleted due to the snap pool running out of space. Create snap pools of at least 50 GB to avoid this situation.

To create a volume in a vdisk

1. In the Configuration View panel, right-click a vdisk and select **Provisioning > Create Volume**.
2. In the main panel, set the options:
   - Volume name. This field is populated with a default name, which you can change. A volume name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in a vdisk or include the following:
     " , < \

- Size. Optionally change the default size, which is all free space in the vdisk.
- Enable Snapshots. If the system is licensed to use Snapshots and you want to create snapshots of this volume, select this option. This specifies to create the volume as a master volume instead of as a standard volume, and enables the Snap Pool and Replication Prepare options.
- Snap Pool. Select either:
    - Standard Policy. This option creates a snap pool named `spvolume-name` whose size is either 20% of the volume size or 5.37 GB, whichever is larger. The recommended minimum size for a snap pool is 50 GB.
    - Reserve Size. Specify the size of the snap pool to create in the vdisk and associate with the new volume. The default size is either 20% of the volume size or 5.37 GB, whichever is larger. The recommended minimum size for a snap pool is 50 GB.
    - Attach Pool. Select an existing snap pool to associate with the new volume.
- Replication Prepare. If the system is licensed to use remote replication and you want to use this volume as a replication destination, select this option. Selecting this option disables the Map option.
- Map. Select this option to change the default mapping for the volume:
    - Access. Select the access level that hosts will have to the volume.
    - LUN. If the access level is set to read-write or read-only, set a LUN for the volume.
    - In the enclosure view or list, select controller host ports through which attached hosts can access the volume.

3. Click **Apply**. If the task succeeds, the new volume appears in the Configuration View panel. If you specified an option to create a snap pool, the new snap pool also appears in that panel.

Deleting volumes

You can use the Delete Volumes panel to delete standard and master volumes.

⚠ **Caution:** Deleting a volume removes its mappings and schedules and deletes its data.

To delete volumes

1. Verify that hosts are not accessing the volumes that you want to delete.
2. In the Configuration View panel, either:
    - Right-click the system or **Vdisks** or a vdisk and then select **Provisioning > Delete Volumes**.
    - Right-click a volume and select **Provisioning > Delete Volume**.
3. In the main panel, select the volumes to delete. To select up to 100 volumes or clear all selections, toggle the check box in the heading row.
4. Click **Delete Volume(s)**.

5. Click **Delete** to continue. Otherwise, click **Cancel**. If you clicked **Delete**, a processing dialog appears. If the task succeeds, an overview panel and a success dialog appear.
6. Click **OK**. As processing completes, the deleted items are removed from the Configuration View panel.

ⓘ **Note:** The system might be unable to delete a large number of volumes in a single operation. If you specified to delete a large number of volumes, verify that all were deleted. If some of the specified volumes remain, repeat the deletion on those volumes.

Changing default mapping for multiple volumes

For all volumes in all vdisks or a selected vdisk, you can change the default access to those volumes by all hosts. When multiple volumes are selected, LUN values are sequentially assigned starting with a LUN value that you specify. For example, if the starting LUN value is 1 for 30 selected volumes, the first volume's mapping is assigned LUN 1 and so forth, and the last volume's mapping is assigned LUN 30. For LUN assignment to succeed, ensure that no value in the sequence is already in use.

⚠ **Caution:** Volume mapping changes take effect immediately. Make changes that limit access to volumes when the volumes are not in use. Before changing a volume's LUN, be sure to unmount/unpresent/unmap the volume.

ⓘ **Note:** You cannot map the secondary volume of a replication set.

ⓘ **Note:** When mapping a volume to a host using the Linux ext3 file system, specify read-write access. Otherwise, the file system will be unable to mount/present/map the volume and will report an error such as "unknown partition table."

To change default mapping for multiple volumes

1. In the Configuration View panel, right-click **Vdisks** or a vdisk and then select **Provisioning > Map Volume Defaults**. In the main panel, a table shows all the volumes for the selected vdisk.
2. In the table, select the volumes to change. To select up to 100 volumes or clear all selections, toggle the check box in the heading row.
3. Either:
   - Map the volumes to all hosts by setting a starting LUN, selecting ports, and setting access to **read-only** or **read-write**.
   - Mask the volumes from all hosts by setting a starting LUN, selecting ports, and setting access to **no-access**. Setting the default mapping to **no-access** will result in the LUN mapping being removed.
4. Click **Apply**. A message specifies whether the change succeeded or failed.
5. Click **OK**.

Explicitly mapping multiple volumes

For all volumes in all vdisks or a selected vdisk, you can change access to those volumes by a specific host. When multiple volumes are selected, LUN values are sequentially assigned starting with a LUN value that you specify. For example, if the starting LUN value is 1 for 30 selected volumes, the first volume's mapping is assigned LUN 1 and so forth, and the last volume's mapping is assigned LUN 30. For LUN assignment to succeed, ensure that no value in the sequence is already in use. When specifying access through specific ports, the ports and host must be the same type (for example, FC or SAS).

⚠ **Caution:** Volume mapping changes take effect immediately. Make changes that limit access to volumes when the volumes are not in use. Before changing a volume's LUN, be sure to unmount/unpresent/unmap the volume.

ℹ **Note:** You cannot map the secondary volume of a replication set.

ℹ **Note:** When mapping a volume to a host using the Linux ext3 file system, specify read-write access. Otherwise, the file system will be unable to mount/present/map the volume and will report an error such as “unknown partition table.”

To explicitly map multiple volumes

1. In the Configuration View panel, right-click **Vdisks** or a vdisk and then select **Provisioning > Map Volumes**. In the main panel, a table shows all the volumes for the selected vdisk.
2. In the table, select the volumes to change. To select up to 100 volumes or clear all selections, toggle the check box in the heading row.
3. In the Hosts table, select the host to change access for.
4. Either:
   - Map the volumes to the host by setting a starting LUN, selecting ports, and setting access to **read-only** or **read-write**.
   - Mask the volumes from the host by setting a starting LUN, selecting ports, and setting access to **no-access**.
5. Click **Apply**.
6. Click **Yes** to continue. Otherwise, click **No**. If you clicked Yes, mapping changes begin. A message specifies whether the change succeeded or failed.

Changing a volume's default mapping

⚠ **Caution:** Volume mapping changes take effect immediately. Make changes that limit access to volumes when the volumes are not in use. Be sure to unmount/unpresent/unmap a volume before changing the volume's LUN.

ⓘ **Note:** You cannot map the secondary volume of a replication set.

ⓘ **Note:** When mapping a volume to a host using the Linux ext3 file system, specify read-write access. Otherwise, the file system will be unable to mount/present/map the volume and will report an error such as "unknown partition table."

To view the default mapping

In the Configuration View panel, right-click a volume and select **Provisioning > Default Mapping**. The main panel shows the volume's default mapping:

- Ports. Controller host ports through which the volume is mapped to the host.
- LUN. Volume identifier presented to the host.
- Access. Volume access type: read-write, read-only, no-access (masked), or not-mapped.

To modify the default mapping

1. Select **Map**.
2. Set the LUN and select the ports and access type. Setting the default mapping to **no-access** will result in the LUN mapping being removed.
3. Click **Apply**. A message specifies whether the change succeeded or failed.
4. Click **OK**. Each mapping that uses the default settings is updated.

To delete the default mapping

1. Clear **Map**.
2. Click **Apply**. A message specifies whether the change succeeded or failed.
3. Click **OK**.
4. Click **Yes** to continue. Otherwise, click **No**. If you clicked Yes, mapping changes begin. A message specifies whether the change succeeded or failed. Each mapping that uses the default settings is updated.

Changing a Volume's Explicit Mappings

⚠ **Caution:** Volume mapping changes take effect immediately. Make changes that limit access to volumes when the volumes are not in use. Be sure to unmount/unpresent/unmap a volume before changing the volume's LUN.

ⓘ **Note:** You cannot map the secondary volume of a replication set.

ⓘ **Note:** When mapping a volume to a host using the Linux ext3 file system, specify read-write access. Otherwise, the file system will be unable to mount/present/map the volume and will report an error such as "unknown partition table."

To view volume mappings

In the Configuration View panel, right-click a volume and select **Provisioning > Explicit Mappings**. The main panel shows the following information about the volume's mappings:

- Type. Explicit or Default. Settings for an explicit mapping override the default mapping.
- Host ID. WWPN or IQN.
- Host Name. User-defined nickname for the host.
- Ports. Controller host ports through which the volume is mapped to the host.
- LUN. Volume identifier presented to the host.
- Access. Volume access type: read-write, read-only, no-access (masked), or not-mapped.

To create an explicit mapping

1. In the Maps for Volume table, select a host.
2. Select **Map**.
3. Set the LUN and select the ports and access type.
4. Click **Apply**. A message specifies whether the change succeeded or failed.
5. Click **OK**. The mapping becomes Explicit with the new settings.

To modify an explicit mapping

1. In the Maps for Volume table, select the Explicit mapping to change.
2. Set the LUN and select the ports and access type.
3. Click **Apply**. A message specifies whether the change succeeded or failed.
4. Click **OK**. The mapping settings are updated.

To delete an explicit mapping

1. In the Maps for Volume table, select the Explicit mapping to delete.
2. Clear **Map**.
3. Click **Apply**. A message specifies whether the change succeeded or failed.
4. Click **OK**. The mapping returns to the Default mapping.

Unmapping Volumes

You can delete all of the default and explicit mappings for multiple volumes.

⚠ **Caution:** Volume mapping changes take effect immediately. Make changes that limit access to volumes when the volumes are not in use. Before changing a volume's LUN, be sure to unmount/unpresent/unmap the volume.

To unmap volumes

1. In the Configuration View panel, right-click **Vdisks** or a vdisk and then select **Provisioning > Unmap Volumes**. In the main panel, a table shows all the volumes for the selected vdisk.
2. In the table, select the volumes to unmap. To select up to 100 items or clear all selections, toggle the check box in the heading row.
3. Click **Unmap Volume(s)**. A message specifies whether the change succeeded or failed.
4. Click **OK**. Default and explicit mappings are deleted and the volumes' access type changes to not-mapped.

Expanding a Volume

You can expand a standard volume if its vdisk has free space and sufficient resources. Because volume expansion does not require I/O to be stopped, the volume can continue to be used during expansion.

Volume sizes are aligned to 4-MB boundaries. When a volume is created or expanded, if the resulting size would be less than 4 MB it will be increased to 4 MB. If the resulting size would be greater than 4 MB it will be decreased to the nearest 4-MB boundary.

Note: This command is not supported for master volumes.

To expand a volume

1. In the Configuration View panel, right-click a standard volume and select **Tools > Expand Volume**.
2. In the main panel, specify the amount of free space to add to the volume.
3. Click **Expand Volume**. If the specified value exceeds the amount of free space in the vdisk, a dialog lets you expand the volume to the limit of free space in the vdisk. If the task succeeds, the volume's size is updated in the Configuration View panel.

Creating Multiple Snapshots

If the system is licensed to use Snapshots, you can select multiple volumes and immediately create a snapshot of each volume.

The first time a snapshot is created of a standard volume, the volume is converted to a master volume and a snap pool is created in the volume's vdisk. The snap pool's size is either 20% of the volume size or 5.37 GB, whichever is larger. The recommended minimum size for a snap pool is 50 GB. Before creating or scheduling snapshots, verify that the vdisk has enough free space to contain the snap pool.

To create snapshots of multiple volumes

1. In the Configuration View panel, right-click the system or **Vdisks** or a vdisk and then select **Provisioning > Create Multiple Snapshots**.
2. In the main panel, select each volume to take a snapshot of. To select up to 100 volumes or clear all selections, toggle the check box in the heading row.
3. Click **Create Snapshots**. If the task succeeds, the snapshots appear in the Configuration View panel.

Creating a Snapshot

If the system is licensed to use Snapshots, you can create a snapshot now or schedule the snapshot task.

The first time a snapshot is created of a standard volume, the volume is converted to a master volume and a snap pool is created in the volume's vdisk. The snap pool's size is either 20% of the volume size or 5.37 GB, whichever is larger. The recommended minimum size for a snap pool is 50 GB. Before creating or scheduling snapshots, verify that the vdisk has enough free space to contain the snap pool.

To create a snapshot now

1. In the Configuration View panel, right-click a volume and select **Provisioning > Create Snapshot**.
2. In the main panel, select **Now**.
3. Optionally change the default name for the snapshot. A snapshot name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in a vdisk or include the following: " , < \
4. Click **Create Snapshot**. If the task succeeds, the snapshot appears in the Configuration View panel.

To schedule a create snapshot task

1. In the Configuration View panel, right-click a volume and select **Provisioning > Create Snapshot**.
2. In the main panel, select **Scheduled**.
3. Set the options:
   - Snapshot prefix. Optionally change the default prefix to identify snapshots created by this task. The prefix is case sensitive and can have a maximum of 26 bytes. It cannot already exist in a vdisk or include the following: " , < \
     Automatically created snapshots are named *prefix*_s*n*, where *n* starts at 001.
   - Snapshots to Retain. Select the number of snapshots to retain. When the task runs, the retention count is compared with the number of existing snapshots:
     - If the retention count has not been reached, the snapshot is created.
     - If the retention count has been reached, the volume's oldest snapshot is unmapped, reset, and renamed to the next name in the sequence.
   - Start Schedule. Specify a date and a time in the future to be the first instance when the scheduled task will run, and to be the starting point for any specified recurrence.
     - Date must use the format *yyyy-mm-dd*.

    - Time must use the format *hh*:*mm* followed by either AM, PM, or 24H (24-hour clock). For example,
      13:00 24H is the same as 1:00 PM.
  - Recurrence. Specify either One Time, which schedules a single instance, or the interval at which the task should run. Set the interval to at least two minutes. For better performance if this task will run under heavy I/O conditions or on more than three volumes, set the retention count and the schedule interval to similar values. For example if the retention count is 10 then the interval should be set to 10 minutes.
  - Time Constraint. Specify either No Time Constraint, which allows the schedule to run at any time, or a time range within which the task should run.
  - Date Constraint. Specify either No Date Constraint, which allows the schedule to run on any day, or days when the task should run. Ensure that this constraint includes the Start Schedule date.
  - End Schedule. Specify either Continuous, which allows the schedule to run without an end date, or when the task should stop running.

4. Click **Schedule Snapshots**. If processing succeeds, the schedule is saved and can be viewed in the overview panel for the volume or system.

Deleting Snapshots

You can use the Delete Snapshots panel to delete standard and replication snapshots.

When you delete a snapshot, all data uniquely associated with that snapshot is deleted and associated space in the snap pool is freed for use. Snapshots can be deleted in any order, irrespective of the order in which they were created.

⚠ **Caution:** Deleting a snapshot removes its mappings and schedules and deletes its data.

⚠ **Caution:** If a replication snapshot's type is shown as a “sync point” for its replication set, consider carefully whether you want to delete that snapshot. If you delete the current sync point, then if a replication-set failure occurs, a prior sync point will be used. If you delete the only sync point then the next replication will require a full sync to be performed (*all* data to be re-replicated from the primary volume to a secondary volume).

To delete snapshots

1. Verify that hosts are not accessing the snapshots that you want to delete.
2. In the Configuration View panel, right-click either the system or a vdisk or a master volume or a primary volume or a secondary volume or a snapshot or a replication image and then select **Provisioning > Delete Snapshot**.
3. In the main panel, select the snapshots to delete.
4. Click **Delete Snapshot(s)**.

5. Click **OK** to continue. Otherwise, click **Cancel**. If you clicked OK, a processing dialog appears. If the task succeeds, an overview panel and a success dialog appear.
6. Click **OK**. As processing completes, the deleted items are removed from the Configuration View panel.

Resetting a Snapshot

If the system is licensed to use Snapshots, as an alternative to taking a new snapshot of a volume, you can replace the data in a standard snapshot with the current data in the source volume. The snapshot’s name and mapping settings are not changed. The snapshot data is stored in the source volume’s snap pool. This task is not allowed for a replication snapshot.

⚠ **Caution:** To avoid data corruption, before resetting a snapshot it must be unmounted/unpresented/unmapped from hosts.

You can reset a snapshot now or schedule the reset task.

To reset a snapshot now

1. Unmount/unpresent/unmap the snapshot from hosts.
2. In the Configuration View panel, right-click a snapshot and select **Provisioning > Reset Snapshot**.
3. In the main panel, select **Now**.
4. Click **Reset Snapshot**. A confirmation dialog appears.
5. Click **Yes** to continue. Otherwise, click **No**. If you clicked Yes, a processing dialog appears. When processing is complete a success dialog appears.
6. Click **OK**.
7. Optionally, remount/re-present/remap the snapshot.

To schedule a reset snapshot task

1. In the Configuration View panel, right-click a snapshot and select **Provisioning > Reset Snapshot**.
2. In the main panel, select **Scheduled**.
3. Set the options:
   - Start Schedule. Specify a date and a time in the future to be the first instance when the scheduled task will run, and to be the starting point for any specified recurrence.
     - Date must use the format *yyyy-mm-dd*.
     - Time must use the format *hh:mm* followed by either AM, PM, or 24H (24-hour clock). For example,
       13:00 24H is the same as 1:00 PM.
   - Recurrence. Specify either One Time, which schedules a single instance, or the interval at which the task should run. Set the interval to at least 2 minutes.

- Time Constraint. Specify either No Time Constraint, which allows the schedule to run at any time, or a time range within which the task should run.
- Date Constraint. Specify either No Date Constraint, which allows the schedule to run on any day, or days when the task should run. Ensure that this constraint includes the Start Schedule date.
- End Schedule. Specify either Continuous, which allows the schedule to run without an end date, or when the task should stop running.

4. Click **Reset Snapshot**. If the task succeeded, the schedule is saved and can be viewed in the overview panel for the snapshot or system.
5. Make a reminder to unmount/unpresent/unmap the snapshot before the scheduled task runs.

Creating a volume copy

If the system is licensed to use Volume Copy, you can copy a volume or a snapshot to a new standard volume. The destination volume must be in a vdisk owned by the same controller as the source volume. If the source volume is a snapshot, you can choose whether to include its modified data (data written to the snapshot since it was created). The destination volume is completely independent of the source volume.

The first time a volume copy is created of a standard volume, the volume is converted to a master volume and a snap pool is created in the volume's vdisk. The snap pool's size is either 20% of the volume size or 5.37 GB, whichever is larger. The recommended minimum size for a snap pool is 50 GB. Before creating or scheduling copies, verify that the vdisk has enough free space to contain the snap pool.

For a master volume, the volume copy creates a transient snapshot, copies the data from the snapshot, and deletes the snapshot when the copy is complete. For a snapshot, the volume copy is performed directly from the source. This source data may change if modified data is to be included in the copy and the snapshot is mounted/presented/mapped and I/O is occurring to it.

To ensure the integrity of a copy of a master volume, unmount/unpresent/unmap the volume or at minimum perform a system cache flush and refrain from writing to the volume. Since the system cache flush is not natively supported on all operating systems, it is recommended to unmount/unpresent/unmap temporarily. The volume copy is for all data on the disk at the time of the request, so if there is data in the operating-system cache, that will not be copied over. Unmounting/unpresenting/unmapping the volume forces the cache flush from the operating system. After the volume copy has started, it is safe to remount/re-present/remap the volume and/or resume I/O.

To ensure the integrity of a copy of a snapshot with modified data, unmount/unpresent/unmap the snapshot or perform a system cache flush. The snapshot will not be available for read or write access until the volume copy is complete, at which time you can remount/re-present/remap the snapshot. If modified write data is not to be included in the copy, then you may safely leave the snapshot mounted/presented/mapped. During a volume copy using snapshot modified data, the system takes the snapshot offline, as shown by the Snapshot Overview panel.

The volume copy's progress is shown in the Volume Overview panel.

You can create a volume copy now or schedule the copy task.

To create a volume copy now

1. In the Configuration View panel, right-click a volume and select **Provisioning > Create Volume Copy**.
2. In the main panel, select **Now**.
3. Set the options:
   - New Volume Name. Optionally change the default name for the destination volume. A volume name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in a vdisk or include the following:
     " , < \
   - Residing On Vdisk. Optionally change the destination vdisk.
   - **With Modified Data**. If the source volume is a snapshot, select this option to include the snapshot's modified data in the copy. Otherwise, the copy will contain only the data that existed when the snapshot was created.
4. Click **Copy the Volume**. A confirmation dialog appears.
5. Click **Yes** to continue. Otherwise, click **No**. If you clicked Yes and With Modified Data is selected and the snapshot has modified data, a second confirmation dialog appears.
6. Click **Yes** to continue. Otherwise, click **No**. If you clicked Yes, the volume copy operation starts. While the operation is in progress, the destination volume is offline and its type is shown as "standard*". If you unmounted/unpresented/unmapped a snapshot to copy its modified data, *wait* until processing is complete before you remount/re-present/remap it. If the task succeeds, the destination volume's type becomes standard and the volume appears in the Configuration View panel.
7. Optionally map the volume to hosts.

To schedule a volume copy task

1. In the Configuration View panel, right-click a volume and select **Provisioning > Create Volume Copy**.
2. In the main panel, select **Scheduled**.
3. Set the options:
   - New Volume Prefix. Optionally change the default prefix to identify volumes created by this task. The prefix is case sensitive and can have a maximum of 26 bytes. It cannot include the following: " , < \ Automatically created volumes are named *prefix*_*cn*, where *n* starts at 001.
   - Residing On Vdisk. Optionally change the destination vdisk.
   - **With Modified Data**. If the source volume is a snapshot, select this option to include the snapshot's modified data in the copy. Otherwise, the copy will contain only the data that existed when the snapshot was created.
   - Start Schedule. Specify a date and a time in the future to be the first instance when the scheduled task will run, and to be the starting point for any specified recurrence.
     - Date must use the format *yyyy*-*mm*-*dd*.
     - Time must use the format *hh*:*mm* followed by either AM, PM, or 24H (24-hour clock). For example,
       13:00 24H is the same as 1:00 PM.
   - Recurrence. Specify interval at which the task should run. Set the interval to at least 2 minutes. The default is 1 minute.

- Time Constraint. Specify a time range within which the task should run.
- Date Constraint. Specify days when the task should run. Ensure that this constraint includes the Start Schedule date.
- End Schedule. Specify when the task should stop running.

4. Click **Schedule Volume Copy**. If the task succeeded, the schedule is saved and can be viewed in the overview panel for the volume or system.
5. If you will copy snapshot modified data, make a reminder to unmount/unpresent/unmap the snapshot before the scheduled task runs.

Aborting a Volume Copy

If the system is licensed to use Volume Copy, you can cancel an in-progress volume copy operation. When the cancellation is complete, the destination volume is deleted.

To abort a volume copy

1. In the Configuration View panel, right-click the destination volume and then select **Provisioning > Abort Volume Copy**. The Volume Overview panel shows the operation’s progress.
2. Click **Abort Volume Copy**. A message confirms that the operation has been aborted.
3. Click **OK**. The destination volume is removed from the Configuration View panel.

Rolling back a volume

You can roll back (revert) the data in a volume to the data that existed when a specified snapshot was created. You also have the option of including its modified data (data written to the snapshot since it was created). For example, you might want to take a snapshot, mount/present/map it for read/write, and then install new software on the snapshot for testing. If the software installation is successful, you can roll back the volume to the contents of the modified snapshot.

⚠ **Caution:**
-Before rolling back a volume you must unmount/unpresent/unmap it from data hosts to avoid data corruption.
-If you want to include snapshot modified data in the roll back, you must also unmount/unpresent/unmap the snapshot.If the snap pool runs out of space, the master volume will change to read only until the rollback has completed.
-Whenever you perform a roll back, the data that existed on the volume is replaced by the data on the snapshot. That is, all data on the volume written since the snapshot was taken is lost. As a precaution, take a snapshot of the volume before starting a roll back.

Only one roll back is allowed on the same volume at one time. Additional roll backs are queued until the current roll back is complete. However, after the roll back is requested, the volume is available for use as if the roll back has already completed.

During a roll back operation using snapshot modified data, the snapshot must be unmounted/unpresented /unmapped and cannot be accessed. Unmounting/unpresenting/unmapping the snapshot ensures that all data cached by the host is written to the snapshot. If unmounting/unpresenting/unmapping is not performed at the host level prior to starting the roll back, data may remain in host cache, and thus not be rolled back to the master volume. As a precaution against inadvertently accessing the snapshot, the system also takes the snapshot offline, as shown by the Snapshot Overview panel. The snapshot becomes inaccessible in order to prevent any data corruption to the master volume. The snapshot can be remounted/re-presented/remapped once the roll back is complete.

To roll back a volume

1. Unmount/unpresent/unmap the volume from hosts.
2. If the roll back will include snapshot modified data, unmount/unpresent/unmap the snapshot from hosts.
3. In the Configuration View panel, right-click a volume and select **Provisioning > Roll Back Volume**.
4. In the main panel, set the options:
   - For Volume. The name of the volume to roll back.
   - From Snapshot Volume. Enter the name of the snapshot to roll back to.
   - **With Modified Data**. Select this option to include the snapshot’s modified data in the roll back. Otherwise, the master volume will contain only the data that existed when the snapshot was created.
5. Click **Roll Back Volume**. The roll back starts. You can now remount/re-present/remap the volume.
6. When the roll back is complete, if you unmounted/unpresented/unmapped the snapshot you can remount/re-present/remap it.

Creating a Snap Pool

Before you can convert a standard volume to a master volume or create a master volume for snapshots, a snap pool must exist. A snap pool and its associated master volumes can be in different vdisks, but must be owned by the same controller.

To create a snap pool

1. In the Configuration View panel, right-click a vdisk and select **Provisioning > Create Snap Pool**.
2. In the main panel set the options:
   - Snap Pool name. Optionally change the default name for the snap pool. A snap pool name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in the system or include the following:
     " , < \

- Size. Optionally change the default size, which is all free space in the vdisk. Although a snap pool can be as small as 5.37 GB, the recommended minimum size is 50 GB.

3. Click **Create Snap Pool**. If the task succeeds, the new snap pool appears in the Configuration View panel.

Deleting Snap Pools

Before you can delete a snap pool you must delete any associated snapshots, and either delete the associated master volume or convert the master volume to a standard volume.

To delete snap pools

1. Verify that no master volume or snapshots are associated with the snap pool.
2. In the Configuration View panel, either:
   - Right-click the local system or **Vdisks** or a vdisk and select **Provisioning > Delete Snap Pools**.
   - Right-click a snap pool and select **Provisioning > Delete Snap Pool**.
3. In the main panel, select the snap pools to delete.
4. Click **Delete Snap Pool(s)**.
5. Click **Delete** to continue. Otherwise, click **Cancel**. If you clicked Delete, a processing dialog appears. If the task succeeds, an overview panel and a success dialog appear.
6. Click **OK**. As processing completes, the deleted items are removed from the Configuration View panel.

Adding a Host

To add a host

1. Determine the host’s WWPN or IQN.
2. In the Configuration View panel, right-click the system or **Hosts** and then select **Provisioning > Add Host**.
3. In the main panel set the options:
   - Host ID (WWN/IQN). Enter the host’s WWPN or IQN. A WWPN value can include a colon between each pair of digits but the colons will be discarded.
   - Host Name. This field is populated with a default name, which you can change to a name that helps you easily identify the host. For example, `FileServer_1`. An host name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in the system or include the following: " * , . < \
   - Profile.

- Standard: Default profile.
- HP-UX: The host uses Flat Space Addressing.

4. Click **Add Host**. If the task succeeds, the new host appears in the Configuration View panel.

Removing Hosts

To remove hosts

1. Verify that the hosts you want to remove are not accessing volumes.
2. In the Configuration View panel, either:
   - Right-click the system or **Hosts** and then select **Provisioning > Remove Hosts**.
   - Right-click a host and select **Provisioning > Remove Host**.
3. In the main panel, select the hosts to remove. To select or clear all items, toggle the check box in the heading row.
4. Click **Remove Host(s)**. A confirmation dialog appears.
5. Click **Remove** to continue. Otherwise, click **Cancel**. If you clicked Remove, a processing dialog appears. If the task succeeds, an overview panel and a success dialog appear.
6. Click **OK**. As processing completes, the deleted items are removed from the Configuration View panel.

Changing a Host’s Name

To change a host’s name

1. In the Configuration View panel, right-click a host and select **Provisioning > Rename Host**.
2. Enter a new name that helps you easily identify the host. For example, FileServer_1. An host name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in the system or include the following: " * , . < \
3. Optionally, change the host profile:
   - Standard: Default profile.
   - HP-UX: The host uses Flat Space Addressing.
4. Click **Modify Name**. A confirmation dialog appears.
5. Click **Yes** to continue. Otherwise, click **No**. If you clicked **Yes**, a message indicates whether the task succeeded or failed.
6. Click **OK**.

Changing Host Mappings

For each volume that is mapped to the selected host, you can create, modify, and delete explicit mappings. To change a volume's default mapping, see Changing a volume's default mapping on page 90.

⚠ **Caution:** Volume mapping changes take effect immediately. Make changes that limit access to volumes when the volumes are not in use. Be sure to unmount/unpresent/unmap a volume before changing the volume's LUN.

ℹ **Note:** You cannot map the secondary volume of a replication set.

ℹ **Note:** When mapping a volume to a host using the Linux ext3 file system, specify read-write access. Otherwise, the file system will be unable to mount/present/map the volume and will report an error such as "unknown partition table."

To view host mappings

In the Configuration View panel, right-click a host and select **Provisioning > Manage Host Mappings**. The main panel shows the following information about volumes mapped to the host:

- Type. Explicit or Default. Settings for an explicit mapping override the default mapping.
- Name. Volume name.
- Serial Number. Volume serial number.
- Ports. Controller host ports through which the volume is mapped to the host.
- LUN. Volume identifier presented to the host.
- Access. Volume access type: read-write, read-only, no-access (masked), or not-mapped.

To create an explicit mapping

1. In the Maps for Host table, select the Default mapping to override.
2. Select **Map**.
3. Set the LUN and select the ports and access type.
4. Click **Apply**. A message specifies whether the change succeeded or failed.
5. Click **OK**. The mapping becomes Explicit with the new settings.

To modify an explicit mapping

1. In the Maps for Host table, select the Explicit mapping to change.
2. Set the LUN and select the ports and access type.
3. Click **Apply**. A message specifies whether the change succeeded or failed.
4. Click **OK**. The mapping settings are updated.

To delete an explicit mapping

1. In the Maps for Host table, select the Explicit mapping to delete.
2. Clear **Map**.

3. Click **Apply**. A message specifies whether the change succeeded or failed.
4. Click **OK**. The mapping returns to the Default mapping.

Configuring CHAP

For iSCSI, you can use Challenge-Handshake Authentication Protocol (CHAP) to perform authentication between the initiator and target of a login request.

To perform this identification, a database of CHAP entries must exist on each device. Each CHAP entry can specify one name-secret pair to authenticate the initiator only (one-way CHAP) or two pairs to authenticate both the initiator and the target (mutual CHAP). For a login request from an iSCSI host to a storage system, the host is the initiator and the storage system is the target.

When CHAP is enabled and the storage system is the recipient of a login request from a known originator (initiator), the system will request a known secret. If the originator supplies the secret, the connection will be allowed.

To enable or disable CHAP for all iSCSI hosts, see Changing Host Interface Settings on page 58.

To add or modify a CHAP entry

1. In the Configuration View panel, right-click **Hosts** or a specific host and then select **Provisioning > Configure CHAP**. If any CHAP entries exist, a table shows them by node name.
2. Optionally, select an entry whose name you want to change to create a new entry. The entry's values appear in the option fields.
3. Set the options:
   - Node Name (IQN). The initiator name, typically in IQN format.
   - Secret. The secret that the target uses to authenticate the initiator. The secret is case sensitive and can include 12–16 bytes. The value can include spaces and printable UTF-8 characters except for the following: " <.
   - Name, if mutual CHAP. Optional. For mutual CHAP only. Specifies the target name, typically in IQN format. The value is case sensitive and can include a maximum of 223 bytes. To find a controller iSCSI port's IQN, select the controller enclosure, view the Enclosure Overview panel (Viewing Information About an Enclosure on page 154), select the Rear Graphical tab, select an iSCSI port, and view the Target ID field.
   - Secret, if mutual CHAP. Optional. For mutual CHAP only. Specifies the secret that the initiator uses to authenticate the target. The secret is case sensitive, can include 12–16 bytes, and must differ from the initiator secret. The value can include spaces and printable UTF-8 characters except for the following: " <.
     A storage system's secret is shared by both controllers.
4. Click **Add/Modify Entry**. If the task succeeds, the new or modified entry appears in the CHAP entries table.

To delete a CHAP entry

⚠ **Caution:** Deleting CHAP records may make volumes inaccessible and the data in those volumes unavailable.

1. In the Configuration View panel, right-click **Hosts** or a specific host and then select **Provisioning > Configure CHAP**. If any CHAP entries exist, a table shows them by node name.
2. Select the entry to delete.
3. Click **Delete Entry**. If the task succeeds, the entry is removed from the CHAP entries table.

Modifying a Schedule

To modify a schedule

1. In the Configuration View panel, right-click the system or a volume or a snapshot and select **Provisioning > Modify Schedule**. In the main panel, a table shows each schedule.
2. In the table, select the schedule to modify. For information about schedule status values, see Schedule Properties on page 147.
3. Set the options:
   - Snapshot Prefix. Optionally change the default prefix to identify snapshots created by this task. The prefix is case sensitive and can have a maximum of 26 bytes. It cannot include the following: " , < \
   - Snapshots to Retain. Select the number of snapshots to retain. When the task runs, the retention count is compared with the number of existing snapshots:
     - If the retention count has not been reached, the snapshot is created.
     - If the retention count has been reached, the volume’s oldest snapshot is unmapped, reset, and renamed to the next name in the sequence.
   - Start Schedule. Specify a date and a time in the future to be the first instance when the scheduled task will run, and to be the starting point for any specified recurrence.
     - Date must use the format *yyyy-mm-dd*.
     - Time must use the format *hh*:*mm* followed by either AM, PM, or 24H (24-hour clock). For example,
       13:00 24H is the same as 1:00 PM.
   - Recurrence. Specify interval at which the task should run. Select either One Time or how often the task should occur. If the task is recurrent, select Minutes, Hours, Days, Weeks, Months, or Years from the list. If One Time is selected, no further options are available and the task will occur only on the date and time specified in Start Schedule.
     - For a snapshot schedule, set the interval to at least 2 minutes. For better performance if this task will run under heavy I/O conditions or on more than three volumes, set the retention count and the interval to similar values. For example if the retention count is 10 then set the interval to 10 minutes.
     - For a volume-copy or reset-snapshot schedule, set the interval to at least 2 minutes.

    - For a replication schedule, set the interval to at least 30 minutes.
- Time Constraint. Specify a time range within which the task should run. Select either No Time Constraint or times between which the task will run.
    - If No Time Constraint is selected, the task will run whenever scheduled.
    - If a set of times is specified, the task can only occur during that period of time.
- Date Constraint. Specify days when the task should run. Ensure that this constraint includes the Start Schedule date. Select No Date Constraint, Any, or a specific time.
    - If No Date Constraint is selected, the task will occur whenever scheduled.
    - For Any, select a type of day (any day, weekday, weekend day, or specific day of the week) and a year, month, or specific month. For example, if you select Any Weekday of June, the task can occur only on weekdays in June.
    - For a specific time, select a type of day (any day, weekday, weekend day, or specific day of the week), a number, and a year, month, or specific month. For example, if you select Sunday number 3 of January, the task can occur only on the 3rd Sunday of January.
- End Schedule. Specify when the task should stop running. Select Continuous, Date, or End After.
    - If Continuous is selected, the task will never end.
    - If a date and time is specified, the task will not run as scheduled after that date.
    - If End After is selected, the task will end after the running the number of times you specify. For example, if you enter 5, the task will run only 5 times.

4. Click **Modify Schedule**.
5. Click **Yes** to continue. Otherwise, click **No**. If you clicked Yes, a processing dialog appears. When processing is complete a success dialog appears.
6. Click **OK**.

Deleting Schedules

If a component has a scheduled task that you no longer want to occur, you can delete the schedule. When a component is deleted, its schedules are also deleted.

To delete task schedules

1. In the Configuration View panel, right-click the system or a volume or a snapshot and select **Provisioning > Delete Schedule**.
2. In the main panel, select the schedule to remove.
3. Click **Delete Schedule**. A confirmation dialog appears.
4. Click **Yes** to continue. Otherwise, click **No**. If you clicked **Yes**, a processing dialog appears. If the task succeeds, the schedules are removed from the table and from the Configuration View panel. When processing is complete a success dialog appears.

5. Click **OK**.

Chapter 4: Using System Tools

This chapter contains the following topics:

Updating Firmware

You can view the current versions of firmware in controller modules, expansion modules, drawers, and disks, and install new versions.

To monitor the progress of a firmware-update operation by using the activity progress interface, see Using the Activity Progress Interface on page 112.

Note: To ensure success of an online update, select a period of low I/O activity. This helps the update complete as quickly as possible and avoids disruptions to host and applications due to timeouts. Attempting to update a storage system that is processing a large, I/O-intensive batch job will likely cause hosts to lose connectivity with the storage system.

Caution:
-Run the check firmware-upgrade-health CLI command before upgrading firmware. This command performs a series of health checks to determine whether any conditions exist that need to be resolved before upgrading firmware. Any conditions that are detected are listed with their potential risks. For information about this command, see the CLI Reference Guide.
-If a vdisk is quarantined, resolve the problem that is causing the vdisk to be quarantined before updating firmware. See information about events 172 and 485 in the Event Descriptions Reference Guide, and Removing a vdisk from Quarantine on page 121.
-If any unwritten cache data is present, firmware update will not proceed. Before you can update firmware, unwritten data must be removed from cache. See information about event 44 in the Event Descriptions Reference Guide and information about the `clear cache` command in the CLI Reference Guide.
-If the system's health is Fault, firmware update will not proceed. Before you can update firmware, you must resolve the problem specified by the Health Reason value on the System Overview panel (Viewing Information About the System on page 126).

Updating Controller-module Firmware

A controller enclosure can contain one or two controller modules. In a dual-controller system, both controllers should run the same firmware versions. Storage systems in a replication set must run the same or compatible firmware versions. You can update the firmware in each controller module by loading a firmware file obtained from the enclosure vendor.

If you have a dual-controller system and the Partner Firmware Update (PFU) option is enabled, when you update one controller the system automatically updates the partner controller. If PFU is disabled, after updating firmware on one controller you must log into the partner controller's IP address and perform this firmware update on that controller also. For information about how to disable or re-enable PFU, using the `set advanced-settings` CLI command, see the CLI Reference Guide.

For best results, the storage system should be in a healthy state before starting firmware update.

Note: For information about supported releases for firmware update, see the product's Release Notes.

To update controller-module firmware

1. Obtain the appropriate firmware file and download it to your computer or network.

2. If the storage system has a single controller, stop I/O to vdisks before starting the firmware update.
3. In the Configuration View panel, right-click the system and select **Tools > Update Firmware**. The table titled Current Controller Versions shows the currently installed versions.
4. Click the button and browse for the firmware file to install.
5. Click **Install Controller-Module Firmware File**. A dialog box shows firmware-update progress.
6. The process starts by validating the firmware file:
   - If the file is invalid, verify that you specified the correct firmware file. If you did, try downloading it again from the source location.
   - If the file is valid, the process continues.

⚠ **Caution:** Do not perform a power cycle or controller restart during a firmware update. If the update is interrupted or there is a power failure, the module might become inoperative. If this occurs, contact technical support. The module might need to be returned to the factory for reprogramming.

   Firmware update typically takes 10 minutes for a controller with current CPLD firmware, or 20 minutes for a controller with downlevel CPLD firmware. If the controller enclosure has attached enclosures, allow additional time for each expansion module’s enclosure management processor (EMP) to be updated. This typically takes
   2.5 minutes for each EMP in a drive enclosure.

   If the Storage Controller cannot be updated, the update operation is cancelled. Verify that you specified the correct firmware file and repeat the update. If this problem persists, contact technical support.

   When firmware update on the local controller is complete, users are automatically signed out and the Management Controller will restart. Until the restart is complete, the Disk Management Utility (V2) Sign In page will say that the system is currently unavailable. When this message is cleared, you may sign in.

   If PFU is enabled, allow 10–20 minutes for the partner controller to be updated.

7. Clear your web browser’s cache, then sign in to the Disk Management Utility (V2). If PFU is running on the controller you sign in to, a dialog box shows PFU progress and prevents you from performing other tasks until PFU is complete.

   ⓘ **Note:** After firmware update has completed on both controllers, if the system health is Degraded and the health reason indicates that the firmware version is incorrect, verify that you specified the correct firmware file and repeat the update. If this problem persists, contact technical support.

Updating Expansion-module and Drawer Firmware

A drive enclosure can contain one or two expansion modules. Each expansion module contains an enclosure management processor (EMP). In an enclosure with drawers, each drawer contains two EMPs, which are also referred to as “modules.” All modules of the same product model should run the same firmware version.

Expansion-module and drawer firmware is updated in either of two ways:

- When you update controller-module firmware, all expansion-module and drawer EMPs are automatically updated to a compatible firmware version.

- You can update the firmware in each expansion-module and drawer EMP by loading a firmware file obtained from the enclosure vendor.

To update expansion-module and drawer firmware

1. Obtain the appropriate firmware file and download it to your computer or network.
2. If the storage system has a single controller, stop I/O to vdisks before starting the firmware update.
3. In the Configuration View panel, right-click the system and select **Tools > Update Firmware**. The table titled Current Versions of All Expansion Modules (EMPs) shows the currently installed versions.
4. Select the modules and/or drawers to update.
5. Click the button and browse for the firmware file to install.
6. Click **Install Expansion-Module Firmware File**. Messages show firmware-update progress.

   ⚠ **Caution:** Do not perform a power cycle or controller restart during the firmware update. If the update is interrupted or there is a power failure, the module or drawer might become inoperative. If this occurs, contact technical support. The module’s FRU might need to be returned to the factory for reprogramming.

   It typically takes 2.5 minutes to update each EMP in a drive enclosure. Wait for a message that the code load has completed.
7. Verify that each updated module and drawer has the correct firmware version.

Updating Disk Firmware

You can update disk firmware by loading a firmware file obtained from your reseller.

Firmware update is supported for all disks, including FDE-capable disks (for the QXS-4/6 Series only).

A dual-ported disk can be updated from either controller.

ⓘ **Note:** Disks of the same model in the storage system must have the same firmware revision.

To update disk firmware

1. Obtain the appropriate firmware file and download it to your computer or network.
2. Check the disk manufacturer’s documentation to determine whether disks must be power cycled after firmware update.
3. Stop I/O to the storage system. During the update all volumes will be temporarily inaccessible to hosts. If I/O is not stopped, mapped hosts will report I/O errors. Volume access is restored after the update completes.
4. In the Configuration View panel, right-click the system and select **Tools > Update Firmware**. The table titled Current Versions (Revisions) of All Disk Drives shows the currently installed versions.
5. Select the disks to update.
6. Click **Browse** and select the firmware file to install.
7. Click **Install Disk Firmware File**. A dialog box shows firmware-update progress.

⚠ **Caution:** Do not power cycle enclosures or restart a controller during the firmware update. If the update is interrupted or there is a power failure, the disk might become inoperative. If this occurs, contact technical support.

It typically takes several minutes for the firmware to load. Wait for a message that the update has completed.

8. If the updated disks must be power cycled:
   a. Shut down both controllers. See Restarting or Shutting Down Controllers on page 117.
   b. Power cycle all enclosures as described in your product's Setup Guide.
9. Verify that each disk has the correct firmware revision.

Using the Activity Progress Interface

The activity progress interface reports whether a firmware update operation is active and shows the progress through each step of the operation. When the update operation completes, status is presented that either indicates successful completion or indicates an error if the operation failed.

When the interface is enabled it is accessible at all times, except when an MC is restarting. The interface is accessed through an HTTP-based query to a specified MC or to both MCs. The content is presented in a unified way so that activity in both MCs in a dual-controller system can be accessed simultaneously.

Use of this interface will not interfere in any way with firmware update performed via the Disk Management Utility (V2) or FTP.

To access the activity progress interface

1. Enable the Activity Progress Monitor service. See Changing Management Interface Settings on page 49.
2. In a new tab in your web browser, enter a URL of the form:

   ```
   http://controller-address:8081/cgi-bin/content.cgi?mc=MC-identifier&refresh=true
   ```

   where:

   - `controller-address` is required and specifies the IP address of a controller network port.
   - `mc=MC-identifier` is an optional parameter that specifies the controller for which to report progress/status:
     - `mc=A` shows output for controller A only.
     - `mc=B` shows output for controller B only.
     - `mc=both` shows output for both controllers.
     - `mc=self` shows output for the controller whose IP address is specified.
   - `refresh=true` is an optional parameter that causes automatic refresh of the displayed output every second. This will continue until either:
     - The parameter is removed.
     - The controller whose IP address is specified is restarted and communication is lost.

Activity progress output

When activity is in progress, the interface will display an MC-specific Activity Progress table with the following properties and values.

Table 13: Activity progress properties and values (v2)

Property	Value
Time	The date and time of the latest status update.
Seconds	The number of seconds this component has been active.
Component	The name of the object being processed.
Status	The status of the component representing its progress/completion state. • ACTIVE: The operation for this component is currently active and in progress. • OK: The operation for this component completed successfully and is now inactive. • N/A: The operation for this component was not completed because it was not applicable. • ERROR: The operation for this component failed with an error (see code and message).
Code	A numeric code indicating the status. • `0`: The operation for this component completed with a “completed successfully” status. • `1`: The operation for this component was not attempted because it is not applicable (the component doesn’t exist or doesn’t need updating). • `2`: The operation is in progress. The other properties will indicate the progress item (message, current, total, percent). • `10` or higher: The operation for this component completed with a failure. The code and message indicate the reason for the error.
Message	A textual message indicating the progress status or error condition.

Saving Logs

To help service personnel diagnose a system problem, you might be asked to provide system log data. Using the Disk Management Utility (V2), you can save log data to a compressed zip file. The file will contain the following data:

- Device status summary, which includes basic status and configuration data for the system
- Each controller’s MC logs
- Each controller’s event log
- Each controller’s debug log
- Each controller’s boot log, which shows the startup sequence

- Critical error dumps from each controller, if critical errors have occurred
- CAPI traces from each controller

Note: The controllers share one memory buffer for gathering log data and for loading firmware. Do not try to perform more than one save-logs operation at a time, or to perform a firmware-update operation while performing a save-logs operation.

To save logs

1. In the Configuration View panel, right-click the system and select **Tools > Save Logs**.
2. In the main panel:
   a. Enter your name, email address, and phone number so support personnel will know who provided the log data. Each value can include a maximum of 100 bytes, using all characters except the following: " < > \
   b. Enter comments that describe the problem and specify the date and time when the problem occurred. This information helps service personnel when they analyze the log data. Each comment can include a maximum of 500 bytes, using all characters except the following: " < > \
3. Click **Save Logs**.

   Note: In Microsoft Internet Explorer if the download is blocked by a security bar, select its **Download File** option. If the download does not succeed the first time, return to the Save Logs panel and retry the save operation.

   Log data is collected, which takes several minutes.
4. When prompted to open or save the file, click **Save**.
   - If you are using Firefox and have a download directory set, the file `store.zip` is saved there.
   - Otherwise, you are prompted to specify the file location and name. The default file name is `store.zip`. Change the name to identify the system, controller, and date.

   Note: Because the file is compressed, you must uncompress it before you can view the files it contains. To examine diagnostic data, first view `store_yyyy_mm_dd__hh_mm_ss.logs`.

Resetting a Host Port

Making a configuration or cabling change on a host might cause the storage system to stop accepting I/O requests from that host. For example, this problem can occur after moving host cables from one HBA to another on the host. To fix such a problem you might need to reset controller host ports (channels).

For FC, you can reset a single port. For an FC host port configured to use FC-AL (loop) topology, a reset issues a loop initialization primitive (LIP).

For iSCSI, you can reset a port pair (either the first and second ports or the third and fourth ports).

For SAS, you can reset a port pair (either the first and second ports or the third and fourth ports). Resetting a SAS host port issues a `COMINIT/COMRESET` sequence and might reset other ports.

To reset a host port

1. In the Configuration View panel, right-click the system and select **Tools > Reset Host Port**.
2. Select the port or port pair to reset.
3. Click **Reset Host Port**.

Rescanning Disk Channels

A rescan forces a rediscovery of disks and enclosures in the storage system. If both Storage Controllers are online and able to communicate with both expansion modules in each connected enclosure, rescan rebuilds the internal SAS layout information, reassigns enclosure IDs of attached enclosures based on controller A’s enclosure cabling order, and ensures that the enclosures are displayed in the proper order. A manual rescan temporarily pauses all I/O processes, then resumes normal operation. It can take up to two minutes for the enclosure IDs to be corrected. For further cabling information, refer to your product's Setup Guide.

A manual rescan may be needed after system power-up to display enclosures in the proper order. Whenever you replace a drive chassis or controller chassis, perform a manual rescan to force fresh discovery of all drive enclosures connected to the controller enclosure.

A manual rescan is not needed after inserting or removing disks. The controllers automatically detect these changes. When disks are inserted they are detected after a short delay, which allows the disks to spin up.

To rescan disk channels

1. Verify that both controllers are operating normally.
2. In the Configuration View panel, right-click the system and select **Tools > Rescan Disk Channels**.
3. Click **Rescan**.

Restoring System Defaults

If the system is not working properly and you cannot determine why, you can restore its default configuration settings. You then can reconfigure the settings that are necessary to use the system.

To restore defaults, use the CLI’s `restore defaults` command, as described in the CLI Reference Guide.

Clearing Disk Metadata

⚠ **Caution:**
-Only use this command when all vdisks are online and leftover disks exist. Improper use of this command may result in data loss.
-Do not use this command when a vdisk is offline and one or more leftover disks exist.
-If you are uncertain whether to use this command, contact technical support for further assistance.

Each disk in a vdisk has metadata that identifies the owning vdisk, the other members of the vdisk, and the last time data was written to the vdisk. The following situations cause a disk to become a *leftover*:

- Vdisk members' timestamps do not match so the system designates members having an older timestamp as leftovers.
- A disk is not detected during a rescan, then is subsequently detected.

When a disk becomes a leftover, the following changes occur:

- The disk's health becomes Degraded and its How Used state becomes LEFTOVR.
- The disk is automatically excluded from the vdisk, causing the vdisk's health to become Degraded or Fault, depending on the RAID level.
- The disk's fault LED is illuminated amber.

If spares are available, and the health of the vdisk is Degraded, the vdisk will use them to start reconstruction. When reconstruction is complete, you can clear the leftover disk's metadata. Clearing the metadata will change the disk's health to OK and its How Used state to AVAIL, making the disk available for use in a new vdisk or as a spare.

If spares are not available to begin reconstruction, or reconstruction has not completed, keep the leftover disk so that you'll have an opportunity to recover its data.

This command clears metadata from leftover disks only. If you specify disks that are not leftovers, the disks are not changed.

To clear metadata from leftover disks

1. In the Configuration View panel, right-click the system and then select **Tools > Clear Disk Metadata**.
2. In the main panel, select leftover disks to clear metadata from. To select or clear all leftover disks, toggle the check box in the heading row.
3. Click **Clear Metadata**. A confirmation dialog appears.
4. Click **Continue** to continue. Otherwise, click **Cancel**. If you clicked Continue, a processing dialog appears. If the task succeeds, a success dialog appears.
5. Click **OK**.

Restarting or Shutting Down Controllers

You can restart the processors in a controller module when the Disk Management Utility (V2) informs you that you have changed a configuration setting that requires restarting or when the controller is not working properly. Shut down the processors in a controller module before you remove it from an enclosure, or before you power off its enclosure for maintenance, repair, or a move.

A restart can be performed on either the Storage Controller processor or the Management Controller processor. A shut down affects both processors.

Restarting

If you restart a Storage Controller, it attempts to shut down with a proper failover sequence, which includes stopping all I/O operations and flushing the write cache to disk, and then the Storage Controller restarts. Restarting a Storage Controller restarts the corresponding Management Controller.

If you restart a Management Controller, communication with it is lost until it successfully restarts. If the restart fails, the partner Management Controller remains active with full ownership of operations and configuration information.

⚠ **Caution:** If you restart both Storage Controllers, both Management Controllers will also be restarted so all users will lose access to the system and its data until the restart is complete.

ⓘ **Note:** When a Storage Controller is restarted, live performance statistics that it recorded will be reset. Historical performance statistics are not affected. In a dual-controller system, disk statistics may be reduced but will not be reset to zero, because disk statistics are summed between the two controllers. For more information, see help for commands that show statistics.

To perform a restart

1. In the Configuration View panel, right-click the local system and select **Tools > Shut Down or Restart Controller**.
2. In the main panel, set the options:
   - Operation. Select **Restart**.
   - Controller Type. Select the type of controller processor to restart: **Management** or **Storage**.
   - Controller. Select the controller to restart: **A**, **B**, or **Both**.
3. Click **Restart now**. A confirmation dialog appears.
4. Click **Yes** to continue. Otherwise, click **No**. If you clicked Yes, a second confirmation dialog appears.
5. Click **Yes** to continue. Otherwise, click **No**. If you clicked Yes, a message describes restart activity.

Shutting Down

Shutting down the Storage Controller in a controller module ensures that a proper failover sequence is used, which includes stopping all I/O operations and writing any data in write cache to disk. If the Storage Controller in both controller modules is shut down, hosts cannot access the system's data. Perform a shut down before removing a controller module or powering down the system.

⚠ **Caution:** You can continue to use the CLI when either or both Storage Controllers are shut down, but information shown might be invalid.

To perform a shut down

1. In the Configuration View panel, right-click the local system and select **Tools > Shut Down or Restart Controller**.
2. In the main panel, set the options:
   - Operation. Select **Shut down**.
   - Controller. Select the controller to shut down: **A**, **B**, or **Both**.
3. Click **Shut down now**. A confirmation dialog appears.
4. Click **Yes** to continue. Otherwise, click **No**. If you clicked Yes, a second confirmation dialog appears.
5. Click **Yes** to continue. Otherwise, click **No**. If you clicked Yes, a message describes shutdown activity.

Testing Notifications

You can send test messages to verify that email, SNMP, and/or syslog settings are properly configured for destinations to receive event notifications and managed-logs notifications.

For event notification, the email, SNMP, or syslog settings must include a notification level other than "none (disabled)." For managed-logs notification, the managed logs feature must be configured and enabled. For an overview of the log-management feature, see About Managed Logs on page 26.

To test event notification

1. In the Configuration View panel, right-click the local system and select **Tools > Test Event Notifications and Managed Logs**.
2. Under the Test Event Notifications heading, click **Send Event**. If the task succeeds, verify that the test message reached the destinations.

To test managed-logs notification

1. In the Configuration View panel, right-click the local system and select **Tools > Test Event Notifications and Managed Logs**.
2. Under the Test Managed Logs Notifications heading, click **Send Managed Logs**. If the task succeeds, verify that the test message reached the destination.

Expanding a vdisk

You can expand the capacity of a vdisk by adding disks to it, up to the maximum number of disks that the storage system supports. Host I/O to the vdisk can continue while the expansion proceeds. You can then create or expand a volume to use the new free space, which becomes available when the expansion is complete. You can expand only one vdisk at a time. As described in About RAID Levels on page 19, the RAID level determines whether the vdisk can be expanded and the maximum number of disks the vdisk can have. This task cannot be performed on an NRAID or RAID-1 vdisk.

Vdisks support a mix of 512n and 512e disks. However, for consistent and predictable performance, do not mix disks of different rotational speed or sector size types (512n, 512e). To identify the sector format for a disk, in the Configuration View panel, right-click an enclosure and select **View > Overview**. Select a disk and click the **Properties** tab to view the disk properties, including its sector format (512n or 512e). Vdisks support a mix of 512n and 512e disks.

Adding single-ported disks to a vdisk that contains dual-ported disks is supported. However, because single-ported disks are not fault-tolerant, a confirmation prompt will appear.

⚠ **Caution:** Expansion can take hours or days to complete, depending on the vdisk's RAID level and size, disk speed, utility priority, and other processes running on the storage system. You can stop expansion only by deleting the vdisk.

Before expanding a vdisk

Back up the vdisk's data so that if you need to stop expansion and delete the vdisk, you can move the data into a new, larger vdisk.

To expand a vdisk

1. In the Configuration View panel, right-click a vdisk and select **Tools > Expand Vdisk**. Information appears about the selected vdisk and all disks in the system.
    - In the Disk Selection Sets table, the number of white slots in the vdisk's Disks field shows how many disks you can add to the vdisk.
    - In the enclosure view or list, only suitable available disks are selectable.
2. Select disks to add.
3. Click **Expand Vdisk**. If your vdisk contains a mix of 512n and 512e disks, a warning dialog box displays.
4. Perform one of the following:
    - Click **Yes** to continue.
    - To cancel the request, click **No**.

   If you clicked Yes or your vdisk does not contain a mix of 512n and 512e disks, a processing dialog appears.
5. Click **OK**. The expansion's progress is shown in the **View > Overview** panel.

Verifying a vdisk

If you suspect that a fault-tolerant (mirror or parity) vdisk has a problem, run the Verify utility to check the vdisk's integrity. For example, if the storage system was operating outside the normal temperature range, verify its vdisks. The Verify utility analyzes the selected vdisk to find and fix inconsistencies between its redundancy data and its user data. This utility fixes parity mismatches for RAID 3, 5, 6, and 50, and mirror mismatches for RAID 1 and 10. This task can be performed only on a vdisk whose status is FTOL (fault tolerant and online). It cannot be performed for NRAID or RAID 0.

Note: Media Scrub Vdisk (Scrubbing a vdisk below) operates similarly to Verify Vdisk but can find and fix media errors for any RAID level, including NRAID and RAID 0.

Verification can last over an hour, depending on the size of the vdisk, the utility priority, and the amount of I/O activity. You can use a vdisk while it is being verified. When verification is complete, event 21 is logged and specifies the number of inconsistencies found. Such inconsistencies can indicate that a disk in the vdisk is going bad. For information about identifying a failing disk, use the SMART option (see Configuring SMART on page 62.

If too many utilities are running for verification to start, either wait until those utilities have completed and try again, or abort a utility to free system resources. If you abort verification, you cannot resume it. You must start it over.

To verify a vdisk

1. In the Configuration View panel, right-click a fault-tolerant vdisk and select **Tools > Verify Vdisk**.
2. Click **Start Verify Utility**. A message confirms that verification has started.
3. Click **OK**. The panel shows the verification's progress.

To abort vdisk verification

1. In the Configuration View panel, right-click a fault-tolerant vdisk and select **Tools > Verify Vdisk**.
2. Click **Abort Verify Utility**. A message confirms that verification has been aborted.
3. Click **OK**.

Scrubbing a vdisk

The system-level Vdisk Scrub option (see Configuring background scrub for vdisks on page 71) automatically checks all vdisks for disk defects. If this option is disabled, you can still perform a scrub on a selected vdisk. Scrub analyzes a vdisk to find and fix disk errors. It will fix parity mismatches for RAID 3, 5, 6, and 50; mirror mismatches for
RAID 1 and 10; and media errors for all RAID levels.

Scrub can last over an hour, depending on the size of the vdisk, the utility priority, and the amount of I/O activity. However, a "foreground" scrub performed by Media Scrub Vdisk is typically faster than a background scrub performed by Vdisk Scrub. You can use a vdisk while it is being scrubbed. When a scrub is complete, event 207 is logged and specifies whether errors were found and whether user action is required.

To scrub a vdisk

1. In the Configuration View panel, right-click a vdisk and select **Tools > Media Scrub Vdisk**.
2. Click **Start Media Scrub Utility**. A message confirms that the scrub has started.
3. Click **OK**. The panel shows the scrub's progress.

To abort a vdisk scrub

1. In the Configuration View panel, right-click a vdisk and select **Tools > Media Scrub Vdisk**.

   Note: If the vdisk is being scrubbed but the Abort Media Scrub Utility button is grayed out, a background scrub is in progress. To stop the background scrub, disable the Vdisk Scrub option as described in Configuring background scrub for vdisks on page 71.

2. Click **Abort Media Scrub Utility**. A message confirms that the scrub has been aborted.
3. Click **OK**.

Removing a vdisk from Quarantine

⚠ **Caution:** Carefully read this topic to determine whether to use the Dequarantine Vdisk panel to manually remove a vdisk from quarantine. The Dequarantine Vdisk panel should only be used as part of the emergency procedure to attempt to recover data and is normally followed by use of the CLI `trust` command. If a vdisk is manually dequarantined and does not have enough disks to continue operation, its status will change to OFFL and its data may or may not be recoverable through use of the `trust` command. It is recommended that you contact technical support for assistance in determining if the recovery procedure that makes use of the Dequarantine Vdisk panel and the `trust` command is applicable to your situation and for assistance in performing it. Also, see the help for the `trust` command.

To continue operation (that is, not go to quarantined status), a RAID-3 or RAID-5 vdisk can have only one inaccessible disk; a RAID-6 vdisk can have only one or two inaccessible disks; a RAID-10 or RAID-50 vdisk can have only one inaccessible disk per sub-vdisk. For example, a 16-disk RAID-10 vdisk can remain online (critical) with
8 inaccessible disks if one disk per mirror is inaccessible.

The system will automatically quarantine a vdisk having a fault-tolerant RAID level if one or more of its disks becomes inaccessible, or to prevent invalid ("stale") data that may exist in the controller from being written to the vdisk. Quarantine will not occur if a known-failed disk becomes inaccessible or if a disk becomes inaccessible after failover or recovery. The system will automatically quarantine an NRAID or RAID-0 vdisk to prevent invalid data from being written to the vdisk. If quarantine occurs because of an inaccessible disk, event 172 is logged. If quarantine occurs to prevent writing invalid data, event 485 is logged.

Examples of when quarantine can occur are:

- At system power-up, a vdisk has fewer disks online than at the previous power-up. This may happen because a disk is slow to spin up or because an enclosure is not powered up. The vdisk will be automatically dequarantined if the inaccessible disks come online and the vdisk status becomes FTOL (fault tolerant and online), or if after 60 seconds the vdisk status is QTCR or QTDN.
- During system operation, a vdisk loses redundancy plus one more disk. For example, three disks are inaccessible in a RAID-6 vdisk or two disks are inaccessible for other fault-tolerant RAID levels. The vdisk will be automatically dequarantined if after 60 seconds the vdisk status is FTOL, FTDN, or CRIT.

Quarantine isolates the vdisk from host access and prevents the system from changing the vdisk status to OFFL (offline). The number of inaccessible disks determines the quarantine status, from least to most severe:

- QTDN (quarantined with a down disk): The RAID-6 vdisk has one inaccessible disk. The vdisk is fault tolerant but degraded. If the inaccessible disks come online or if after 60 seconds from being quarantined the vdisk is QTCR or QTDN, the vdisk is automatically dequarantined.
- QTCR (quarantined critical): The vdisk is critical with at least one inaccessible disk. For example, two disks are inaccessible in a RAID-6 vdisk or one disk is inaccessible for other fault-tolerant RAID levels. If the inaccessible disks come online or if after 60 seconds from being quarantined the vdisk is QTCR or QTDN, the vdisk is automatically dequarantined.
- QTOF (quarantined offline): The vdisk is offline with multiple inaccessible disks causing user data to be incomplete, or is an NRAID or RAID-0 vdisk.

When a vdisk is quarantined, its disks become write-locked, its volumes become inaccessible, and it is not available to hosts until it is dequarantined. If there are interdependencies between the quarantined vdisk’s volumes and volumes in other vdisks, quarantine may temporarily impact operation of those other volumes. For example, if the quarantined vdisk contains the snap pool used for snapshot or volume-copy operations, quarantine may temporarily cause the associated master volume to go offline; a volume-copy operation can also be disrupted if an associated volume (snap pool, source volume, or destination volume) goes offline. For example, if the quarantined vdisk contains the snap pool used for snapshot, volume-copy, or replication operations, quarantine may temporarily cause the associated master volume to go offline. A volume-copy or replication operation can also be disrupted if an associated volume (snap pool, source volume, or destination volume) goes offline. Depending on the operation, the length of the outage, and the settings associated with the operation, the operation may automatically resume when the vdisk is dequarantined or may require manual intervention. A vdisk can remain quarantined indefinitely without risk of data loss.

A vdisk is dequarantined when it is brought back online, which can occur in three ways:

- If the inaccessible disks come online, making the vdisk FTOL, the vdisk is automatically dequarantined.
- If after 60 seconds from being quarantined the vdisk is QTCR or QTDN, the vdisk is automatically dequarantined. The inaccessible disks are marked as failed and the vdisk status changes to CRIT (critical) or FTDN (fault tolerant with a down disk). If the inaccessible disks later come online, they are marked as LEFTOVR (leftover).
- The dequarantine command is used to manually dequarantine the vdisk. If the inaccessible disks later come online, they are marked as LEFTOVR (leftover). If event 485 was logged, use the dequarantine command only as specified by the event’s recommended-action text to avoid data corruption or loss.

A quarantined vdisk can be fully recovered if the inaccessible disks are restored. Make sure that all disks are properly seated, that no disks have been inadvertently removed, and that no cables have been unplugged. Sometimes not all disks in the vdisk power up. Check that all enclosures have restarted after a power failure. If these problems are found and then fixed, the vdisk recovers and no data is lost.

If the inaccessible disks cannot be restored (for example, they failed), and the vdisk's status is FTDN or CRIT, and compatible spares are available, reconstruction will automatically begin.

If a replacement disk (reconstruct target) is inaccessible at power up, the vdisk becomes quarantined. When the disk is found, the vdisk is dequarantined and reconstruction starts. If reconstruction was in process, it continues where it left off.

Note: The only tasks allowed for a quarantined vdisk are Dequarantine Vdisk and Delete Vdisk. If you delete a quarantined vdisk and its inaccessible disks later come online, the vdisk will reappear as quarantined or offline and you must delete it again (to clear those disks).

To remove a vdisk from quarantine (if specified by the recommended action for event 172 or 485)

1. In the Configuration View panel, right-click a quarantined vdisk and select **Tools > Dequarantine Vdisk**.
2. Click **Dequarantine Vdisk**. Depending on the number of disks that remain active in the vdisk, its health might change to Degraded (RAID 6 only) and its status changes to FTOL, CRIT, or FTDN. For status descriptions, see Vdisk Properties on page 139.

Expanding a Snap Pool

By default, snap pools are configured to automatically expand when they become 90% full.

However, if a snap pool's policy is *not* set to Auto Expand and the snap pool is running out of free space, you can manually expand the snap pool.

For expansion to succeed, the vdisk must have free space and sufficient resources. Because expansion does not require I/O to be stopped, the snap pool can continue to be used during expansion.

To expand a snap pool

1. In the Configuration View panel, right-click a snap pool and select **Tools > Expand Snap Pool**.
2. In the main panel, specify the amount of free space to add to the snap pool.
3. Click **Expand Snap Pool**. A message indicates whether the task succeeded or failed.
4. Click **OK**. If the task succeeds, the snap pool's size is updated in the Configuration View panel.

Checking Links to a Remote System

After a remote system has been added, you can check the connectivity between host ports in the local system and the remote system. A host port in the local system can only link to other host ports with the same host interface, such as Fibre Channel (FC), in a remote system. When you check links, this panel will show this information for each linked host port in the local system:

- The link type
- The ID of the port in the local system
- The ID of each accessible port in the remote system

If a host port is not shown then either:

- It is not linked
- Its link type is not supported by both systems

To check links to a remote system

1. In the Configuration View panel, right-click a remote system and select **Tools > Check Remote System Link**.
2. Click **Check Links**.

Checking Local System Links

You can check the connectivity between host ports in both controllers in the local system. A host port can only link to other ports with the same host interface. When you check links, this panel will show this information for each linked host port in both controllers:

- The link type
- The port ID
- The ID of each linked port in the local system

To check links in the local system

1. In the Configuration View panel, right-click the local system and select **Tools > Check Local System Link**.
2. Click **Check Links**.

Resetting or Saving Historical Disk-performance Statistics

Resetting Historical Disk-performance Statistics

You can reset (clear) all historical performance statistics for all disks. When you reset historical statistics, an event will be logged and new data samples will continue to be stored every quarter hour.

To reset historical disk performance statistics

1. In the Configuration View panel, right-click the local system and select **Tools > Reset or Save Disk Performance Statistics**.
2. In the main panel, under the Reset Disk Performance Statistics heading, click **Reset**. A confirmation dialog appears.
3. Click **Yes** to continue. Otherwise, click **No**. If you clicked Yes, a processing dialog appears. When processing is complete a success dialog appears.
4. Click **OK**.

Saving Historical Disk-performance Statistics

You can download historical disk-performance statistics for all disks in the storage system. This task downloads the data in CSV format to a file, for import into a spreadsheet or other third-party application.

The number of data samples downloaded is fixed at 100 to limit the size of the data file to be generated and transferred. The default is to retrieve all the available data (up to six months) aggregated into 100 samples. You can specify a different time range by specifying a start and end time. If the specified time range spans more than 100 15-minute samples, the data will be aggregated into 100 samples.

The resulting file will contain a row of property names and a row for each data sample, as shown in the following example. For property descriptions, see the topic about the `disk-hist-statistics` basetype in the CLI Reference Guide.

```
“sample-time”,"durable-id","serial-number","number-of-ios", ...
"2012-01-18 01:00:00","disk_1.1","PLV2W1XE","2467917", ...
"2012-01-18 01:15:00","disk_1.1","PLV2W1XE","2360042", ...
...
```

To save historical disk-performance statistics

1. In the Configuration View panel, right-click the local system and select **Tools > Reset or Save Disk Performance Statistics**.
2. In the main panel, under the Save Disk Performance Statistics heading, specify start and end dates and times to define the range of performance data to retrieve.
3. Click **Save**.

   Note: In Microsoft Internet Explorer if the download is blocked by a security bar, select its **Download File** option. If the download does not succeed the first time, return to the Reset or Save Disk Performance Statistics panel and retry the save operation.

4. When prompted to open or save the file, click **Save**.
   - If you are using Firefox and have a download directory set, the file `Disk_Performance.csv` is saved there.
   - Otherwise, you are prompted to specify the file location and name. The default file name is `Disk_Performance.csv`. Change the name to identify the system, controller, and date.

Chapter 5: Viewing System Status

This chapter contains the following topics:

Viewing Information About the System

In the Configuration View panel, right-click the system and select **View > Overview**. The System Overview table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ❓ N/A

  ❓ Unknown

- Component. System, Enclosures, Disks, Vdisks, Volumes, Schedules, Configuration Limits, Versions, Snap Pools, Snapshots, Licensed Features.
- Count.
- Capacity.
- Storage Space. For descriptions of storage-space color codes, see About Storage-space Color Codes on page 23.

Select a component to see more information about it.

ℹ **Note:** If the system is not working properly and you cannot determine why, you can restore its default configuration settings. You then can reconfigure the settings that are necessary to use the system. To restore defaults, in the CLI, use the `restore defaults` command, as described in the CLI Reference Guide.

System Properties

When you select System in the System Overview table, two tables display information about the system.

The System Information table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ❓ N/A

  ❓ Unknown

- Health Reason. If the system's health is not OK, its Health Reason specifies that a subcomponent is unhealthy. In the System Overview table, notice which other components are unhealthy and view their properties as described in the following sections.
- System Name. User-defined system name.
- System Contact. User-defined system contact.

- System Location. User-defined system location.
- System Information. User-defined description of the system.
- Vendor Name.
- Product ID.
- Product Brand.
- SCSI Vendor ID.
- SCSI Product ID.
- Supported Locales. Languages supported by the system.
- FDE Security Status (for QXS-4//6 Series only).
    - Not Secured: The disk is not secured.
    - Unknown: The FDE state is unknown.
    - Not FDE Capable: The disk is not FDE-capable.
    - Secured, Unlocked: The system is secured and the disk is unlocked.
    - Secured, Locked: The system is secured and the disk is locked to data access, preventing its use.
    - FDE Protocol Failure: A temporary state that can occur while the system is securing the disk.

The System Redundancy table shows:

- Controller Redundancy Mode.
- Controller Redundancy Status.
- Controller A Status.
- Controller B Status.

Enclosure Properties

When you select Enclosures in the System Overview table, a table displays the following information for each enclosure:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown

  If an enclosure’s health is not OK, select it in the Configuration View panel to view details about it.

- Enclosure ID.
- Enclosure WWN.
- Vendor.
- Model.
- Number of Disks. The number of disks installed in the enclosure.

Disk Properties

When you select Disks in the System Overview table, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown

  If a disk's health is not OK, select it in the Configuration View panel to view details about it.
- Enclosure ID.
- Slot. The number of the slot the disk resides in.
- Serial Number.
- Vendor.
- Model.
- Revision.
- Type.
  - SAS: Enterprise SAS.
  - SAS MDL: Midline SAS.
  - sSAS: SAS SSD (for QXS-4/6 Series only).
- How Used

  Two values are listed together: the first is How Used and the second is Current Job. For example, for a disk used in a vdisk (VDISK) that is being scrubbed (VRSC), VDISKVRSC displays.
  - How Used
    - AVAIL: Available.
    - FAILED: The disk is unusable and must be replaced. Reasons for this status include: excessive media errors; SMART error; disk hardware failure; unsupported disk.

        - GLOBAL SP: Global spare.
        - LEFTOVR: Leftover.
        - UNUSABLE: The disk cannot be used in a vdisk because the system is secured and the disk is not FDE-capable, or because the disk is locked to data access (for QXS-4/6 Series only).
        - VDISK: Used in a vdisk.
        - VDISK SP: Spare assigned to a vdisk.
    - Current Job
        - DRSC: Disks in the vdisk are being scrubbed.
        - EXPD: The vdisk is being expanded.
        - INIT: The vdisk is being initialized.
        - RCON: The vdisk is being reconstructed.
        - VRFY: The vdisk is being verified.
        - VRSC: The vdisk is being scrubbed.
- Status.
    - Up: The disk is present and is properly communicating with the expander.
    - Spun Down: The disk is present and has been spun down by the DSD feature.
    - Warning: The disk is present but the system is having communication problems with the disk LED processor. For disk and midplane types where this processor also controls power to the disk, power-on failure will result in Error status.
    - Error: The disk is present but is not detected by the expander.
    - Unknown: Initial status when the disk is first detected or powered on.
    - Not Present: The disk slot indicates that no disk is present.
    - Unrecoverable: The disk is present but has unrecoverable errors.
    - Unavailable: The disk is present but cannot communicate with the expander.
    - Unsupported: The disk is present but is an unsupported type.
- Size. Total size of the disk.
- FDE State (for QXS-4/6 Series only).
    - Not Secured: The disk is not secured.
    - Unknown: The FDE state is unknown.
    - Not FDE-Capable: The disk is not FDE-capable.
    - Secured, Unlocked: The system is secured and the disk is unlocked.
    - Secured, Locked: The system is secured and the disk is locked to data access, preventing its use.
    - FDE Protocol Failure: A temporary state that can occur while the system is securing the disk.

If there are no disks in the system, the table displays no data.

Vdisk Properties

When you select Vdisks in the System Overview table, a table displays the following information for each vdisk:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown

  If a vdisk's health is not OK, select it in the Configuration View panel to view details about it.
- Name. Vdisk name.
- Size. Total size of the vdisk.
- Free. Amount of free space remaining on the vdisk.
- RAID. RAID level.
- Status.
  - CRIT: Critical. The vdisk is online but isn't fault tolerant because some of its disks are down.
  - DMGD: Damaged. The vdisk is online and fault tolerant, but some of its disks are damaged.
  - FTDN: Fault tolerant with down disks. The vdisk is online and fault tolerant, but some of its disks are down.
  - FTOL: Fault tolerant and online.
  - MSNG: Missing. The vdisk is online and fault tolerant, but some of its disks are missing.
  - OFFL: Offline. Either the vdisk is using offline initialization, or its disks are down and data may be lost.
  - QTCR: Quarantined critical. The vdisk is critical with at least one inaccessible disk. For example, two disks are inaccessible in a RAID-6 vdisk or one disk is inaccessible for other fault-tolerant RAID levels. If the inaccessible disks come online or if after 60 seconds from being quarantined the vdisk is QTCR or QTDN, the vdisk is automatically dequarantined.
  - QTDN: Quarantined with a down disk. The RAID-6 vdisk has one inaccessible disk. The vdisk is fault tolerant but degraded. If the inaccessible disks come online or if after 60 seconds from being quarantined the vdisk is QTCR or QTDN, the vdisk is automatically dequarantined.
  - QTOF: Quarantined offline. The vdisk is offline with multiple inaccessible disks causing user data to be incomplete, or is an NRAID or RAID-0 vdisk.
  - STOP: The vdisk is stopped.
  - UNKN: Unknown.
  - UP: Up. The vdisk is online and does not have fault-tolerant attributes

- Disk Type.
  - SAS: Enterprise SAS.
  - SAS MDL: Midline SAS.
  - sSAS: SAS SSD (for QXS-4/6 Series only).

Note: In the Configuration View panel, if a vdisk contains more than one type of disk, its RAID-level label includes the suffix `-MIXED`.

If no vdisks exist, the table displays no data.

Virtual Storage Properties

When you select Virtual Storage in the System Overview table, the amount of storage created and managed through the user interface of the Disk Management Utility (V2) virtual storage system displays in the Capacity column. For more information, see the explanation below the System Overview table or click the WBIv3 link to access the user interface.

Volume Properties

When you select Volumes in the System Overview table, a table displays the following information for each volume:

- Name.
- Serial Number.
- Size. Total size of the volume.
- Vdisk Name. The name of the vdisk the volume resides on.

If no volumes exist, the table displays no data.

Schedule Properties

When you select Schedules in the System Overview table, a table displays the following information for each schedule:

- Schedule Name.
- Schedule Specification. The start day and time of the schedule.
- Status. Schedule status.
  - Uninitialized: Schedule is not yet ready to run.
  - Ready: Schedule is ready to run.
  - Suspended: Schedule is suspended.

  - Expired: Schedule has expired.
  - Invalid: Schedule is invalid.
  - Deleted: Schedule has been deleted.
- Next Time. The next time the task is scheduled to run.
- Task Type. Type of task assigned to run.
- Status. Task status.
  - Uninitialized: Task is not yet ready to run.
  - Ready: Task is ready to run.
  - Active: Task is running.
  - Error: Task has an error.
  - Invalid: Task is invalid.
  - Complete: Task is complete.
  - Deleted: Task has been deleted.
- Task State. Specific information about task type.

When you select a schedule, two tables display: the Schedule Details table and the Task Details table.

The Schedule Details table displays specifics about the schedule:

- Schedule Name.
- Schedule Specification. The start day and time of the schedule.
- Status.
  - Uninitialized: Schedule is not yet ready to run.
  - Ready: Schedule is ready to run.
  - Suspended: Schedule is suspended.
  - Expired: Schedule has expired.
  - Invalid: Schedule is invalid.
  - Deleted: Schedule has been deleted.
- Next Time. The next time the task is scheduled to run.

The Task Details table displays specifics about the task for the selected schedule:

- Task Name.
- Task Type. Type of task assigned to run.
- Status.
  - Uninitialized: Task is not yet ready to run.
  - Ready: Task is ready to run.
  - Active: Task is running.

  - Error: Task has an error.
  - Invalid: Task is invalid.
  - Complete: Task is complete.
  - Deleted: Task has been deleted.
- Task State. Specific information about task type.

When you select a task of type TakeSnapshot, a third table displays. The Retained Set table shows the name and serial number of each snapshot that the task has created and that is being retained.

If no schedules exist, the table displays no data.

To modify or delete scheduled tasks to suspend (disable) and resume (re-enable) DSD, use the Advanced Settings Disk panel. See Scheduling drive spin down for all disks on page 63.

Configuration Limits

When you select Configuration Limits in the System Overview table, a table shows the Maximum Vdisks, Maximum Volumes, Maximum LUNs, Maximum Disks, and Number of Host Ports that the system supports. For a summary of the physical and logical limits of the storage system, see the system configuration limits topic in the Disk Management Utility (V2) help.

Version Properties

When you select Versions in the System Overview table, a table shows the versions of firmware and hardware in each controller module.

- Storage Controller CPU Type.
- Bundle Version.
- Build Date.
- Storage Controller Code Version.
- Storage Controller Code Baselevel.
- Memory Controller FPGA Code Version.
- Storage Controller Loader Code Version.
- CAPI Version.
- Management Controller Code Version.
- Management Controller Loader Code Version.
- Expander Controller Code Version.
- CPLD Code Version.
- Hardware Version.

- Host Interface Module Version.
- Host Interface Module Model.
- Backplane Type.
- Host Interface Hardware (Chip) Version.
- Disk Interface Hardware (Chip) Version.
- SC Boot Memory Reference Code.

Snap-pool Properties

When you select Snap Pools in the System Overview table, a table shows each snap pool's name, serial number, size, free space, master volumes, snapshots, and vdisk name.

If no snap pools exist, the table displays no data.

Snapshot Properties

When you select Snapshots in the System Overview table, a table shows each snapshot's name; serial number; source volume; snap-pool name; amounts of snap data, unique data, and shared data; and vdisk name.

- Snap data is the total amount of data associated with the specific snapshot (data copied from a source volume to a snapshot and data written directly to a snapshot).
- Unique data is the amount of data that has been written to the snapshot since the last snapshot was taken. If the snapshot has not been written or is deleted, this value is zero bytes.
- Shared data is the amount of data that is potentially shared with other snapshots and the associated amount of space that will be freed if the snapshot is deleted. This represents the amount of data written directly to the snapshot. It also includes data copied from the source volume to the storage area for the oldest snapshot, since that snapshot does not share data with any other snapshot. For a snapshot that is not the oldest, if the modified data is deleted or if it had never been written to, this value is zero bytes.

If no snapshots exist, the table displays no data.

Viewing the System Event Log

In the Configuration View panel, right-click the system and select **View > Event Log**. The System Events panel shows the 100 most recent events that have been logged by either controller. All events are logged, regardless of event-notification settings. Click the buttons above the table to view all events, or only critical, warning, or informational events.

The event log table shows the following information:

- Severity.

  ✖ Critical. A failure occurred that may cause a controller to shut down. Correct the problem *immediately*.

  ▼ Error. A failure occurred that may affect data integrity or system stability. Correct the problem as soon as possible.

  ⚠ Warning. A problem occurred that may affect system stability but not data integrity. Evaluate the problem and correct it if necessary.

  ℹ Informational. A configuration or state change occurred, or a problem occurred that the system corrected. No action is required.

  Resolved. A status for a condition that caused an event to be logged that is now resolved.

- Time. Date and time when the event occurred, shown as *year-month-day hour*:*minutes*:*seconds*. Time stamps have one-second granularity.
- Event ID. An identifier for the event. The prefix A or B identifies the controller that logged the event.
- Code. An event code that helps you and support personnel diagnose problems. For event-code descriptions and recommended actions, see the Event Descriptions Reference Guide.
- Message. Brief information about the event. Click the message to show or hide additional information and recommended actions.

ℹ **Note:** If you are having a problem with the system or a vdisk, check the event log before calling technical support. Event messages might enable you to resolve the problem.

When reviewing events, do the following:

1. For any critical, error, or warning events, click the message to view additional information and recommended actions. This information also appears in the Event Descriptions Reference Guide.

   Identify the primary events and any that might be the cause of the primary event. For example, an over-temperature event could cause a disk failure.

2. View the event log and locate other critical/error/warning events in the sequence for the controller that reported the event.

   Repeat this step for the other controller if necessary.

3. Review the events that occurred before and after the primary event.

   During this review you are looking for any events that might indicate the cause of the critical/error/warning event. You are also looking for events that resulted from the critical/error/warning event, known as secondary events.

4. Review the events following the primary and secondary events.

   You are looking for any actions that might have already been taken to resolve the problems reported by the events.

Viewing Information About All vdisks

In the Configuration View panel, right-click **Vdisks** and select **View > Overview**. The Vdisks Overview table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ⊗ Fault

  ? N/A

  ? Unknown
- Component.
- Count. Number of components.
- Capacity. Total capacity of the component.
- Storage Space. Amount of space on the component. For descriptions of storage-space color codes, see About Storage-space Color Codes on page 23.

The Vdisks table shows more information about each vdisk.

- Health.
- Name. Vdisk name.
- Size. Total storage space in the vdisk.
- Free. Available space in the vdisk.
- RAID. RAID level of the vdisk and all of its volumes.
- Status.
  - CRIT: Critical. The vdisk is online but isn’t fault tolerant because some of its disks are down.
  - DMGD: Damaged. The vdisk is online and fault tolerant, but some of its disks are damaged.
  - FTDN: Fault tolerant with a down disk. The vdisk is online and fault tolerant, but some of its disks are down.
  - FTOL: Fault tolerant and online.
  - MSNG: Missing. The vdisk is online and fault tolerant, but some of its disks are missing.
  - OFFL: Offline. Either the vdisk is using offline initialization, or its disks are down and data may be lost.
  - QTCR: Quarantined critical. The vdisk is critical with at least one inaccessible disk. For example, two disks are inaccessible in a RAID-6 vdisk or one disk is inaccessible for other fault-tolerant RAID levels. If the inaccessible disks come online or if after 60 seconds from being quarantined the vdisk is QTCR or QTDN, the vdisk is automatically dequarantined.

  - QTDN: Quarantined with a down disk. The RAID-6 vdisk has one inaccessible disk. The vdisk is fault tolerant but degraded. If the inaccessible disks come online or if after 60 seconds from being quarantined the vdisk is QTCR or QTDN, the vdisk is automatically dequarantined.
  - QTOF: Quarantined offline. The vdisk is offline with multiple inaccessible disks causing user data to be incomplete, or is an NRAID or RAID-0 vdisk.
  - STOP: The vdisk is stopped.
  - UNKN: Unknown.
  - UP: Up. The vdisk is online and does not have fault-tolerant attributes.
- Disk Type.
  - SAS: Enterprise SAS.
  - SAS MDL: Midline SAS.
  - sSAS: SAS SSD (for QXS-4/6 Series only).
- Preferred Owner. Controller that owns the vdisk and its volumes during normal operation.
- Current Owner. Either the preferred owner during normal operation or the partner controller when the preferred owner is offline.
- Disks. Quantity of disks in the vdisk.
- Spares. Quantity of dedicated spares in the vdisk.

Viewing Information About a vdisk

In the Configuration View panel, right-click a vdisk and select **View > Overview**. The Vdisks Overview table shows:

- Health.

  ✅ OK

  ⚠ Degraded

  ❌ Fault

  ❓ N/A

  ❓ Unknown
- Component. Vdisk, disks, volumes.
- Count.
- Capacity.
- Storage Space. For descriptions of storage-space color codes, see About Storage-space Color Codes on page 23.

Select a component to see more information about it. When the Vdisk component is selected, you can view properties or historical performance statistics.

Note: Failure of a disk in the vdisk causes the Vdisk and Disks components to have Degraded health. Because tables displayed when the Disks component is selected exclude failed disks, those tables will show fewer disks than the Disk component's Count value.

Vdisk Properties

When you select Vdisk in the Vdisk Overview table and click the **Properties** tab, the Properties for *Vdisk* table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown
- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Health Recommendation. If Health is not OK, this field shows recommended actions to take to resolve the health issue.
- Name. Vdisk name.
- Size. Total storage space in the vdisk.
- Free. Available space in the vdisk.
- Current Owner. Either the preferred owner during normal operation or the partner controller when the preferred owner is offline.
- Preferred Owner. Controller that owns the vdisk and its volumes during normal operation.
- Serial Number. Vdisk serial number.
- RAID. RAID level of the vdisk and all of its volumes.
- Disks. Quantity of disks in the vdisk.
- Spares. Quantity of dedicated spares in the vdisk.
- Chunk Size.
  - For RAID levels except NRAID, RAID 1, and RAID 50, the configured chunk size for the vdisk.
  - For NRAID and RAID 1, chunk size has no meaning and is therefore shown as not applicable (N/A).

  - For RAID 50, the vdisk chunk size calculated as: *configured-chunk-size* x (*subvdisk-members* - 1). For a vdisk configured to use 32-KB chunk size and 4-disk sub-vdisks, the value would be 96k (32KB x 3).

- Created. Date and time when the vdisk was created.
- Minimum Disk Size. Capacity of the smallest disk in the vdisk.
- Status.
  - CRIT: Critical. The vdisk is online but isn't fault tolerant because some of its disks are down.
  - DMGD: Damaged. The vdisk is online and fault tolerant, but some of its disks are damaged.
  - FTDN: Fault tolerant with a down disk. The vdisk is online and fault tolerant, but some of its disks are down.
  - FTOL: Fault tolerant and online.
  - MSNG: Missing. The vdisk is online and fault tolerant, but some of its disks are missing.
  - OFFL: Offline. Either the vdisk is using offline initialization, or its disks are down and data may be lost.
  - QTCR: Quarantined critical. The vdisk is critical with at least one inaccessible disk. For example, two disks are inaccessible in a RAID-6 vdisk or one disk is inaccessible for other fault-tolerant RAID levels. If the inaccessible disks come online or if after 60 seconds from being quarantined the vdisk is QTCR or QTDN, the vdisk is automatically dequarantined.
  - QTDN: Quarantined with a down disk. The RAID-6 vdisk has one inaccessible disk. The vdisk is fault tolerant but degraded. If the inaccessible disks come online or if after 60 seconds from being quarantined the vdisk is QTCR or QTDN, the vdisk is automatically dequarantined.
  - QTOF: Quarantined offline. The vdisk is offline with multiple inaccessible disks causing user data to be incomplete, or is an NRAID or RAID-0 vdisk.
  - STOP: The vdisk is stopped.
  - UNKN: Unknown.
  - UP: Up. The vdisk is online and does not have fault-tolerant attributes.
- Current Job. If a utility is running on the vdisk, this field shows the utility's name and progress.
  - Disk Scrub: Disks in the vdisk are being scrubbed.
  - Expand: The vdisk is being expanded.
  - Initialize: The vdisk is being initialized.
  - Media Scrub: The vdisk is being scrubbed.
  - Reconstruct: The vdisk is being reconstructed.
  - Verify: The vdisk is being verified.
  - Virtual Drain: The virtual disk group is being drained.
  - Virtual Prepare: The virtual disk group is being prepared.
- Active Drive Spin Down Enable. Shows whether drive spin down is enabled or disabled for this vdisk.
- Sector Format.

- 512n (512-byte native sector size).
- 512e (512-byte emulated sector size).

A second table displays information about unhealthy components. If all components are healthy, this table displays the text, “There is no data for your selection.”

Note: In the Configuration View panel, if a vdisk contains more than one type of disk, its RAID-level label includes the suffix `-MIXED`.

Vdisk Performance

When you select Vdisk in the Vdisk Overview table and click the **Performance** tab, the Performance Statistics panel shows three graphs of historical performance statistics for the vdisk: Data Transferred, Data Throughput, and Average Response Time. Data samples are taken every quarter hour and the graphs represent up to 50 samples.

To specify a time range of samples to display, set the start and end values and click **Update**. The system determines whether the number of samples in the time range exceeds the number of samples that can be displayed (50), requiring aggregation. To determine this, the system divides the number of samples in the specified time range by 50, giving a quotient and a remainder. If the quotient is 1, the 50 newest samples will be displayed. If the quotient exceeds 1, each “quotient” number of newest samples will be aggregated into one sample for display. The remainder is the number of oldest samples that will be excluded from display.

- Example 1: A 1-hour range includes 4 samples. 4 is less than 50 so all 4 samples are displayed.
- Example 2: A 15-hour range includes 60 samples. 60 divided by 50 gives a quotient of 1 and a remainder of 10. Therefore, the newest 50 samples will be displayed and the oldest 10 samples will be excluded.
- Example 3: A 30-hour range includes 120 samples. 120 divided by 50 gives a quotient of 2 and a remainder of 20. Therefore, each two newest samples will be aggregated into one sample for display and the oldest 20 samples will be excluded.

If aggregation is required, the system aggregates samples for each disk in the vdisk (as described in Disk performance on page 159) and then aggregates the resulting values as follows:

- For a count statistic such as data transferred, the aggregated values are added to produce the value of the aggregated sample.
- For a rate statistic such as data throughput, the aggregated values are added and then are divided by their combined interval (seconds per sample multiplied by the number of samples).

The system will change the time settings to match the times of the oldest and newest samples displayed. The graphs are updated each time you click either the Performance tab or the Update button.

- For the vdisk, the Data Transferred graph shows the amounts of data read and written and the combined total over the sampling time period. The base unit is bytes.
- For the vdisk, the Data Throughput graph shows the rates at which data are read and written and the combined total over the sampling time period. The base unit is bytes per second.
- For each disk in the vdisk, the Average Response Time graph shows the average response times for reads and writes over the sampling time period. The base unit is microseconds. To view the graph’s legend, which identifies the color-coding for each disk, select **Show Legend**.

Note: If you specify a time range, it is recommended to specify a range of 12 hours or less.

To view performance data for an individual disk, use the Enclosure Overview panel (Viewing Information About an Enclosure on page 154). To view live (non-historical) performance statistics for one more vdisks, in the CLI use the `show vdisk-statistics` command.

Note: Values for the amount of data transferred and for data throughput appear to be much higher in historical output than in live output. This is caused by a difference in the way that historical and live values are calculated.

Live values are calculated based on the vdisk as viewed from the controller cache perspective. In the live statistics, performance numbers are obtained by accounting for when data is written from cache to disk or is read from disk to cache.

Historical data is obtained by using the summation of the disk statistics for the disks in the vdisk. The historical vdisk data shows transfers to and from the disks in the vdisk that include the overhead of any RAID transfers as well as any host activity.

Because I/Os from the RAID engine are included, values for the historical data appear higher than the numbers for the live data.

Disk Properties

When you select Disks in the Vdisk Overview table, a Disk Sets table and enclosure view appear. The Disk Sets table shows:

- Total Space. Total storage space in the vdisk, followed by a color-coded measure of how the space is used.
- Type. For RAID 10 or RAID 50, the sub-vdisk that the disk is in; for other RAID levels, the disk’s RAID level; or SPARE.
- Disk Type.
  - SAS: Enterprise SAS.
  - SAS MDL: Midline SAS.
  - sSAS: SAS SSD (for QXS-4/6 Series only).
- Disks. Quantity of disks in the vdisk or sub-vdisk.
- Size. Total capacity of the disks in the vdisk or sub-vdisk.

The enclosure view has two tabs. The Tabular tab shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✗ Fault

  ? N/A (if the disk is spun down)

❓ Unknown

If the disk’s health is not OK, view health details in the Enclosure Overview panel (Viewing Information About an Enclosure on page 154).

- Name. System-defined disk name using the format Disk-*enclosure-number*.*disk-slot-number*.
- Type.
  - SAS: Enterprise SAS.
  - SAS MDL: Midline SAS.
  - sSAS: SAS SSD (for QXS-4/6 Series only)
- State. Shows how the disk is used:
  - AVAIL: Available
  - FAILED: The disk is unusable and must be replaced. Reasons for this status include: excessive media errors; SMART error; disk hardware failure; unsupported disk.
  - GLOBAL SP: Global spare
  - LEFTOVR: Leftover
  - UNUSABLE: The disk cannot be used in a vdisk because the system is secured and the disk is not FDE-capable, or because the disk is locked to data access.
  - VDISK: Used in a vdisk.
  - VDISK SP: Spare assigned to a vdisk.

  This also shows any job running on the disk:

  - DRSC: The disk is being scrubbed
  - EXPD: The vdisk is being expanded
  - INIT: The vdisk is being initialized
  - RCON: The vdisk is being reconstructed
  - VRFY: The vdisk is being verified
  - VRSC: The vdisk is being scrubbed
- Size. Disk capacity.
- Enclosure. Name of the enclosure containing the disk.
- Serial Number. Disk serial number.
- Status. Up (operational) or Not Present.

The Graphical tab shows the locations of the vdisk’s disks in system enclosures and each disk’s Health and State. If a disk belongs to the virtual storage system, “VIRTUAL POOL” will appear on it.

Volume Properties

When you select Volumes in the Vdisk Overview table, the Volumes table shows:

- Name. Volume name.
- Serial Number. Volume serial number.
- Size. Volume size.
- Vdisk Name. The name of the vdisk containing the volume.

Snap-pool Properties

When you select Snap Pools in the Vdisk Overview table, the Snap Pools table shows:

- The snap pool’s name, serial number, size, and free space.
- The quantity of master volumes and snapshots associated with the snap pool.
- The name of the vdisk containing the snap pool.

Viewing Information About a Volume

In the Configuration View panel, right-click a volume and select **View > Overview**. The Volume Overview table shows:

- Component. Volume, Maps, or Schedules.
- Count. The quantity of mappings for the volume.
- Capacity. The capacity of the volume.
- Storage Space. The space usage of the volume. For descriptions of storage-space color codes, see About Storage-space Color Codes on page 23.
- Replication Addresses. The quantity of replication addresses for the volume.
- Replication Images. The quantity of replication images for the volume.

Select a component to see more information about it.

Volume Properties

When you select Volume in the Volume Overview table, the Properties for *Volume* table shows:

- Vdisk Name. Name of the vdisk that the volume is in.
- Name. Volume name.

- Size. Volume size.
- Preferred Owner. Controller that owns the vdisk and its volumes during normal operation.
- Current Owner. Either the preferred owner during normal operation or the partner controller when the preferred owner is offline.
- Serial Number. Volume serial number.
- Cache Write Policy. Write-back or Write-through. See Using write-back or write-through caching on page 13.
- Read Ahead Size. See Optimizing read-ahead caching on page 14.
- Type. Standard volume, master volume, or snapshot.
- Progress. If the volume is being created by a volume-copy operation, the percent complete.
- Health. OK, Degraded, Fault, or Unknown.

  Health Reason. If Health is not OK, this field shows the reason for the health state.
- Health Recommendation. If Health is not OK, this field shows the recommended actions to take to resolve the health issue.

For a *local* primary or secondary volume, the Replication Properties for Volume table shows:

- Name. Replication volume name.
- Serial Number. Replication volume serial number.
- Status. Replication volume status:
  - Initializing: The initial (full) replication to the volume is in progress.
  - Online: The volume is online and is consistent with the last replicated image.
  - Inconsistent: The volume is online but is in an inconsistent state. A full replication is required to initialize it.
  - Replicating: The volume is online and replication is in progress.
  - Replicate-delay: The volume is online but the in-progress replication has been temporarily delayed. A retry is occurring.
  - Suspended: The volume is online but the in-progress replication has been suspended.
  - Offline: The volume cannot be accessed or is unusable due to an error.
  - Establishing proxy: The volume is establishing a proxy connection to a remote volume. This will occur when a detached secondary volume is reattached and is re-establishing a connection with the primary system in preparation for replication.
  - Detached: The volume is detached for removal.
- Status-Reason. More information about the status value, or N/A for Online status.
- Monitor. Replication volume monitoring status:
  - OK: Communication to the remote volume is successfully occurring on the FC or iSCSI network.
  - Failed: Communication to the remote volume has failed because of an FC or iSCSI network issue or because the remote volume has gone offline.

- Location. Local or Remote.
- Primary Volume Name. Primary volume name. If the replication set has a primary-volume conflict, all associated primary volumes are displayed.
- Primary Volume Serial Number. Primary volume serial number. If the replication set has a primary-volume conflict, all associated primary volumes are displayed.
- Primary Volume Status. Primary volume status: Online, Offline, Conflict, or N/A.
- Maximum Number of Queued Images. Number of replication images to consider when determining the next image to replicate. Used only if the On Collision parameter is set to Oldest.
- Maximum Retry Time (Seconds). Amount of time in seconds that the replication volume should retry a replication operation on any specific image when errors occur. Used only if the On Error parameter is set to Retry.
- On Error. Error policy to invoke when errors occur during the replication process: Retry or Suspend.
- Link Type. Type of ports used to link the primary and secondary volumes: FC or iSCSI.
- On Collision. Collision policy used to determine the next image to replicate when multiple replication images are queued: Newest or Oldest.
- Monitor Interval. Interval in seconds at which the primary volume should query the secondary volume.
- Priority. Priority of the replication process on the replication volume: Low, Medium, or High.
- Connection Status.
  - Not Attempted. Communication has not been attempted to the remote volume.
  - Online. The volumes in the replication set have a valid connection but communication is not currently active.
  - Active. Communication is currently active to the remote volume.
  - Offline. No connection is available to the remote system.
- Connection Time. Date and time of the last communication with the remote volume, or N/A.

Mapping Properties

When you select Maps in the Volume Overview table, the Maps for *Volume* table shows:

- Type. Explicit or Default. Settings for an explicit mapping override the default mapping.
- Host ID. WWPN or IQN.
- Host Name. User-defined nickname for the host.
- Ports. Controller host ports through which the volume is mapped to the host.
- LUN. Volume identifier presented to the host.
- Access. Volume access type: read-write, read-only, no-access (masked), or not-mapped.

Schedule Properties

If any schedules exist for this volume, when you select the Schedules component, the Schedules table shows each schedule's name, specification, status, next run time, task type, task status, and task state. For the selected schedule, two tables appear.

The Schedule Details table shows:

- Schedule Name. Schedule name.
- Schedule Specification. The schedule's start time and recurrence or constraint settings.
- Status.
  - Uninitialized: Schedule is not yet ready to run.
  - Ready: Schedule is ready to run.
  - Suspended: Schedule is suspended.
  - Expired: Schedule has expired.
  - Invalid: Schedule is invalid.
  - Deleted: Schedule has been deleted.
- Next Time. The next time the associated task will run.

The Task Details table shows different properties depending on the task type. Properties shown for all task types are:

- Task Name. Task name.
- Task Type. ReplicateVolume, ResetSnapshot, TakeSnapshot, or VolumeCopy.
- Status.
  - Uninitialized: Task is not yet ready to run.
  - Ready: Task is ready to run.
  - Active: Task is running.
  - Error: Task has an error.
  - Invalid: Task is invalid.
  - Complete: Task is complete.
  - Deleted: Task has been deleted.
- Task State. Current step of task processing. Steps vary by task type.
- Source Volume. Name of the volume to snap, copy, or replicate.
- Source Volume Serial. Source volume serial number.
- Destination Vdisk. Name of the destination vdisk for a volume copy.
- Destination Vdisk Serial. Destination vdisk serial number.
- Prefix. Label that identifies snapshots, volume copies, or replication images created by this task.

- Count. Number of snapshots to retain with this prefix. When a new snapshot exceeds this limit, the oldest snapshot with the same prefix is deleted.
- Last Created. Name of the last snapshot, volume copy, or replication image created by the task.
- Last Used Snapshot. For a task whose replication mode is last-snapshot, the name of the last snapshot used for replication.
- Snapshot Name. Name of the snapshot to reset.
- Snapshot Serial. Snapshot serial number.
- Mode. Replication mode:
    - new-snapshot: Replicate a new snapshot of the primary volume.
    - last-snapshot: Replicate the most recent existing snapshot of the primary volume.

For a TakeSnapshot task, the Retained Set table shows the name and serial number of each snapshot that the task has taken and is retaining.

Replication Addresses

If any remote port addresses are associated with this volume, when you select the Replication Addresses component, the Replication Addresses table shows:

- Connected Ports.
    - For a remote primary or secondary volume, this field shows the IDs of up to two hosts ports in the local system that are connected to the remote system. If two ports are connected but only one is shown, this indicates that a problem is preventing half the available bandwidth from being used.
    - For a local primary or secondary volume, this field shows N/A.
- Remote Address. The address of each host port in the remote system through which the volume is accessible.

Replication Images

If any replication images exist for this volume, when you select the Replication Images component, the Replication Images table shows information about each image. For the selected image, the Replication Images table shows:

- Image Serial Number. Replication image serial number.
- Image Name. User-defined name assigned to the primary replication image.
- Snapshot Serial Number. Replication snapshot serial number associated with the image. The replication snapshot is associated with the replication volume specified in the request.
- Snapshot Name. Replication snapshot name associated with the image. For a secondary replication image, this value is not filled in until the replication is completed.
- Creation Date/Time. Date and time when the replication image was created on the replication volume.

Viewing Information About a Snapshot

In the Configuration View panel, right-click a snapshot and select **View > Overview**. The Snapshot Overview table shows:

- The capacity and space usage of the snapshot
- The quantity of mappings for the snapshot
- The quantity of task schedules for the snapshot

For descriptions of storage-space color codes, see About Storage-space Color Codes on page 23.

Select a component to see more information about it.

Snapshot Properties

When you select the Snapshot component, the Properties for Snapshot table shows:

- Name and serial number of the pool containing the snapshot
- Snapshot name, creation date/time, status, and status reason
- Source volume name
- Parent volume name
- Base volume name
- Number of snapshots and snapshots in the tree
- Snap pool name
- Amounts of total, unique, and shared data associated with the snapshot
  - Snap Data. The total amount of data associated with the specific snapshot (data copied from a source volume to a snapshot and data written directly to a snapshot).
  - UniqueData. The amount of data that has been written to the snapshot since the last snapshot was taken. If the snapshot has not been written or is deleted, this value is zero bytes.
  - SharedData. The amount of data that is potentially shared with other snapshots and the associated amount of space that will be freed if the snapshot is deleted. This represents the amount of data written directly to the snapshot. It also includes data copied from the source volume to the storage area for the oldest snapshot, since that snapshot does not share data with any other snapshot. For a snapshot that is not the oldest, if the modified data is deleted or if it had never been written to, this value is zero bytes.
- Default and user-specified retention priorities for this type of snapshot
- Type.
  - Standard snapshot: Snapshot of a master volume that consumes a snapshot license.
  - Standard snapshot (DRM): A temporary standard snapshot created from a replication snapshot for the purpose of doing a test failover for disaster recovery management (DRM).

- Replication snapshot: For a primary or secondary volume, a snapshot that was created by a replication operation but is not a sync point.
- Replication snapshot (Replicating): For a primary volume, a snapshot that is being replicated to a secondary system.
- Replication snapshot (Current sync point): For a primary or secondary volume, the latest snapshot that is copy-complete on any secondary system in the replication set.
- Replication snapshot (Common sync point): For a primary or secondary volume, the latest snapshot that is copy-complete on all secondary systems in the replication set.
- Replication snapshot (Old Common sync point): For a primary or secondary volume, a common sync point that has been superseded by a new common sync point.
- Replication snapshot (Only sync point): For a primary or secondary volume, the only snapshot that is copy-complete on any secondary system in the replication set.
- Replication snapshot (Queued): For a primary volume, a snapshot associated with a replication operation that is waiting for a previous replication operation to complete.
- Replication snapshot (Awaiting replicate): For a primary volume, a snapshot that is waiting to be replicated to a secondary system.

Mapping Properties

When you select the Maps component, the Maps for *Volume* table shows:

- Type. Explicit or Default. Settings for an explicit mapping override the default mapping.
- Host ID. WWPN or IQN.
- Host Name. User-defined nickname for the host.
- Ports. Controller host ports through which the volume is mapped to the host.
- LUN. Volume identifier presented to the host.
- Access. Volume access type: read-write, read-only, no-access (masked), or not-mapped.

Schedule Properties

If any schedules exist for the snapshot, when you select the Schedules component, the Schedules table shows information about each schedule. For the selected schedule, the Schedule Details table shows:

- Schedule Name.
- Schedule Specification.
- Schedule Status.
- Next Time.
- Task Type.

- Task Status.
- Task State.
- Source Volume.
- Source Volume Serial.
- Prefix.
- Count.
- Last Created.

Viewing Information About a Snap Pool

In the Configuration View panel, right-click a snap pool and select **View > Overview**. The Snap Pool Overview table shows:

- The capacity and space usage of the snap pool
- The quantity of volumes using the snap pool
- The quantity of snapshots in the snap pool

For descriptions of storage-space color codes, see About Storage-space Color Codes on page 23.

Note: The process of freeing space associated with deleted snapshots occurs more slowly when the system is operating write-through cache mode than in write-back cache mode. Therefore, there will be a delay between deleting the snapshots and when their used space is shown as available space in the Snap Pool Overview panel.

Select a component to see more information about it.

Snap Pool Properties

When you select the Snap Pool component, two tables appear. The first table shows the snap pool’s name, serial number, size (total capacity), vdisk name, and free space, the number of snapshots in the snap pool, and its status. The status values are:

- Available: The snap pool is available for use.
- Offline: The snap pool is not available for use, as in the case where its disks are not present.
- Corrupt: The snap pool’s data integrity has been compromised. The snap pool can no longer be used.

The second table shows the snap pool’s threshold values and associated policies. Three thresholds are defined:

- Warning: The snap pool is moderately full. When this threshold is reached, an event is generated to alert the administrator.

- Error: The snap pool is nearly full and unless corrective action is taken, snapshot data loss is probable. When this threshold is reached, an event is generated to alert the administrator and the associated snap-pool policy is triggered.
- Critical: The snap pool is 98% full and data loss is imminent. When this threshold is reached, an event is generated to alert the administrator and the associated snap-pool policy is triggered.

The following policies are defined:

- Auto Expand: Automatically expand the snap pool by the indicated expansion-size value. This is the default policy for the Error threshold.

  If the snap pool's space usage reaches the percentage specified by its error threshold, the system will log Warning event 230 and will try to automatically expand the snap pool by the snap pool's expansion-size value. If the snap pool cannot be expanded because there is not enough available space in its vdisk, the system will log Warning event 444 and will automatically delete the oldest snapshot that is not a current sync point.
- Delete Oldest Snapshot: Delete the oldest snapshot.
- Delete Snapshots: Delete all snapshots. This is the default policy for the Critical threshold.
- Halt Writes: Halt writes to all master volumes and snapshots associated with the snap pool.
- Notify Only: Generates an event to notify the administrator. This is the only policy for the Warning threshold.
- No Change: Take no action.

Note: The policies Delete Oldest Snapshot and Delete Snapshots do not apply business logic to the delete decision and may delete snapshots that are mounted/presented/mapped or modified. You may set retention priorities for a snap pool as a way of suggesting that some snapshots are more important than others, but these priorities do not ensure any specific snapshot is protected.

For details about setting snap-pool thresholds and policies, see the CLI Reference Guide.

Volume Properties

When you select the Client Volumes component, a table shows the name, serial number, size, vdisk name, and vdisk serial number for each volume using the snap pool.

Snapshot Properties

When you select the Resident Snapshots component, a table shows each snapshot's name; serial number; amounts of snap data, unique data, and shared data; and status (Available or Unavailable).

- Snap data is the total amount of data associated with the specific snapshot (data copied from a source volume to a snapshot and data written directly to a snapshot).
- Unique data is the amount of data that has been written to the snapshot since the last snapshot was taken. If the snapshot has not been written or is deleted, this value is zero bytes.

- Shared data is the amount of data that is potentially shared with other snapshots and the associated amount of space that will be freed if the snapshot is deleted. This represents the amount of data written directly to the snapshot. It also includes data copied from the source volume to the storage area for the oldest snapshot, since that snapshot does not share data with any other snapshot. For a snapshot that is not the oldest, if the modified data is deleted or if it had never been written to, this value is zero bytes.

Viewing Information About All Hosts

In the Configuration View panel, right-click **Hosts** and select **View > Overview**. The Hosts table shows the quantity of hosts configured in the system.

For each host, the Hosts Overview table shows the following details:

- Host ID. WWPN or IQN.
- Name. User-defined nickname for the host.
- Discovered. If the host was discovered and its entry was automatically created, Yes. If the host entry was manually created, No.
- Mapped. If volumes are mapped to the host, Yes. Otherwise, No.
- Profile.
  - Standard: Default profile.
  - HP-UX: The host uses Flat Space Addressing.
- Host Type.
  - If the host was discovered and its entry was automatically created, its host-interface type.
  - If the host entry was manually created: Undefined.

Viewing information about a host

In the Configuration View panel, right-click a host and select **View > Overview**. The Host Overview table shows:

- Host properties
- The quantity of mappings for the host

Select a component to see more information about it.

Host properties

When you select Host in the Host Overview table, the Properties for `Host` table shows:

- Host ID. WWPN or IQN.
- Name. User-defined nickname for the host.
- Discovered. If the host was discovered and its entry was automatically created, Yes. If the host entry was manually created, No.
- Mapped. If volumes are mapped to the host, Yes. Otherwise, No.
- Profile.
  - Standard: Default profile.
- Host Type.
  - If the host was discovered and its entry was automatically created, its host-interface type.
  - If the host entry was manually created: Undefined.

Mapping properties

When you select Maps in the Host Overview table, the Maps for `Host` table shows:

- Type. Explicit or Default. Settings for an explicit mapping override the default mapping.
- Name. Volume name.
- Serial Number. Volume serial number.
- Ports. Controller host ports through which the volume is mapped to the host.
- LUN. Volume identifier presented to the host.
- Access. Volume access type: read-write, read-only, no-access (masked), or not-mapped.

Viewing Information About an Enclosure

In the Configuration View panel, right-click an enclosure and select **View > Overview**. You can view information about the enclosure and its components in a front or rear graphical view, or in a front or rear tabular view.

- Front Graphical. Shows a graphical view of the front of each enclosure and its drawers and disks.
- Front Tabular. Shows a tabular view of each enclosure and its drawers and disks.
- Rear Graphical. Shows a graphical view of components at the rear of the enclosure.
- Rear Tabular. Shows a tabular view of components at the rear of the enclosure.

Tabular views are initially sorted by the Name property.

In any of these views, select a component to see more information about it. Components vary by enclosure model. If any components are unhealthy, a table at the bottom of the panel identifies them. When a disk is selected, you can view properties or historical performance statistics.

Enclosure properties

When you select an enclosure, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown
- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Health Recommendation. If Health is not OK, this field shows recommended actions to take to resolve the health issue.
- Status.
- Enclosure ID.
- Vendor.
- Model.
- Number of Disks. The number of disks installed in the enclosure.
- Enclosure WWN.
- Midplane Serial Number.
- Part Number.
- Manufacturing Date.
- Manufacturing Location.
- Revision.
- EMP A Revision. Firmware revision of the Enclosure Management Processor in controller module A’s Expander Controller.
- EMP B Revision. Firmware revision of the Enclosure Management Processor in controller module B’s Expander Controller.
- EMP A Bus ID.
- EMP B Bus ID.

- EMP A Target ID.
- EMP B Target ID.
- Midplane Type.
- Enclosure Power (watts).
- PCIe 2-Capable. Shows whether the enclosure is capable of using PCIe version 2.

Drawer properties

For a 2U48 enclosure, each drawer and its disks are depicted from a side view, as you would see the disks when the drawer is open. For a more detailed view of the physical layout of disks in a 2U48 enclosure drawer, see the Setup Guide for your system.

When you select a drawer, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown
- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Health Recommendation. If Health is not OK, this field shows recommended actions to take to resolve the health issue.
- Status.
- Drawer ID.
- Drawer WWN.
- EMP A Revision. Firmware revision of the drawer’s Enclosure Management Processor for controller module A’s Expander Controller.
- EMP B Revision. Firmware revision of the drawer’s Enclosure Management Processor for controller module B’s Expander Controller.
- EMP A Bus ID.
- EMP B Bus ID.
- EMP A Target ID.
- EMP B Target ID.

Disk properties

When you select a disk and click the **Properties** tab, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A (if the disk is spun down)

  ? Unknown
- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Health Recommendation. If Health is not OK, this field shows recommended actions to take to resolve the health issue.
- Status.
  - Up: The disk is present and is properly communicating with the expander.
  - Spun Down: The disk is present and has been spun down by the DSD feature.
  - Warning: The disk is present but the system is having communication problems with the disk LED processor. For disk and midplane types where this processor also controls power to the disk, power-on failure will result in Error status.
  - Error: The disk is present but is not detected by the expander.
  - Unknown: Initial status when the disk is first detected or powered on.
  - Not Present: The disk slot indicates that no disk is present.

  For QXS-4/6 Series : For an SSD, the Front Tabular view also shows the percentage of disk life remaining from 100% to 0%. When the value decreases to 20%, event 502 is logged with Informational severity. Event 502 is logged again with Warning severity when the value decreases to 5%, 2%, and 0%.
- Enclosure ID.
- Slot.
- How Used.
  - AVAIL: Available.
  - FAILED: The disk is unusable and must be replaced. Reasons for this status include: excessive media errors; SMART error; disk hardware failure; unsupported disk.
  - GLOBAL SP: Global spare.
  - LEFTOVR: Leftover.
  - UNUSABLE: The disk cannot be used in a vdisk because the system is secured and the disk is not FDE-capable, or because the disk is locked to data access (for QXS-4/6 Series only).
  - VDISK: Used in a vdisk.

  - VDISK SP: Spare assigned to a vdisk.
- Type.
  - SAS: Enterprise SAS.
  - SAS MDL: Midline SAS.
  - sSAS: SAS SSD (for QXS-4/6 Series only).
- Vendor.
- Model.
- Size.
- Speed (kr/min).
- Transfer Rate. The data transfer rate in Gbit/s. Some 6-Gbit/s disks might not consistently support a 6-Gbit/s transfer rate. If this happens, the controller automatically adjusts transfers to those disks to 3 Gbit/s, increasing reliability and reducing error messages with little impact on system performance. This rate adjustment persists until the controller is restarted or power-cycled.
- Revision. Disk firmware revision number.
- Serial Number.
- Current Job.
  - DRSC: Disks in the vdisk are being scrubbed.
  - EXPD: The vdisk is being expanded.
  - INIT: The vdisk is being initialized.
  - RCON: The vdisk is being reconstructed.
  - VRFY: The vdisk is being verified.
  - VRSC: The vdisk is being scrubbed.
- SMART. Shows whether Self-Monitoring Analysis and Reporting Technology is enabled. For more information, see Configuring SMART on page 62.
- Current Owner. For the disk’s vdisk, either the preferred owner during normal operation or the partner controller when the preferred owner is offline.
- Drive Spin Down Count. How many times the disk has been spun down.
- Power On Hours. The total number of hours that the disk has been powered on since it was manufactured. This value is stored in disk metadata and is updated in 30-minute increments.
- Sector Format.
  - 512n (512-byte native sector size).
  - 512e (512-byte emulated sector size).
- SSD Life Remaining (for QXS-4/6 Series only).
  - For an SSD this property shows the percentage of disk life remaining, represented by a color-coded bar graph:

Life remaining	Bar color	Disk health
100–20%	🟩	OK
19–5%	🟦	OK
4–1%	🟨	Degraded
0%	(No bar)	Critical or Fault

When the value decreases to 20%, event 502 is logged with Informational severity. Event 502 is logged again with Warning severity when the value decreases to 5%, 2%, and 0%.

  - For a non-SSD this property shows N/A.

- FDE State (for QXS-4/6 Series only).
  - Not Secured: The disk is not secured.
  - Unknown: The FDE state is unknown.
  - Not FDE-Capable: The disk is not FDE-capable.
  - Secured, Unlocked: The system is secured and the disk is unlocked.
  - Secured, Locked: The system is secured and the disk is locked to data access, preventing its use.
  - FDE Protocol Failure: A temporary state that can occur while the system is securing the disk.

Disk performance

When you select a disk and click the **Performance** tab, a table shows eight graphs of historical performance statistics for the disk. Data samples are taken every quarter hour and the graphs represent up to 50 samples. By default, the graphs show the newest 50 samples.

To specify a time range of samples to display, set the start and end values and click **Update**. The system determines whether the number of samples in the time range exceeds the number of samples that can be displayed (50), requiring aggregation. To determine this, the system divides the number of samples in the specified time range by 50, giving a quotient and a remainder. If the quotient is 1, the 50 newest samples will be displayed. If the quotient exceeds 1, each “quotient” number of newest samples will be aggregated into one sample for display. The remainder is the number of oldest samples that will be excluded from display.

- Example 1: A 1-hour range includes 4 samples. 4 is less than 50 so all 4 samples are displayed.
- Example 2: A 15-hour range includes 60 samples. 60 divided by 50 gives a quotient of 1 and a remainder of 10. Therefore, the newest 50 samples will be displayed and the oldest 10 samples will be excluded.
- Example 3: A 30-hour range includes 120 samples. 120 divided by 50 gives a quotient of 2 and a remainder of 20. Therefore, each two newest samples will be aggregated into one sample for display and the oldest 20 samples will be excluded.

If aggregation is required, the system calculates values for the aggregated samples. For a count statistic (total data transferred, data read, data written, total I/Os, number of reads, number of writes), the samples’ values are added to produce the value of the aggregated sample. For a rate statistic (total data throughput, read throughput, write throughput, total IOPS, read IOPS, write IOPS), the samples' values are added and then are divided by their combined interval. The base unit for data throughput is bytes/s.

- Example 1: Two samples' number-of-reads values must be aggregated into one sample. If the value for sample 1 is 1060 and the value for sample 2 is 2000 then the value of the aggregated sample is 3060.
- Example 2: Continuing from example 1, each sample's interval is 900 seconds so their combined interval is
  1800 seconds. Their aggregate read-IOPs value is their aggregate number of reads (3060) divided by their combined interval (1800 seconds), which is 1.7.

The system will change the time settings to match the times of the oldest and newest samples displayed. The graphs are updated each time you click either the Performance tab or the Update button.

- Data Transferred. Shows the amounts of data read and written and the combined total over the sampling time period. The base unit is bytes.
- Data Throughput. Shows the rates at which data are read and written and the combined total over the sampling time period. The base unit is bytes/s.
- I/O. Shows the numbers of reads and writes and the combined total over the sampling time period.
- IOPS. Shows numbers of reads and writes per second and the combined total over the sampling time period.
- Average Response Time. Shows the average response times for reads and writes and the combined average over the sampling time period. The base unit is microseconds.
- Average I/O Size. Shows the average sizes of reads and writes and the combined average over the sampling time period. The base unit is bytes.
- Disk Error Counters. Shows the number of disk errors over the sampling time period.
- Average Queue Depth. Shows the average number of pending I/O operations that are being serviced over the sampling time period. This value represents periods of activity only and excludes periods of inactivity.

ℹ **Note:** If you specify a time range, it is recommended to specify a range of 12 hours or less.

To view summary performance data for a vdisk, use the Vdisk Overview panel as described on Viewing Information About a vdisk on page 138. To view live (non-historical) performance statistics for one or more disks, in the CLI use the `show disk-statistics` command.

Power supply properties

When you select a power supply, a table shows:

- Health.

  ✅ OK

  ⚠ Degraded

  ❌ Fault

  ? N/A

  ? Unknown

- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Health Recommendation. If Health is not OK, this field shows recommended actions to take to resolve the health issue.
- Status.
- Model.
- Vendor.
- Location.
- Serial Number.
- Revision.
- Part Number.
- Manufacturing Date.
- Manufacturing Location.

Fan properties

In a 4U56 enclosure when you select a fan, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown

- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Health Recommendation. If Health is not OK, this field shows recommended actions to take to resolve the health issue.
- Status.
- Location.
- Speed.
- Serial Number.
- Firmware Version.

- Hardware Version.

Controller module properties

When you select a controller module, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown
- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Health Recommendation. If Health is not OK, this field shows recommended actions to take to resolve the health issue.
- Status.
- Controller ID.
- Description.
- CPLD Version.
- Storage Controller Code Version.
- Model.
- Storage Controller CPU Type.
- Serial Number.
- Part Number.
- Position.
- Hardware Version.
- Revision.
- System Cache Memory (MB).
- Manufacturing Date.
- Manufacturing Location.

Controller module: network port properties

When you select a network port, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown
- Health Reason. If Health is not OK, this field shows the reason for the health state.
- MAC Address.
- Addressing Mode.
- IP Address.
- Gateway.
- Subnet Mask.

Controller module: FC host port properties

When you select an FC host port, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown
- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Status.
  - Up: The port is cabled and has an I/O link.
  - Warning: Not all of the port’s PHYs are up.
  - Error: The port is reporting an error condition.
  - Not Present: The controller module is not installed or is down.

  - Disconnected: Either no I/O link is detected or the port is not cabled.
- Ports. The port ID, which is the controller ID and port number.
- Media.
  - FC(L): Fibre Channel-Arbitrated Loop (public or private).
  - FC(P): Fibre Channel Point-to-Point.
  - FC(-): Fibre Channel disconnected.
- Target ID. The port WWN.
- **For QXS-4/6 Series** : Configured Speed. Auto, 4Gb, 8Gb, or 16Gb (Gbit/s).
- **For QXS-312/324** : Configured Speed. Auto, 4Gb, 8Gb, or 16Gb (Gbit/s).
- Actual Speed. Actual link speed in Gbit/s, or blank if not applicable.
- Configured Topology.
  - PTP: Fibre Channel Point-to-Point.
  - Loop: Fibre Channel-Arbitrated Loop (public or private).
- Primary Loop ID. Primary loop ID, or blank if not applicable.
- SFP Status.
  - OK
  - Not present: No SFP is inserted in this port.
  - Not compatible: The SFP in this port is not qualified for use in this system. When this condition is detected, event 464 is logged.
  - Incorrect protocol: The SFP protocol does not match the port protocol. When this condition is detected, event 464 is logged.
- Part Number. The SFP part number.
- Supported Speeds. The link speeds that the SFP supports, in Gbit/s.

Controller module: iSCSI host port properties

When you select an iSCSI host port, a table shows:

- Health.

  - ✅ OK
  - ⚠ Degraded
  - ❌ Fault
  - ? N/A
  - ? Unknown

- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Status.
  - Up: The port is cabled and has an I/O link.
  - Warning: Not all of the port’s PHYs are up.
  - Error: The port is reporting an error condition.
  - Not Present: The controller module is not installed or is down.
  - Disconnected: Either no I/O link is detected or the port is not cabled.
- Ports. The port ID, which is the controller ID and port number.
- Media. iSCSI.
- Target ID. The port IQN.
- Configured Speed. Auto: the link speed is auto-negotiated.
- Actual Speed. Actual link speed in Gbit/s, or blank if not applicable.
- IP Version. The IP version: IPv4 or IPv6.
- MAC. The port’s MAC address.
- IP Address. For IPv4 or IPv6, assigned port IP address.
- Netmask. For IPv4, subnet mask for assigned port IP address.
- Gateway. For IPv4, gateway for assigned port IP address.
- Default Router. For IPv6, default router for assigned port IP address.
- Link-Local Address. For IPv6, the link-local address that is automatically generated from the MAC address and assigned to the port.
- SFP Status.
  - OK
  - Not present: No SFP is inserted in this port.
  - Not compatible: The SFP in this port is not qualified for use in this system. When this condition is detected, event 464 is logged.
  - Incorrect protocol: The SFP protocol does not match the port protocol. When this condition is detected, event 464 is logged.
- 10G Compliance. The SFP’s 10G compliance code, if supported.

- Cable Length. The link length (in meters) that is supported by the SFP while operating in compliance with applicable standards for the cable type, or 0 if this information is not provided by the SFP manufacturer.
- Cable Technology. Shows whether the SFP supports active or passive cable technology, or N/A if this information is not provided by the SFP manufacturer.
- Ethernet Compliance. The SFP’s Ethernet compliance code, if supported.
- Part Number. The SFP part number.

Controller module: SAS host port properties

For QXS-312/324 : The SAS fan-out cable capability is only applicable to systems with a 2-port SAS controller module. If fan-out cables are connected to SAS ports that are configured to use them, fan-out cable icons appear between the depicted SAS ports. The number of SAS ports that display depends on the configuration.

When you select a SAS host port, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown

- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Health Recommendation. If Health is not OK, this field shows recommended actions to take to resolve the health issue.
- Status.
  - Up: The port is cabled and has an I/O link.
  - Warning: Not all of the port’s PHYs are up.
  - Error: The port is reporting an error condition.
  - Not Present: The controller module is not installed or is down.
  - Disconnected: Either no I/O link is detected or the port is not cabled.
- Ports. The port ID, which is the controller ID and port number.
- Media. SAS.
- Target ID. The port WWN.

- Configured Speed. Blank: not applicable for SAS.
- Actual Speed. Auto: the link speed is auto-negotiated.
- Lanes Expected. The expected number of PHY lanes in the SAS port.
- Active Lanes. The number of active lanes in the SAS port. If the port is connected and fewer lanes are active than are expected, the port status will change to Warning, the health will change to Degraded, and event 354 will be logged. If the port is disconnected, the value will be 0.
- Num Ports Per Connector. The number of host ports per controller host-port connector. This reflects whether the system is set to use fan-out SAS cables or standard SAS cables. (for QXS-312/324 only).
  - 1: The system is set to use standard SAS cables.
  - 2: The system is set to use fan-out SAS cables.

Controller module: expansion port properties

When you select an expansion (Out) port, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown
- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Health Recommendation. If Health is not OK, this field shows recommended actions to take to resolve the health issue.
- Status.
- Name.

Controller module: CompactFlash properties

When you select a CompactFlash card in the Rear Tabular view, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown

- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Health Recommendation. If Health is not OK, this field shows recommended actions to take to resolve the health issue.
- Status.
- Cache Flush.
  - Enabled: If the controller loses power, it will automatically write cache data to the CompactFlash card. Cache flush is normally enabled, but is temporarily disabled during controller shut down.
  - Disabled: Cache flush is disabled.

Drive enclosure: I/O module properties

When you select an I/O module, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown
- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Status.
- Controller ID.

I/O module: In port properties

When you select an In port, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown

- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Health Recommendation. If Health is not OK, this field shows recommended actions to take to resolve the health issue.
- Status.
- Name.

I/O module: Out port properties

When you select an Out port, a table shows:

- Health.

  ✓ OK

  ⚠ Degraded

  ✖ Fault

  ? N/A

  ? Unknown

- Health Reason. If Health is not OK, this field shows the reason for the health state.
- Health Recommendation. If Health is not OK, this field shows recommended actions to take to resolve the health issue.
- Status.
- Name.

Viewing information about a remote system

In the Configuration View panel, right-click a remote system and select **View > Overview**. The System Information table shows:

- The username and network-port IP addresses that are configured on the local system to access the remote system. The configured password is not shown.
- Information such as the system name, location, and status that is read from the remote system.

To sign in to the remote system, click one of its IP address links.

Chapter 6: Using AssuredRemote to Replicate Volumes

This chapter contains the following topics:

About the AssuredRemote Replication Feature

AssuredRemote™ is a licensed feature for disaster recovery. This feature performs asynchronous (batch) replication of block-level data from a volume on a local storage system to a volume that can be on the same system or on a second, independent system. This second system can be located at the same site as the first system or at a different site.

A typical replication configuration involves these physical and logical components:

- A host connected to a local storage system, which is networked via FC or iSCSI ports to a remote storage system as described in installation documentation.
- *Remote system*. A management object on the local system that enables the MCs in the local system and in the remote system to communicate and exchange data.
- *Replication set*. Associated master volumes that are enabled for replication and that typically reside in two physically or geographically separate storage systems. These volumes are also called replication volumes.
- *Primary volume*. The volume that is the source of data in a replication set and that can be mapped to hosts. For disaster recovery purposes, if the primary volume goes offline, a secondary volume can be designated as the primary volume. The primary volume exists in a primary vdisk in the primary system.
- *Secondary volume*. The volume that is the destination for data in a replication set and that is not accessible to hosts. For disaster recovery purposes, if the primary volume goes offline, a secondary volume can be designated as the primary volume. The secondary volume exists in a secondary vdisk in a secondary system.
- *Replication snapshot*. A special type of snapshot that preserves the state of data of a replication set's primary volume as it existed when the snapshot was created. For a primary volume, the replication process creates a replication snapshot on both the primary system and, when the replication of primary-volume data to the secondary volume is complete, on the secondary system. Replication snapshots are unmappable and are not counted toward a license limit, although they are counted toward the system's maximum number of volumes. A replication snapshot can be exported to a regular, licensed snapshot.
- *Replication image*. A conceptual term for replication snapshots that have the same image ID in the primary and secondary systems. These synchronized snapshots contain identical data and can be used for disaster recovery.

Replication process overview

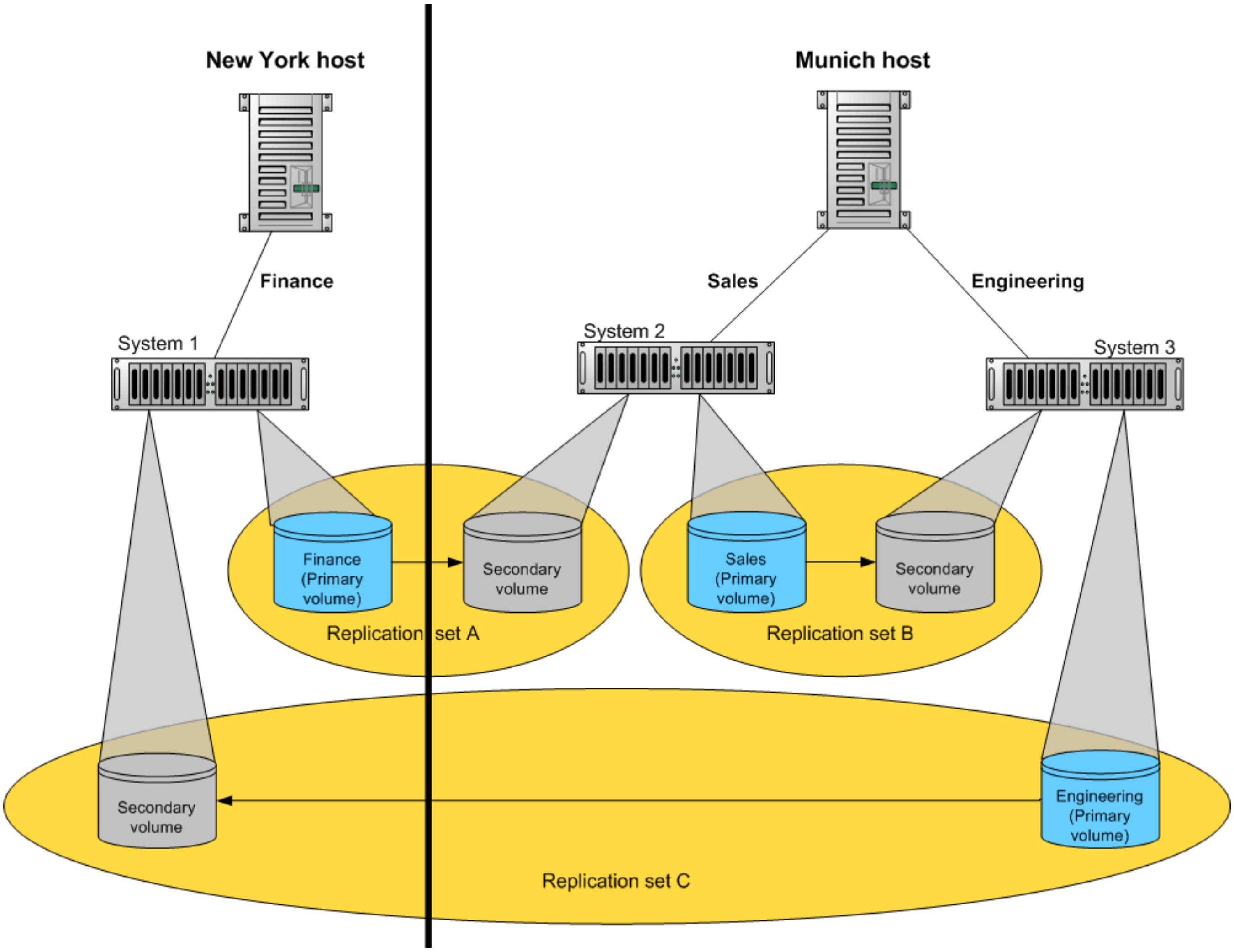
As a simplified overview of the remote-replication process, it can be configured to provide a single point-in-time replication of volume data or a periodic delta-update replication of volume data.

The periodic-update process has multiple steps. At each step, matching snapshots are created: in the primary system, a replication snapshot is created of the primary volume's current data. This snapshot is then used to copy new (delta) data from the primary volume to the secondary volume. Then in the secondary system, a matching snapshot is created for the updated secondary volume. This pair of matching snapshots establishes a replication sync point and these sync points are used to continue the replication process.

The following figure illustrates three replication sets in use by two hosts:

- The host in New York is mapped to and updates the Finance volume. This volume is replicated to the system in Munich.
- The host in Munich is mapped to and updates the Sales and Engineering volumes. The Sales volume is replicated from System 2 to System 3 in the Munich data center. The Engineering volume is replicated from System 3 in Munich to System 1 in New York.

Figure 13: Intersite and intrasite replication sets



Remote replication uses snapshot functionality to track the data to be replicated and to determine the differences in data updated on the master volume, minimizing the amount of data to be transferred.

In order to perform a replication, a snapshot of the primary volume is taken, creating a point-in-time image of the data. This point-in-time image is then replicated to the secondary volume by copying the data represented by the snapshot using a transport medium such as TCP/IP (iSCSI) or Fibre Channel. The first replication copies all data from the primary volume to the secondary volume. Subsequent replications use sparse snapshots. A sparse snapshot stores only those blocks that are different from an already existing full copy of the data.

Replication snapshots are retained for both the primary volume and the secondary volume. When a matching pair of snapshots is retained for both volumes, the matching snapshots are referred to as *replication sync points*. The two snapshots (one on each volume) are used together as a synchronization reference point, minimizing the amount of data to transfer. The two snapshots in a replication sync point are assigned the same *image ID*, which uniquely identifies that the data in those snapshots are from the same point-in-time image and are block-for-block identical.

When a replication snapshot is created from a standard snapshot, while that snapshot remains present the replication snapshot's total data represented is zero bytes. This behavior occurs because the snapshot data remains associated with the standard snapshot and there is no data specifically associated with the replication snapshot. If the standard snapshot is deleted, its data becomes associated with (is preserved by) the replication snapshot and the replication snapshot's size changes to reflect the size of the deleted snapshot.

An added benefit of using snapshots for replication is that these snapshots can be kept and restored later in the event of a non-hardware failure, such as virus attack. Since the replication source is a snapshot, any writes performed on the primary volume after the snapshot is taken are not replicated by that task. This gives you more control over what is contained in each replication image.

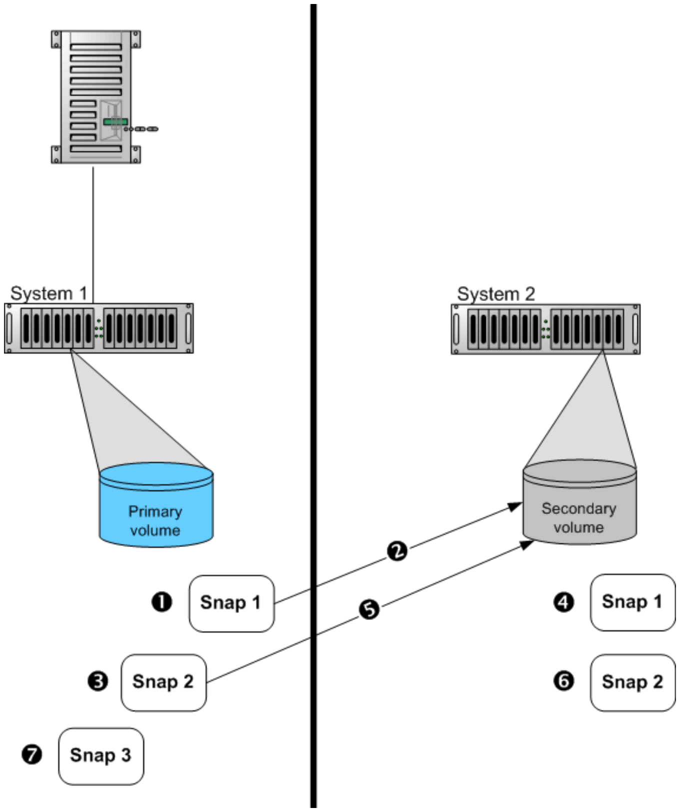
Note: Because replication is not synchronous (continuous), data in a secondary volume is only as current as the last replication that completed successfully. Replications can be performed manually or scheduled.

Note: Snapshot operations are I/O-intensive. Every write to a unique location in a master volume after a snapshot is taken will cause an internal read and write operation to occur in order to preserve the snapshot data. If you intend to create snapshots of, create volume copies of, or replicate volumes in a vdisk, ensure that the vdisk contains no more than four master volumes, snap pools, or both. For example: 2 master volumes and 2 snap pools; 3 master volumes and 1 snap pool; 4 master volumes and 0 snap pools.

Replication Actions

The following figure illustrates actions that occur during a series of replications from System 1 to System 2.

Figure 14: Actions that occur during a series of replications



1. **Take initial snapshot and initiate replication**
2. **Initial replication consists of a full data copy**
3. **Take second snapshot and request replication. This can be taken while the initial replication is in progress.**
4. **Snapshot taken on secondary volume. This is the first replication sync point.**
5. **When the initial replication is complete, the second replication automatically starts. Only the data changed since Snap 1 is replicated.**
6. **Second snapshot taken on secondary volume. This is the second sync point.**
7. **Other snapshots can be taken and replication initiated on the primary volume while replication is in progress. These snapshots are queued waiting for prior replications to complete. These replication snapshots will not become sync points until their replications are complete.**

The figure above illustrates initial, delta, and queued replications:

- Initial replication: When the first replication is initiated, a snapshot of the primary volume is taken and every block of data is then copied to the secondary volume. When the copy is complete, the first snapshot is taken on the secondary volume, creating the first sync point. This sync point can be used to determine the delta data from that sync point to a later snapshot. Actions 1–4 are the initial replication.

- Delta replications: Delta data is the “list” of 64-KB blocks that differs between the last snapshot replicated and the next snapshot to be replicated. This delta data is then replicated from the replication snapshot on the primary volume to the secondary volume. Once the initial replication has completed, all future replications for that replication set will be delta replications so long as sync points are maintained. Action 5 is a delta replication.
- Queued replications: New replications can be initiated while other replication snapshots are in the process of being replicated. This enables you to take snapshots at specific intervals while other replications are ongoing. Note that a replication that is initiated while another to the same secondary volume is ongoing will be queued, and will not begin to transfer data until the prior one completes. In action 3, Snap 2 is queued while Snap 1 is being replicated. In action 7, Snap 3 is queued while Snap 2 is being replicated.

An in-progress replication can be suspended, either manually by a user or automatically if a network error occurs. If you want the replication to continue, you must manually resume it. If you want to cancel the replication, you can abort it.

Caution: For a replication to begin, the controller that owns the secondary volume must have a link to the controller that owns the primary volume. This link must be of the type specified by the link-type parameter supplied during replication set creation or modification. If all links to the controller that owns the primary volume fail, but links remain between its partner controller and the controller that owns the secondary volume, replications currently in progress or queued may continue, but their progress may not be reported correctly. If the controller that owns the secondary volume loses all links to both controllers of the primary system, then the replications will suspend and progress will be updated appropriately. Links from the partner controller of the controller that owns the secondary volumes are not considered for use. Replications that enter the suspended state must be resumed manually.

Performing initial replication locally or remotely

When you set up replication for a volume, you specify to use a secondary volume in a vdisk in either the local (primary) system or a remote (secondary) system. Local replication is allowed only if the primary and secondary volumes are in vdisks owned by different controllers.

- If the speed of the initial replication is most important, replicate locally. In the local system, specify a vdisk owned by a different controller than the one that owns the primary volume's vdisk in the same system.

  After replication is set up, you can perform the initial replication and then physically move the vdisk containing the secondary volume and its snap pool into a remote system. Moving a vdisk involves using the Disk Management Utility (V2) to detach the secondary volume and stop its vdisk, removing the vdisk’s disks or enclosure, transporting the disks or enclosure to the remote location, inserting the disks or enclosure into the remote system, and using the Disk Management Utility (V2) to restart the vdisk and reattach the secondary volume. If the secondary volume’s snap pool is in a different vdisk then that vdisk must also be stopped, moved, and restarted.
- If ease of setup is most important, replicate remotely. Specify a vdisk owned by either controller in a remote system. After replication is set up, you can start replication.
- A third method is to physically co-locate the primary and secondary systems, set up and perform the initial replication, and then move the secondary system to the remote site. Ensure that the local system can communicate over the network with the remote system at its new location.

In either case, you must specify the link type to be used for replication between the primary and secondary systems and you cannot change this setting for the life of the replication set.

You can only select a vdisk that has enough available space for replication. For details, see the following topic.

Criteria for selecting a vdisk to contain a secondary volume

When setting up replication for a volume that will become the primary volume in a replication set, you have the option to select an existing vdisk in which to create the secondary volume.

The vdisk-selection option only lists vdisks that have sufficient available space for replication, and that do not contain a volume with a conflicting name (`rprimary-volume-name`) or a snap pool with a conflicting name (`sprprimary-volume-name`). The system calculates the required space for the secondary volume (the reserve size) and its snap pool as follows:

- The snap-pool size will be either 20% of the primary volume's size or 5.37GB, whichever is larger.
- The reserve size is calculated as follows:
  - If the primary volume and the snap pool are each less than 500 GB, the reserve will be the same size as the primary volume.
  - If the primary volume is larger than 500 GB, the reserve size will be the maximum, 500 GB.
  - If the snap pool is larger than 500 GB, the reserve will be the same size as the snap pool.
- The required space in the vdisk is calculated as follows:
  - If the combined size of the primary volume and the reserve is less than the combined size of the primary volume and the snap pool, the required space is the combined size of the primary volume and the snap pool.
  - If the combined size of the primary volume and the reserve is larger than the combined size of the primary volume and the snap pool, the required space is the combined size of the primary volume and the reserve.

The following table shows examples of how much available space a vdisk must have in order to be shown by the vdisk option. If you want to replicate a volume whose size is not shown, you can use the above calculations to determine how much available space the secondary vdisk must have.

Table 14: Available space required for a vdisk to be selectable to contain a secondary volume (v2)

Primary volume size (GB)	Available space required in vdisk (GB)	Primary volume size (GB)	Available space required in vdisk (GB)	Primary volume size (GB)	Available space required in vdisk (GB)
100	200	1100	1600	2100	2600
200	400	1200	1700	2200	2700

Primary volume size (GB)	Available space required in vdisk (GB)	Primary volume size (GB)	Available space required in vdisk (GB)	Primary volume size (GB)	Available space required in vdisk (GB)
300	600	1300	1800	2300	2800
400	800	1400	1900	2400	2900
500	1000	1500	2000	2500	3000
600	1100	1600	2100	2600	3120
700	1200	1700	2200	2700	3240
800	1300	1800	2300	2800	3360
900	1400	1900	2400	2900	3480
1000	1500	2000	2500	3000	3600

Remote replication disaster recovery

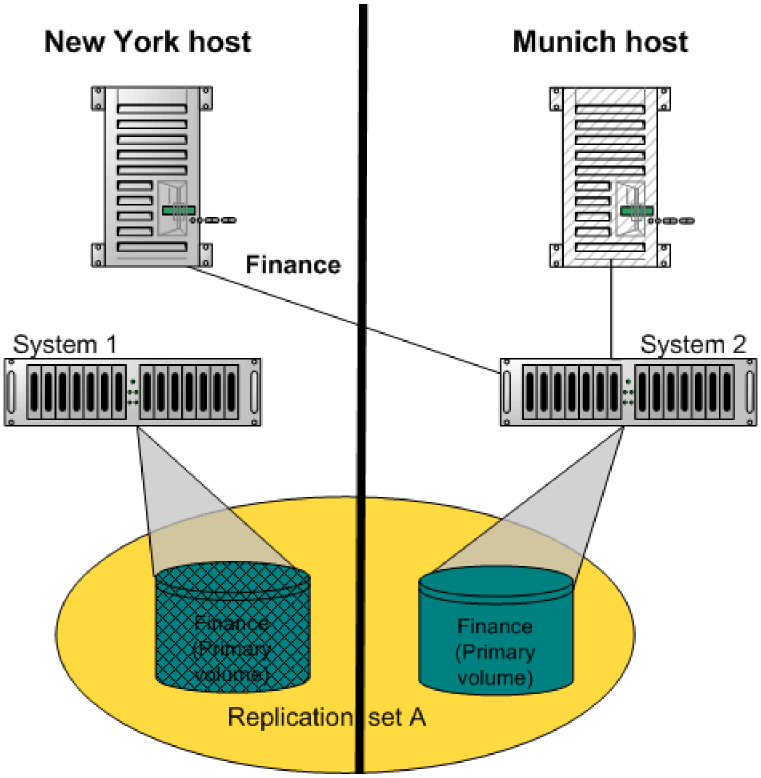
Replication can continue in the event of system faults such as:

- Temporary communication failure. Remote replication will retry replication operations according to user-configured policies.
- Controller failure. In a dual-controller system, failover will occur and the surviving controller will take over replication processing until controller recovery occurs.
- Disk or power supply failure.

If a disaster causes the primary volume to become inaccessible, you can set the secondary volume to be the primary volume so that volume can be mapped to hosts. Disaster recovery requires user intervention because decisions must be made based on the data content of replication volumes and their snapshots.

1. Synchronize the secondary volume to a replication snapshot, preferably a replication sync point. Any data written to the primary volume since the last-completed replication will not be available.
2. After synchronization, set the secondary volume to be the new primary volume.
3. Map the new primary volume to hosts, as was the original primary volume.

Figure 15: Example of primary-volume failure



If the original primary volume becomes accessible, you can set it to be the primary volume again as described in the following process overview:

1. Take a snapshot of the original primary volume. This preserves the volume's current data state for later comparison with the new primary volume.
2. Remove the volume's mappings.
3. Set the original primary volume to be a secondary volume.
4. Replicate any data written to the new primary volume to the original primary volume (now a secondary volume). This can be done as one or more replications. On the final replication, halt host access to the primary volume to ensure that all data has been transferred to the secondary volume.
5. Set the secondary volume (the original primary volume) to be the new primary volume.
6. You can now mount/present/map the snapshot taken in Step 1 and compare it with the new primary volume to identify any data discrepancies and try to recover any data from the snapshot that would otherwise be lost. For example, you could use host file-system tools to find any files modified since a certain time, or for a database you could export any differing records from the snapshot and re-enter them into the current database.

For details, see the procedure to change the primary volume back to the original primary volume in Changing the primary volume for a replication set on page 191.

Remote Replication Licensing

The AssuredRemote and AssuredSnap features are separately licensed. AssuredRemote can operate without AssuredSnap being enabled. However, to get the most out of AssuredRemote, it is recommended to enable both features. Normally, replication snapshots are not accessible to hosts. However, if AssuredSnap is enabled, a replication snapshot can be exported for use as a standard snapshot and will count toward the snapshot license limit.

Using the Replication Setup Wizard

If the system is licensed to use remote replication, you can use the Replication Setup Wizard to prepare to replicate an existing volume to another vdisk in the local system or to a remote system. Before using this wizard, read the documentation for your product to learn about replication. Then plan the storage systems, replication mode, and volumes you want to use for the replication.

The wizard guides you through the following steps. For each step you can view help by clicking the help icon ? in the wizard panel. As you complete steps they are highlighted at the bottom of the panel. If you cancel the wizard at any point, no changes are made.

- Select the primary volume, which is an existing volume or snapshot to replicate.
- Specify whether the replication mode will be local or remote. If the replication will be to a remote system that has not already been added to the local system, you can add it. To do so, you must know the user name and password of a user with the Manage role on that system and the system's IP address.
- Specify the secondary volume. You can select an existing replication-prepared volume or specify to create a volume in an existing vdisk that has sufficient available space for the replicated data.
- Confirm changes and apply them.

⚠ **Caution:** Before starting this procedure, if you intend to use CHAP to authenticate iSCSI login requests between the local system and a remote system, do the following:

- Create a one-way CHAP record on each system. On the local system, the CHAP record must refer to the node name of the remote system. On the remote system, the CHAP record must refer to the node name of the local system. Both records must use the same secret. (Mutual CHAP is not used between storage systems. CHAP records' mutual fields can be set but are not used.) To create a CHAP record, see Configuring CHAP on page 104.
- After the CHAP records are created, enable CHAP on the primary system, the secondary system, or both. To enable CHAP, see Changing Host Interface Settings on page 58.

If both records don't exist or don't use the same secret, replication-set creation will fail.

⚠ **Caution:** Enabling or disabling CHAP will cause all iSCSI host ports in the system to be reset and restarted. This may prevent iSCSI hosts from being able to reconnect if their CHAP settings are incorrect.

Step 1: Starting the wizard

1. In the Configuration View panel, right-click the system and select **Wizards > Replication Setup Wizard**. The wizard panel appears.
2. Click **Next** to continue.

Step 2: Selecting the primary volume

Select the volume whose data you want to replicate. If the volume has at least one snapshot, you can select a snapshot to be the replication source.

To select the primary volume

1. Set the options:
   - Select the vdisk that contains the volume to replicate. Only vdisks that contain at least one volume are listed for selection.
   - Select the volume to replicate. Only volumes that are not already part of a replication set are listed for selection.
2. Click **Next** to continue.

Step 3: Selecting the replication mode

Select the replication mode, which specifies whether the replication destination is in the local system or a remote system. If you want to replicate to a remote system that hasn't already been added to the local system, you can add it. Local replication is allowed only if the primary and secondary volumes are in vdisks owned by different controllers.

To replicate within the local system

1. Select **Local Replication**.
2. Although it is recommended to check host-port links between controllers in the local system, if you already know the status of links you can clear the **Check Links** check box to skip this task.
3. Click **Next** to continue. If Check Links is selected and there are no links between the controllers, a message appears, and only vdisks and volumes that are owned by the same controller as the primary volume will appear in the next step.

To replicate to a remote system

1. Select **Remote Replication**.
2. In the Remote System list, look for the remote system that you want to use.
   - If you find the system, select it and continue with Step 5.
   - If you don't find it, add it as described in Step 3.
3. To add a remote system, in the Add new Remote System area:

   a. Enter the IP address of a network port on the remote system.

   b. Enter the user name of a user with a Manage role on the remote system.

   c. Enter that user's password.

   d. Click **Add Remote System**. If task succeeds, the new remote system appears in the Remote System list and is selected.

4. Although it is recommended to check host-port links between the two systems, this can take up to 3 minutes, so if you already know the status of links you can clear the **Check Links** check box to skip this task.

5. Click **Next** to continue. If Check Links is selected and there are no links to the remote system, a message appears and you cannot proceed. For a CNC system, if only one link type is up, only that link type will appear in the next step.

Step 4: Selecting the secondary volume

Specify the secondary volume. You can either select an existing vdisk in which to create the secondary volume, or select an existing replication-prepared volume to be the secondary volume.

To specify the secondary volume

1. Either:

   - Select **Create new volume on vdisk** and select an existing vdisk in which to create the secondary volume. For an explanation of the criteria that determines which vdisks are listed for selection, see Criteria for selecting a vdisk to contain a secondary volume on page 176.

   - Select **Use existing replication-prepared volume** and select an existing replication-prepared volume to be the secondary volume. Only replication-prepared volumes that are exactly the same size in blocks as the primary volume are listed for selection.

2. Select the link type used between the two systems.

3. Click **Next** to continue.

Step 5: Confirming replication settings

Confirm that the values listed in the wizard panel are correct.

- If they are not correct, click **Previous** to return to previous steps and make necessary changes.
- If they are correct, click **Finish** to apply the setting changes and finish the wizard.

Replicating a volume

If the system is licensed to use remote replication, you can create a replication set that uses the selected volume as the primary volume, and to immediately start or schedule replication. The primary volume can be a standard volume or a master volume.

To create a replication set you must select a secondary system and a secondary vdisk or volume. The secondary system can be the local system, or a remote system added by using the Add Remote System panel. When using the Disk Management Utility (V2) it is recommended to select a secondary vdisk and let the secondary volume be created automatically, instead of selecting an existing secondary volume. For a secondary (replication-prepared) volume to be available for selection, it must be exactly the same size in blocks as the primary volume, and that is difficult to ensure, especially with maximum-size volumes.

You can select the local system if you intend to create the replication set on the local system and then physically move the secondary vdisk's disks (or enclosure) to a remote system. Otherwise, select a remote system for which you've already added a management object on the local system. Local replication is allowed only if the primary and secondary volumes are in vdisks owned by different controllers.

Note: A best practice is to schedule no more than three volumes to start replicating at the same time, and for those replications to recur no less than 60 minutes apart. If you schedule more replications to start at the same time, or schedule replications to start more frequently, some scheduled replications may not have time to complete.

Caution: Before starting this procedure, if you intend to use CHAP to authenticate iSCSI login requests between the local system and a remote system, do the following:

- Create a one-way CHAP record on each system. On the local system, the CHAP record must refer to the node name of the remote system. On the remote system, the CHAP record must refer to the node name of the local system. Both records must use the same secret. (Mutual CHAP is not used between storage systems. CHAP records' mutual fields can be set but are not used.) To create a CHAP record, see Configuring CHAP on page 104.
- After the CHAP records are created, enable CHAP on the primary system, the secondary system, or both. To enable CHAP, see Changing Host Interface Settings on page 58.

If both records don't exist or don't use the same secret, replication-set creation will fail.

Caution: Enabling or disabling CHAP will cause all iSCSI host ports in the system to be reset and restarted. This may prevent iSCSI hosts from being able to reconnect if their CHAP settings are incorrect.

Note: If replication requests are sent to a secondary system whose temporary replication license has expired, the requests are queued but are not processed, and the secondary system reports event 472. If this condition occurs, check for this event in the event log, event-notification emails, and SNMP traps. To continue using replication, purchase a permanent replication license.

To create a replication set and optionally start or schedule replication

1. In the Configuration View panel, right-click a volume and select **Provisioning > Replicate Volume**.
2. In the main panel, set the destination options:

- Secondary System. Select a storage system to replicate the volume to.
- Secondary Volume. Select either an existing vdisk in which to create the secondary volume, or an existing replication-prepared volume to be the secondary volume. For an explanation of the criteria that determines which vdisks are listed for selection, see Criteria for selecting a vdisk to contain a secondary volume on page 176.

3. Select the link type used between the two systems.
4. If you want to start replication now:
   a. Select the **Initiate Replication** and **Now** options.
   b. Optionally change the default replication image name. A name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in a vdisk or include the following: " , < \
   c. Continue with Step 7.
5. If you want to schedule replication:
   a. Select the **Initiate Replication** and **Scheduled** options.
   b. Set the options:
      - Replication image prefix. Optionally change the default prefix to identify images created by this schedule. The prefix is case sensitive and can have a maximum of 26 bytes. It cannot already exist in a vdisk or include the following: " , < \
      - Replication Mode. Specifies whether to replicate a new snapshot of the volume to the remote system, or to replicate the last (most recent existing) snapshot of the volume to the remote system.
      - Replication images to Retain. Select the number of replication images to retain for both the primary volume and the secondary volume. When the task runs, the retention count is compared with the number of existing replication images:

      Whether the retention count has been reached or not, a new replication image is created.

      If the retention count has been reached, the volume’s oldest replication image that was created by this schedule and is neither being replicated, nor a current sync point, nor a queued snapshot, is deleted.

      If there is more than one queued snapshot, only the oldest queued snapshot is retained. It is retained to serve as the source for the next scheduled replication to create a replication image from.

      - Start Schedule. Specify a date and a time in the future to be the first instance when the scheduled task will run, and to be the starting point for any specified recurrence. Date must use the format *yyyy-mm-dd*. Time must use the format *hh*:*mm* followed by either AM, PM, or 24H (24-hour clock). For example, 13:00 24H is the same as 1:00 PM.
      - Recurrence. Specify either One Time, which schedules a single instance, or the interval at which the schedule should run.
      - Time Constraint. Specify either No Time Constraint, which allows the schedule to run at any time, or a time range within which the schedule should run.

    - Date Constraint. Specify either No Date Constraint, which allows the schedule to run on any day, or days when the schedule should run. Ensure that this constraint includes the Start Schedule date.
    - End Schedule. Specify either Continuous, which allows the schedule to run without an end date, or when the schedule should stop running.

   c. Continue with Step 7.

6. If you do not want to start or schedule replication, clear the **Initiate Replication** check box. The replication set will still be created and you can replicate the volume at a later time.
7. Click **Apply**. Within a couple of minutes, the replication set is created and the following changes occur in the Configuration View panel:
    - Under the primary vdisk:
        - The selected primary volume changes to a master volume, and is designated as a Primary Volume.
        - If the secondary volume is on a remote system, the secondary volume appears under the primary volume.
        - If a replication was performed, under both the primary volume and the secondary volume a replication image appears.
        - If not already present, the primary volume’s snap pool appears.
    - Under the secondary vdisk:
        - The secondary volume appears.
        - If the primary volume is on a remote system, the primary volume appears under the secondary volume.
        - If a replication was performed, under both the primary volume and the secondary volume a replication image appears.
        - If not already present, the secondary volume’s snap pool appears.

Replicating a snapshot

If the system is licensed to use remote replication, you can replicate an existing, primary snapshot that is mapped to a host. You can only replicate a snapshot of a volume that is already part of a replication set.

If the selected snapshot hasn’t already been replicated to a secondary volume, each replication volume in the replication set is requested to replicate the snapshot data. Only snapshot preserved data is replicated. Snapshot modified data is not replicated.

To replicate a snapshot

1. In the Configuration View panel, right-click a snapshot and select **Provisioning > Replicate Snapshot**.

2. In the main panel, optionally change the default replication image name. A name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in a vdisk or include the following: " , < \
3. Click **Initiate Replication**. A message indicates whether the task succeeded or failed.
4. Click **OK**. After a few seconds, in the Configuration View panel, under both the primary volume and the secondary volume, a replication image appears.

Removing replication from a volume

If the system is licensed to use remote replication and you no longer want to replicate a volume, you can remove its replication set. When a replication set is removed:

- A rollback is automatically performed to the latest available snapshot on the secondary volume to ensure that data is consistent.
- Replication volumes associated with the replication set are converted to master volumes.
- Any replication images associated with the replication volumes are converted to standard snapshots. Snapshots are converted regardless of the number of snapshots allowed by the system’s license.
- There is no longer a relationship between the volumes or their snapshots in the two vdisks.

To remove replication from a volume

1. In the Configuration View panel, right-click a local primary volume and select **Provisioning > Remove Replication Set**.
2. In the main panel, click **Remove Replication Set**. A confirmation dialog appears.
3. Click **Remove** to continue. Otherwise, click **Cancel**. If you clicked Remove, a processing dialog appears. A message indicates whether the task succeeded or failed.
4. Click **OK**. If the task succeeded, the following changes occur in the Configuration View panel:
    - Under the primary vdisk:
        - The primary volume’s designation is changed from Primary Volume to Volume
        - The secondary volume is removed
        - Any replication images are replaced by snapshots
    - Under the secondary vdisk:
        - The secondary volume’s designation is changed from Secondary Volume to Volume
        - The primary volume is removed
        - Any replication images are replaced by snapshots

Note: Normally, if you want to remove a replication set you must select its primary volume. However, if the primary volume is inaccessible, you can set the secondary volume to be the primary volume (as described in Changing the primary volume for a replication set on page 191) and then perform a Remove Replication Set operation.

Suspending a replication

If the system is licensed to use remote replication, you can suspend the current replication operation for a selected a replication volume. You must perform this task on the system that owns the secondary volume. Once suspended, the replication must be resumed or aborted to allow the replication volume to resume normal operation.

To suspend replication

1. In the Configuration View panel, right-click a local replication volume and select **Provisioning > Suspend Replication**.
2. In the main panel, click **Suspend Replication**. A message indicates whether the task succeeded or failed.
3. Click **OK**.

Resuming a suspended replication

If the system is licensed to use remote replication, you can resume a suspended replication operation for a selected replication volume. You must perform this task on the system that owns the secondary volume.

To resume replication

1. In the Configuration View panel, right-click a local replication volume and select **Resume Replication**.
2. In the main panel, click **Resume Replication**. A message indicates whether the task succeeded or failed.
3. Click **OK**.

Aborting Replication

If the system is licensed to use remote replication, you can abort the current replication operation for the selected replication volume. The current replication may be running or suspended. You must perform this task on the system that owns the secondary volume.

To abort replication

1. In the Configuration View panel, right-click a local replication volume and select **Provisioning > Abort Replication**.
2. In the main panel, click **Abort Replication**. A message indicates whether the task succeeded or failed.
3. Click **OK**.

Detaching a secondary volume

When using the replication feature, if you chose to create a replication set's primary and secondary volumes in the primary system, you can perform the initial replication and then physically move the secondary volume's vdisk into the secondary system.

The process to move a secondary volume is:

1. In the system where the secondary volume resides:
    a. Detach the secondary volume.
    b. If the secondary volume's vdisk contains other secondary volumes, detach those volumes.
    c. Stop the secondary volume's vdisk. For details see Stopping a vdisk on the next page.
    d. If the secondary volumes' snap pools are in other vdisks, stop those vdisks.
    e. Move the vdisks into the secondary system. This system must support the link type that the replication set is configured to use. For example, if the replication set's link type is configured to use FC links, the secondary system must have FC ports.
2. In the secondary system:
    a. Start the snap pools' vdisks. For details see Starting a vdisk on page 189.
    b. Start the secondary volumes' vdisks.
    c. Reattach the secondary volumes. For details see Reattaching a secondary volume on page 190.

Detached volumes remain associated with their replication sets but are not updated with replication data or with replication control information.

Note:
-It is recommended that the vdisk that you are moving contains only secondary volumes and their snap pools. You are allowed to move other volumes along with secondary volumes and their snap pools, but be sure that you are doing so intentionally.
-If you intend to move a vdisk's enclosure and you want to allow I/O to continue to the other enclosures, it is best if it is at the end of the chain of connected enclosures. If the enclosure is in the middle of the chain, the enclosures must be cabled with no single point of failure, so that removing the enclosure does not prevent communication between other enclosures.

To detach a secondary volume

1. In the Configuration View panel, right-click the secondary volume and select **Provisioning > Detach Replication Volume**.
2. In the main panel, click **Detach Replication Volume**. A message indicates whether the task succeeded or failed.
3. Click **OK**. When a volume is detached its status is shown as Detached.

Stopping a vdisk

Stopping a vdisk is part of the process for moving a secondary volume into a secondary system.

To move a secondary volume

1. In the system where the secondary volume resides:
   a. Detach the secondary volume. For details see Detaching a secondary volume on the previous page.
   b. If the secondary volume's vdisk contains other secondary volumes, detach those volumes.
   c. Stop the secondary volume's vdisk.
   d. If the secondary volumes' snap pools are in other vdisks, stop those vdisks.
   e. Move the vdisks into the secondary system. This system must support the link type that the replication set is configured to use. For example, if the replication set's link type is configured to use FC links, the secondary system must have FC ports.
2. In the secondary system:
   a. Start the snap pools' vdisks. For details see Starting a vdisk on the next page.
   b. Start the secondary volumes' vdisks.
   c. Reattach the secondary volumes. For details see Reattaching a secondary volume on page 190.

Before stopping a vdisk, ensure that all secondary volumes that it contains are detached. When a vdisk is stopped:

- The volumes in the vdisk become inaccessible to hosts.
- Its cached data is flushed to disk.
- Removing its disks will not cause the system to report errors or to attempt reconstruction.

Note: You cannot stop a vdisk that contains a primary volume.

Note: If a secondary volume and its snap pool are in different vdisks, you cannot stop the snap pool's vdisk until you stop the secondary volume's vdisk.

To stop a vdisk

1. In the Configuration View panel, right-click the vdisk and select **Provisioning > Stop Vdisk**.
2. In the main panel, click **Stop Vdisk**. A confirmation prompt appears.

3. Click **Yes** to continue. Otherwise, click **No**. If you clicked **Yes**, the stop operation begins. A message indicates whether the task succeeded or failed. If the stop operation succeeds, the vdisk's health is shown as `Unknown`, its status is shown as `STOP`, and its subcomponents are no longer displayed in the Configuration View panel.
4. If the stop operation succeeded for the secondary volume's vdisk and for its snap pool's vdisk (if applicable), you can move the disks into the remote system.

Starting a vdisk

Starting a vdisk is part of the process for moving a secondary volume from a primary system into a secondary system.

To move a secondary volume

1. In the system where the secondary volume resides:
   a. Detach the secondary volume. For details see Detaching a secondary volume on page 187.
   b. If the secondary volume's vdisk contains other secondary volumes, detach those volumes.
   c. Stop the secondary volume's vdisk. For details see Stopping a vdisk on the previous page.
   d. If the secondary volumes' snap pools are in other vdisks, stop those vdisks.
   e. Move the vdisks into the secondary system. This system must support the link type that the replication set is configured to use. For example, if the replication set's link type is configured to use FC links, the secondary system must have FC ports.
2. In the secondary system:
   a. Start the snap pools' vdisks.
   b. Start the secondary volumes' vdisks.
   c. Reattach the secondary volumes. For details see Reattaching a secondary volume on the next page.

To start a vdisk

1. In the Configuration View panel, right-click a stopped vdisk and select **Provisioning > Start Vdisk**.
2. In the main panel, click **Start Vdisk**. A message indicates whether the task succeeded or failed.

Note: If the replication set was deleted while the secondary volume's vdisk was stopped, restarting the vdisk will make the set partially reappear. To clean up this remnant, reattach the secondary volume, set it to be the primary volume (by using the Set Replication Primary Volume panel on Changing the primary volume for a replication set on page 191), and then delete the replication set again.

Reattaching a secondary volume

Reattaching a secondary volume is the last part of the process for moving a secondary volume from a primary system into a secondary system.

To move a secondary volume

1. In the system where the secondary volume resides:
   a. Detach the secondary volume. For details see Detaching a secondary volume on page 187.
   b. If the secondary volume's vdisk contains other secondary volumes, detach those volumes.
   c. Stop the secondary volume's vdisk. For details see Stopping a vdisk on page 188.
   d. If the secondary volumes' snap pools are in other vdisks, stop those vdisks.
   e. Move the vdisks into the secondary system. This system must support the link type that the replication set is configured to use. For example, if the replication set's link type is configured to use FC links, the secondary system must have FC ports.
2. In the secondary system:
   a. Start the snap pools' vdisks. For details see Starting a vdisk on the previous page.
   b. Start the secondary volumes' vdisks.
   c. Reattach the secondary volumes.

To reattach a secondary volume

1. In the Configuration View panel, right-click the secondary volume and select **Provisioning > Reattach Replication Volume**.
2. In the main panel, click **Reattach Replication Volume**. A confirmation dialog appears.
3. Click **Yes** to continue. Otherwise, click **No**. If you clicked **Yes**, a message indicates whether the task succeeded or failed.
4. Click **OK**. In a few seconds, the following changes occur in the Configuration View panel:
   - If the task succeeds, the secondary volume's status changes to “Establishing proxy” while it is establishing the connection to the remote (primary) system in preparation for replication. Then the status changes to Online. The replication set is ready to resume replication operations.
   - If the reattach operation fails and says it is unable to get the primary volume's link type, the vdisk that contains the secondary volume may not have completed its startup activities. Wait approximately one minute for these activities to complete, then retry the operation. If this message continues to occur, check the event log to better understand the condition and for an indication of how to correct it.

Note: If the secondary system does not support the link type that the replication set is configured to use, the secondary volume will be attached with the wrong link type. To fix this, repeat process steps 1 and 2 above to move the secondary volume into a system that supports the required link type.

Exporting a replication image to a snapshot

If the system is licensed to use remote replication, you can export a replication image to a new standard snapshot. For example, you could export a replication image from a secondary volume for use on the remote system. The standard snapshot will reside in the same snap pool, take a snapshot license, and be independent of the primary replication image, which can continue to be used as a sync point. The standard snapshot can be used like any other standard snapshot, and changes to it will not affect the replication image.

The standard snapshot is subject to the snap pool's deletion policies. If the snap pool reaches its critical threshold, the snapshot may be deleted, even if it is mapped. If you want to preserve the standard snapshot's data, you can create a standard volume from the snapshot. See Creating a volume copy on page 97.

Note: The export task will not succeed if the resulting snapshot would exceed license limits.

To export a replication image to a snapshot

1. In the Configuration View panel, right-click a replication image and select **Provisioning > Export Snapshot**.
2. In the main panel, optionally change the default name for the snapshot. A snapshot name is case sensitive and can have a maximum of 32 bytes. It cannot already exist in a vdisk or include the following: " , < \
3. Click **Export Snapshot**. A message specifies whether the task succeeded or failed.
4. Click **OK**. If the task succeeds, in the Configuration View panel the snapshot appears under the secondary volume on the remote system.

Changing the primary volume for a replication set

If a replication set's primary system goes offline, and the secondary volume is in a remote system, you can set the secondary volume to be the primary volume so hosts can access that volume and the replicated data it contains.

When the secondary volume becomes the primary volume, it only retains the replication images that the primary volume had and deletes any images that the primary volume did not have. Because the secondary volume may not have successfully replicated all the images associated with the primary volume, the secondary volume might have a subset of the primary volume's images.

If the primary system comes back online, you can set its volume to be the primary volume again.

The following procedures apply to a replication set in which the primary and secondary volume are in separate storage systems. To change the primary volume for a replication set in which both volumes are in the same system (local replication), use the CLI `set replication-primary-volume` command.

To change the secondary volume of a replication set to be its primary volume

1. On the secondary system, in the Configuration View panel, right-click the secondary volume and select **Provisioning > Set Replication Primary Volume**.
2. In the main panel, select the primary volume in the list.
3. Click **Set Replication Primary Volume**. In the Configuration View panel, the volume's designation changes from Secondary Volume to Primary Volume.

Note: The offline primary volume remains designated a Primary Volume.

To change the primary volume of a replication set back to its original primary volume

1. On the primary system:
   a. Create a standard snapshot (Creating a Snapshot on page 94) to preserve the primary volume's current data state.
   b. Remove all mappings from the original primary volume: in the Configuration View panel, right-click the original primary volume, select **Provisioning > Explicit Mappings**, record the mappings, and remove them. Then select **Provisioning > Default Mapping**, record the mapping, and remove it.
   c. Select **Provisioning > Set Replication Primary Volume**.
   d. In the main panel, in the Primary Volume list select the primary volume that is in the secondary system.
   e. Click **Set Replication Primary Volume**. In the Configuration View panel, the original primary volume is designated a Secondary Volume.
2. On the secondary system:
   a. Replicate the primary volume (Replicating a volume on page 182) to the secondary volume that is in the primary system to synchronize their data at the last valid common sync point. This will replicate any data changes made in the secondary volume back to the original primary volume. Let the replication operation complete.

   Note: An administrator can mount/present/map this snapshot and the snapshot taken in the previous step and compare them to verify any discrepancies.

   b. Remove all mappings from the primary volume: in the Configuration View panel, right-click the primary volume, select **Provisioning > Explicit Mappings**, record the mappings, and remove them. Then select **Provisioning > Default Mapping**, record the mapping, and remove it.
3. On the primary system:
   a. In the Configuration View panel, right-click the secondary volume and select **Provisioning > Set Replication Primary Volume**.
   b. In the main panel, in the Primary Volume list select the original primary volume.
   c. Click **Set Replication Primary Volume**. In the Configuration View panel, the original primary volume is designated a Primary Volume. (The replication set now has a primary volume in each system.)
   d. Re-create the mappings for the primary volume: in the Configuration View panel, right-click the primary volume, select **Provisioning > Default Mapping**, and re-create the default mapping that

you recorded. Then select **Provisioning > Explicit Mappings** and re-create the explicit mappings that you recorded.

4. On the secondary system:
   a. In the Configuration View panel, right-click the primary volume and select **Provisioning > Set Replication Primary Volume**.
   b. In the main panel, in the Primary Volume list select the original primary volume.
   c. Click **Set Replication Primary Volume**. The replication set once again has its primary volume in the primary system, and its secondary volume in the secondary system.

Viewing Replication Properties, Addresses, and Images For a Volume

In the Configuration View panel, right-click a volume and select **View > Overview**. The Volume Overview table shows:

- As described in Viewing Information About a Volume on page 144: the capacity and space usage of the volume; the quantity of mappings for the volume; and the quantity of task schedules for the volume
- The quantity of replication addresses for the volume
- The quantity of replication images for the volume

For descriptions of storage-space color codes, see About Storage-space Color Codes on page 23.

Select a component to see more information about it.

Replication properties

For a *local* primary or secondary volume, the Replication Properties for *Volume* table shows:

- Name. Replication volume name.
- Serial Number. Replication volume serial number.
- Status. Replication volume status:
  - Initializing: The initial (full) replication to the volume is in progress.
  - Online: The volume is online and is consistent with the last replicated image.
  - Inconsistent: The volume is online but is in an inconsistent state. A full replication is required to initialize it.
  - Replicating: The volume is online and replication is in progress.
  - Replicate-delay: The volume is online but the in-progress replication has been temporarily delayed. A retry is occurring.

    - Suspended: The volume is online but the in-progress replication has been suspended.
    - Offline: The volume cannot be accessed or is unusable due to an error.
    - Establishing proxy: The volume is establishing a proxy connection to a remote volume. This will occur when a detached secondary volume is reattached and is re-establishing a connection with the primary system in preparation for replication.
    - Detached: The volume is detached for removal.
- Status-Reason. More information about the status value, or N/A for Online status.
- Monitor. Replication volume monitoring status:
    - OK: Communication to the remote volume is successfully occurring on the FC or iSCSI network.
    - Failed: Communication to the remote volume has failed because of an FC or iSCSI network issue or because the remote volume has gone offline.
- Location. Local or Remote.
- Primary Volume Name. Primary volume name. If the replication set has a primary-volume conflict, all associated primary volumes are displayed.
- Primary Volume Serial Number. Primary volume serial number. If the replication set has a primary-volume conflict, all associated primary volumes are displayed.
- Primary Volume Status. Primary volume status: Online, Offline, Conflict, or N/A.
- Maximum Number of Queued Images. Number of replication images to consider when determining the next image to replicate. Used only if the On Collision parameter is set to Oldest.
- Maximum Retry Time (Seconds). Amount of time in seconds that the replication volume should retry a replication operation on any specific image when errors occur. Used only if the On Error parameter is set to Retry.
- On Error. Error policy to invoke when errors occur during the replication process: Retry or Suspend.
- Link Type. Type of ports used to link the primary and secondary volumes: FC or iSCSI.
- On Collision. Collision policy used to determine the next image to replicate when multiple replication images are queued: Newest or Oldest.
- Monitor Interval. Interval in seconds at which the primary volume should query the secondary volume.
- Priority. Priority of the replication process on the replication volume: Low, Medium, or High.
- Connection Status.
    - Not Attempted. Communication has not been attempted to the remote volume.
    - Online. The volumes in the replication set have a valid connection but communication is not currently active.
    - Active. Communication is currently active to the remote volume.
    - Offline. No connection is available to the remote system.
- Connection Time. Date and time of the last communication with the remote volume, or N/A.

Replication addresses

If any remote port addresses are associated with this volume, when you select the Replication Addresses component, the Replication Addresses table shows:

- Connected Ports.
  - For a remote primary or secondary volume, this field shows the IDs of up to two hosts ports in the local system that are connected to the remote system. If two ports are connected but only one is shown, this indicates that a problem is preventing half the available bandwidth from being used.
  - For a local primary or secondary volume, this field shows N/A.
- Remote Address. The address of each host port in the remote system through which the volume is accessible.

Replication images

If any replication images exist for this volume, when you select the Replication Images component, the Replication Images table shows information about each image. For the selected image, the Replication Images table shows:

- Image Serial Number. Replication image serial number.
- Image Name. User-defined name assigned to the primary replication image.
- Snapshot Serial Number. Replication snapshot serial number associated with the image. The replication snapshot is associated with the replication volume specified in the request.
- Snapshot Name. Replication snapshot name associated with the image. For a secondary replication image, this value is not filled in until the replication is completed.
- Creation Date/Time. Date and time when the replication image was created on the replication volume.

Viewing information about a remote primary or secondary volume

In the Configuration View panel, right-click a *remote* primary or secondary volume and select **View > Overview**. The Replication Volume Overview table shows:

- Replication properties for the volume
- The quantity of replication addresses for the volume
- The quantity of replication images for the volume

Select a component to see more information about it.

Replication properties

When you select the Replication component a table shows the volume’s replication properties, including the volume’s name, serial number, status, status reason, monitor status, and location (local or remote); primary volume name, serial number, and status; maximum number of queued images, maximum retry time, error policy, link type, collision policy, monitor interval, and priority; and connection status and last connection date/time.

Replication addresses

When you select the Replication Addresses component a table shows:

- Connected Ports.
  - For a remote primary or secondary volume, this field shows the ID of the port in the local system that is being used for communication with the remote system. To determine this, the system first probes all host ports on the controller that owns the replication set to find communication paths to a remote address. After all host ports are probed, if at least one path is found, the IDs of host ports found are shown and the probing stops. If no path is found, the system will repeat this process on the partner controller. If no path is found, N/A is shown.
  - For a local primary or secondary volume, this field shows N/A.
- Remote Address. The address of each host port in the remote system through which the volume is accessible.

Replication image properties

When you select the Replication Images component a table shows replication image details including the image serial number and name, snapshot serial number and name, and image creation date/time.

Viewing information about a replication image

In the Configuration View panel, right-click a replication image and select **View > Overview**. The Replication Image Overview table shows:

- Replication status properties
- Primary volume snapshot properties
- Secondary volume snapshot properties

Select a component to see more information about it.

Replication status properties

When you select the Status component a table shows the status, progress, start date/time, date/time of last update, date/time the replication was suspended, estimated completion time, elapsed or total replication time (including any suspension time). The panel also shows the replication image's serial number.

Primary-volume snapshot properties

If the snapshot is on the local system, when you select the Primary Volume Snapshot component a table shows the:

- Name and serial number of the pool containing the snapshot
- Snapshot name, creation date/time, status, and status reason
- Source volume name
- Parent volume name
- Base volume name
- Number of snapshots and snapshots in the tree
- Snap pool name
- Amounts of total, unique, and shared data associated with the snapshot
- Default and user-specified retention priorities for this type of snapshot
- Snapshot type

If the snapshot is on a remote system, when you select the Primary Volume Snapshot component a table shows the snapshot serial number and creation date/time.

Secondary volume snapshot properties

If the snapshot is on the local system, when you select the Secondary Volume Snapshot component a table shows the:

- Name and serial number of the pool containing the snapshot
- Snapshot name, creation date/time, status, and status reason
- Source volume name
- Parent volume name
- Base volume name
- Number of snapshots and snapshots in the tree
- Snap pool name
- Amounts of total, unique, and shared data associated with the snapshot

- Default and user-specified retention priorities for this type of snapshot
- Snapshot type

If the snapshot is on a remote system, when you select the Secondary Volume Snapshot component a table shows the snapshot serial number and creation date/time.

Chapter 7: SNMP Reference

This chapter contains the following topics:

SNMP Reference

This section describes the Simple Network Management Protocol (SNMP) capabilities that the storage systems support. This includes standard MIB-II, the FibreAlliance SNMP Management Information Base (MIB) version 2.2 objects, and enterprise traps.

The storage systems can report their status through SNMP. SNMP provides basic discovery using MIB-II, more detailed status with the FA MIB 2.2, and asynchronous notification using enterprise traps.

SNMP is a widely used network monitoring and control protocol. It is an application layer protocol that facilitates the exchange of management information between network devices. It is part of the Transmission Control Protocol/Internet Protocol (TCP/IP) protocol suite.

SNMP enables network administrators to manage network performance, find and solve network problems, and plan for network growth. Data is passed from SNMP agents reporting activity on each network device to the workstation console used to oversee the network. The agents return information contained in a Management Information Base (MIB), which is a data structure that defines what is obtainable from the device and what can be controlled (turned on and off, etc.).

Supported SNMP versions

The storage systems allow use of SNMPv2c or SNMPv3. SNMPv2c uses a community-based security scheme. For improved security, SNMPv3 provides authentication of the network management system that is accessing the storage system, and encryption of the information transferred between the storage system and the network management system.

When SNMPv3 is disabled, SNMPv2c will be active. When SNMPv3 is enabled, SNMPv2c will only have access to the MIB-II common system information. This allows device discovery.

Whether you use SNMPv2c or v3, note that the only SNMP-writable information is the system contact, name, and location. System data, configuration, and state cannot be changed via SNMP.

Standard MIB-II Behavior

MIB-II is implemented to support basic discovery and status.

An SNMP object identifier (OID) is a number assigned to devices in a network for identification purposes. OID numbering is hierarchical. Using the IETF notation of digits and dots resembling very long IP addresses, various registries such as ANSI assign high-level numbers to vendors and organizations. They, in turn, append digits to the number to identify individual devices or software processes.

The system object identifier (`sysObjectID`) is based on the vendor name followed by “.2.” and the identifier for the particular product model. For example, the object identifier for the storage systems is 1.3.6.1.4.1.11.2.347. System uptime is an offset from the first time this object is read.

In the system group, all objects can be read. The contact, name, and location objects can be set.

In the interfaces group, an internal PPP interface is documented, but it is not reachable from external to the device.

The address translation (at) and external gateway protocol (egp) groups are not supported.

Enterprise Traps

Traps can be generated in response to events occurring in the storage system. These events can be selected by severity and by individual event type. A maximum of three SNMP trap destinations can be configured by IP address.

Enterprise event severities are informational, minor, major, and critical. There is a different trap type for each of these severities. The trap format is represented by the enterprise traps MIB, `dhtraps.mib`. Information included is the event ID, the event code type, and a text description generated from the internal event. Equivalent information can also be sent using email or popup alerts to users who are logged in to WBI.

The text of the trap MIB is included at the end of this appendix.

FA MIB 2.2 SNMP Behavior

The FA MIB 2.2 objects are in compliance with the FibreAlliance MIB v2.2 Specification (FA MIB2.2 Spec). For a full description of this MIB, go to: www.emc.com/microsites/fibrealliance.

FA MIB 2.2 was never formally adopted as a standard, but it is widely implemented and contains many elements useful for storage products. This MIB generally does not reference and integrate with other standard SNMP information. It is implemented under the experimental subtree.

Significant status within the device includes such elements as its temperature and power sensors, the health of its storage elements such as virtual disks, and the failure of any redundant component including an I/O controller. While sensors can be individually queried, for the benefit of network management systems all the above elements are combined into an “overall status” sensor. This is available as the unit status (`connUnitStatus` for the only unit).

The revisions of the various components within the device can be requested through SNMP.

The port section is only relevant to products with Fibre Channel host ports.

The event table allows 400 recently-generated events to be requested. Informational, minor, major, or critical event types can be selected. Whichever type is selected enables the capture of that type and more severe events. This mechanism is independent of the assignment of events to be generated into traps.

The traps section is not supported. It has been replaced by an ability to configure trap destinations using the CLI or WBI. The statistics section is not implemented.

The following table lists the MIB objects, their descriptions and the value set in a storage system. Unless specified otherwise, objects are *not* settable.

Table 15: FA MIB 2.2 objects, descriptions, and values

Object	Description	Value
`revisionNumber`	Revision number for this MIB	0220

Object	Description	Value
`uNumber`	Number of connectivity units present	1
`systemURL`	Top-level URL of the device; for example, `http://10.1.2.3`. If a web server is not present on the device, this string is empty in accordance with the FA MIB2.2 Spec.	Default: `http://10.0.0.1`
`statusChangeTime`	`sysuptime` timestamp of the last status change event, in centiseconds. `sysuptime` starts at 0 when the SC boots and keeps track of the up time. `statusChangeTime` is updated each time an event occurs.	`0` at startup
`configurationChangeTime`	`sysuptime` timestamp of the last configuration change event, in centiseconds. `sysuptime` starts at 0 when the SC boots and keeps track of the up time. `configurationChangeTime` is updated each time an event occurs.	`0` at startup
`connUnitTableChangeTime`	`sysuptime` timestamp of the last update to the `connUnitTable` (an entry was either added or deleted), in centiseconds	`0` always (entries are not added to or deleted from the `connUnitTable`)
`connUnitTable`	**Includes the following objects as specified by the FA MIB2.2 Spec**	
`connUnitId`	Unique ID for this connectivity unit	Total of 16 bytes comprised of 8 bytes of the node WWN or similar serial number-based identifier (for example, 1000005013b05211) with the trailing 8 bytes equal to zero
`connUnitGlobalId`	Same as `connUnitId`	Same as `connUnitId`
`connUnitType`	Type of connectivity unit	storage-subsystem(11)
`connUnitNumports`	Number of host ports in the connectivity unit	Number of host ports

Object	Description	Value
connUnitState	Overall state of the connectivity unit	online(2) or unknown(1), as appropriate
connUnitStatus	Overall status of the connectivity unit	ok(3), warning(4), failed(5), or unknown(1), as appropriate
connUnitProduct	Connectivity unit vendor's product model name	Model string
connUnitSn	Serial number for this connectivity unit	Serial number string
connUnitUpTime	Number of centiseconds since the last unit initialization	0 at startup
connUnitUrl	Same as systemURL	Same as systemURL
connUnitDomainId	Not used; set to all 1s as specified by the FA MIB2.2 Spec	0xFFFF
connUnitProxyMaster	Stand-alone unit returns yes for this object	yes(3) since this is a stand-alone unit
connUnitPrincipal	Whether this connectivity unit is the principal unit within the group of fabric elements. If this value is not applicable, returns unknown.	unknown(1)
connUnitNumSensors	Number of sensors in the connUnitSensorTable	33
connUnitStatus ChangeTime	Same as statusChangeTime	Same as statusChangeTime
connUnit ConfigurationChangeTime	Same as configurationChangeTime	Same as configurationChangeTime
connUnitNumRevs	Number of revisions in the connUnitRevsTable	16
connUnitNumZones	Not supported	0
connUnitModuleId	Not supported	16 bytes of 0s
connUnitName	Settable: Display string containing a name for this connectivity unit	Default: Uninitialized Name

Object	Description	Value
connUnitInfo	Settable: Display string containing information about this connectivity unit	Default: Uninitialized Info
connUnitControl	Not supported	invalid(2) for an SNMP GET operation and not settable through an SNMP SET operation.
connUnitContact	Settable: Contact information for this connectivity unit	Default: Uninitialized Contact
connUnitLocation	Settable: Location information for this connectivity unit	Default: Uninitialized Location
connUnitEventFilter	Defines the event severity that will be logged by this connectivity unit. Settable only through the Disk Storage Management Utility.	Default: info(8)
connUnitNumEvents	Number of events currently in the connUnitEventTable	Varies as the size of the Event Table varies
connUnitMaxEvents	Maximum number of events that can be defined in the connUnitEventTable	400
connUnitEventCurrID	Not supported	0
connUnitRevsTable	Includes the following objects as specified by the FA MIB2.2 Spec	
connUnitRevsUnitId	connUnitId of the connectivity unit that contains this revision table	Same as connUnitId
connUnitRevsIndex	Unique value for each connUnitRevsEntry between 1 and connUnitNumRevs	See External details for connUnitRevsTable on page 209
connUnitRevsRevId	Vendor-specific string identifying a revision of a component of the connUnit	String specifying the code version. Reports “Not Installed or Offline” if module information is not available.
connUnitRevs Description	Description of a component to which the revision corresponds	See External details for connUnitRevsTable on page 209
connUnitSensorTable	**Includes the following objects as specified by the FA MIB2.2 Spec**	

Object	Description	Value
connUnitSensorUnitId	connUnitId of the connectivity unit that contains this sensor table	Same as connUnitId
connUnitSensorIndex	Unique value for each connUnitSensorEntry between 1 and connUnitNumSensors	See External Details For connUnitSensorTable on page 211
connUnitSensorName	Textual ID of the sensor intended primarily for operator use	See External Details For connUnitSensorTable on page 211
connUnitSensorStatus	Status indicated by the sensor	ok(3), warning(4), or failed(5) as appropriate for FRUs that are present, or other(2) if FRU is not present.
connUnitSensorInfo	Not supported	Empty string
connUnitSensorMessage	Description the sensor status as a message	connUnitSensorName followed by the appropriate sensor reading. Temperatures display in both Celsius and Fahrenheit; for example, CPU Temperature (Controller Module A): 48C 118F). Reports “Not installed” or “Offline” if data is not available.
connUnitSensorType	Type of component being monitored by this sensor	See External Details For connUnitSensorTable on page 211
connUnitSensorCharacteristic	Characteristics being monitored by this sensor	See External Details For connUnitSensorTable on page 211
connUnitPortTable	**Includes the following objects as specified by the FA MIB2.2 Spec**	
connUnitPortUnitId	connUnitId of the connectivity unit that contains this port	Same as connUnitId
connUnitPortIndex	Unique value for each connUnitPortEntry between 1 and connUnitNumPorts	Unique value for each port, between 1 and the number of ports
connUnitPortType	Port type	not-present(3), or n-port(5) for point-to-point topology, or l-port(6)
connUnitPortFCClassCap	Bit mask that specifies the classes of service capability of this port. If this is not applicable, returns all bits set to zero.	FC ports return 8 for class-three

Object	Description	Value
`connUnitPortFC ClassOp`	Bit mask that specifies the classes of service that are currently operational. If this is not applicable, returns all bits set to zero.	FC ports return 8 for class-three
`connUnitPortState`	State of the port hardware	unknown(1), online(2), offline(3), bypassed(4)
`connUnitPortStatus`	Overall protocol status for the port	unknown(1), unused(2), ok(3), warning(4), failure(5), notparticipating (6), initializing(7), bypass(8)
`connUnitPort TransmitterType`	Technology of the port transceiver	unknown(1) for FC ports
`connUnitPortModule Type`	Module type of the port connector	unknown(1)
`connUnitPortWwn`	FC WWN of the port if applicable	WWN octet for the port, or empty string if the port is not present
`connUnitPortFCId`	Assigned FC ID of this port	FC ID of the port All bits set to 1 if the FC ID is not assigned or if the port is not present
`connUnitPortSn`	Serial number of the unit (for example, for a GBIC). If this is not applicable, returns an empty string.	Empty string
`connUnitPort Revision`	Port revision (for example, for a GBIC)	Empty string
`connUnitPortVendor`	Port vendor (for example, for a GBIC)	Empty string
`connUnitPortSpeed`	Speed of the port in KB/s (1 KByte = 1000 Byte)	Port speed in KB/s, or 0 if the port is not present
`connUnitPortControl`	Not supported	invalid(2) for an SNMP GET operation and not settable through an SNMP SET operation
`connUnitPortName`	String describing the addressed port	See External Details For connUnitPortTable on page 213

Object	Description	Value
connUnitPort PhysicalNumber	Port number represented on the hardware	Port number represented on the hardware
connUnitPortStat Object	Not supported	0 (No statistics available)
connUnitEventTable	Includes the following objects as specified by the FA MIB2.2 Spec	
connUnitEventUnitId	connUnitId of the connectivity unit that contains this port	Same as connUnitId
connUnitEventIndex	Index into the connectivity unit's event buffer, incremented for each event	Starts at 1 every time there is a table reset or the unit's event table reaches its maximum index value
connUnitEventId	Internal event ID, incremented for each event, ranging between 0 and connUnitMaxEvents	Starts at 0 every time there is a table reset or connUnitMaxEvents is reached
connUnitREventTime	Real time when the event occurred, in the following format: DDMMYYYY HHMMSS	0 for logged events that occurred prior to or at startup
connUnitSEventTime	sysuptime timestamp when the event occurred	0 at startup
connUnitEvent Severity	Event severity level	error(5), warning(6) or info(8)
connUnitEventType	Type of this event	As defined in CAPI
connUnitEventObject	Not used	0
connUnitEventDescr	Text description of this event	Formatted event, including relevant parameters or values
connUnitLinkTable	Not supported	N/A
connUnitPortStat FabricTable	Not supported	N/A
connUnitPortStat SCSITable	Not supported	N/A
connUnitPortStatLANTable	Not supported	N/A
SNMP TRAPS	**The following SNMP traps are supported**	

Object	Description	Value
`trapMaxClients`	Maximum number of trap clients	1
`trapClientCount`	Number of trap clients currently enabled	1 if traps enabled; 0 if traps not enabled
`connUnitEventTrap`	This trap is generated each time an event occurs that passes the `connUnitEventFilter` and the `trapRegFilter`	N/A
`trapRegTable`	Includes the following objects per the FA MIB2.2 Spec	
`trapRegIpAddress`	IP address of a client registered for traps	IP address set through Telnet
`trapRegPort`	User Datagram Protocol (UDP) port to send traps to for this host	162
`trapRegFilter`	Settable: Defines the trap severity filter for this trap host. The `connUnit` will send traps to this host that have a severity level less than or equal to this value.	Default: warning(6)
`trapRegRowState`	Specifies the state of the row	READ: rowActive(3) if traps are enabled through Telnet; otherwise rowInactive(2) WRITE: Not supported
`Enterprise-specific fields`	Includes the following objects	
`cpqSiSysSerialNum`	System serial number	For example, 3CL8Y40991
`cpqSiSysProductId`	System product ID	For example, 481321-001
`cpqSiProductName`	System product name	For example, QX-1200

Object	Description	Value

`cpqHoMibStatusArray`	An array of MIB status structures. Octets 0–3 in block 0 are reserved for systems management and serve as an aggregate of the other MIBs.	Octet 0: 0.
		Octet 1 (overall status):
		0 = Not available;
		1 = Unknown/other;
		2 = OK/normal;
		3 = Degraded/warning;
		4 = Failed/critical
		Octet 2 (system flags):
		9 = device is not a server and web-based management is enabled
		Octet 3 (device type):
		14 = enclosure
		For example, 00.02.09.14 (hex)

`cpqHoGUID`	Globally unique identifier formed from the product ID and serial number	For example, 4813213CL8Y40991

External details for certain FA MIB 2.2 objects

Tables in this section specify values for certain objects described in Table 1.

External details for connUnitRevsTable

Table 16: connUnitRevsTable index and description values

connUnitRevsIndex	connUnitRevsDescription
1	CPU Type for Storage Controller (Controller A)
2	Bundle revision for Controller (Controller A)
3	Build date for Storage Controller (Controller A)
4	Code revision for Storage Controller (Controller A)
5	Code baselevel for Storage Controller (Controller A)
6	FPGA code revision for Memory Controller (Controller A)

connUnitRevsIndex	connUnitRevsDescription
7	Loader code revision for Storage Controller (Controller A)
8	CAPI revision (Controller A)
9	Code revision for Management Controller (Controller A)
10	Loader code revision for Management Controller (Controller A)
11	Code revision for Expander Controller (Controller A)
12	CPLD code revision (Controller A)
13	Hardware revision (Controller A)
14	Host interface module revision (Controller A)
15	HIM revision (Controller A)
16	Backplane type (Controller A)
17	Host interface hardware (chip) revision (Controller A)
18	Disk interface hardware (chip) revision (Controller A)
19	CPU Type for Storage Controller (Controller B)
20	Bundle revision for Controller (Controller B)
21	Build date for Storage Controller (Controller B)
22	Code revision for Storage Controller (Controller B)
23	Code baselevel for Storage Controller (Controller B)
24	FPGA code revision for Memory Controller (Controller B)
25	Loader code revision for Storage Controller (Controller B)
26	CAPI revision (Controller B)
27	Code revision for Management Controller (Controller B)
28	Loader code revision for Management Controller (Controller B)
29	Code revision for Expander Controller (Controller B)
30	CPLD code revision (Controller B)
31	Hardware revision (Controller B)

connUnitRevsIndex	connUnitRevsDescription
32	Host interface module revision (Controller B)
33	HIM revision (Controller B)
34	Backplane type (Controller B)
35	Host interface hardware (chip) revision (Controller B)
36	Disk interface hardware (chip) revision (Controller B)

External Details For connUnitSensorTable

Table 17: connUnitSensorTable index, name, type, and characteristic values

connUnitSensor Index	connUnitSensorName	connUnitSensor Type	connUnitSensor Characteristic
1	On-Board Temperature 1 Controller A	board(8)	temperature
2	On-Board Temperature 1 Controller B	board(8)	temperature
3	On-Board Temperature 2 Controller A	board(8)	temperature
4	On-Board Temperature 2 Controller B	board(8)	temperature
5	On-Board Temperature 3 Controller A	board(8)	temperature
6	On-Board Temperature 3 Controller B	board(8)	temperature
7	Disk Controller Temp Controller A	board(8)	temperature
8	Disk Controller Temp Controller B	board(8)	temperature
9	Memory Controller Temp Controller A	board(8)	temperature
10	Memory Controller Temp Controller B	board(8)	temperature
11	Capacitor Pack Voltage Controller A	board(8)	power
12	Capacitor Pack Voltage Controller B	board(8)	power
13	Capacitor Cell 1 Voltage Controller A	board(8)	power
14	Capacitor Cell 1 Voltage Controller B	board(8)	power
15	Capacitor Cell 2 Voltage Controller A	board(8)	power

connUnitSensor Index	connUnitSensorName	connUnitSensor Type	connUnitSensor Characteristic
16	Capacitor Cell 2 Voltage Controller B	board(8)	power
17	Capacitor Cell 3 Voltage Controller A	board(8)	power
18	Capacitor Cell 3 Voltage Controller B	board(8)	power
19	Capacitor Cell 4 Voltage Controller A	board(8)	power
20	Capacitor Cell 4 Voltage Controller B	board(8)	power
21	Capacitor Charge Controller A	board(8)	other
22	Capacitor Charge Controller B	board(8)	other
23	Overall Unit Status: OK	enclosure(7)	other
24	Upper IOM Temperature (Controller A)	enclosure(7)	temperature
25	Lower IOM Temperature (Controller B)	enclosure(7)	temperature
26	Power Supply 1 (Left) Temperature	power-supply(5)	temperature
27	Power Supply 2 (Right) Temperature	power-supply(5)	temperature
28	Upper IOM Voltage, 12V (Controller A)	enclosure(7)	power
29	Upper IOM Voltage, 5V (Controller A)	enclosure(7)	power
30	Lower IOM Voltage, 12V (Controller B)	enclosure(7)	power
31	Lower IOM Voltage, 5V (Controller B)	enclosure(7)	power
32	Power Supply 1 (Left) Voltage, 12V	power-supply(5)	power
33	Power Supply 1 (Left) Voltage, 5V	power-supply(5)	power
34	Power Supply 1 (Left) Voltage, 3.3V	power-supply(5)	power
35	Power Supply 2 (Right) Voltage, 12V	power-supply(5)	power
36	Power Supply 2 (Right) Voltage, 5V	power-supply(5)	power
37	Power Supply 2 (Right) Voltage, 3.3V	power-supply(5)	power
38	Upper IOM Voltage, 12V (Controller A)	enclosure(7)	current
39	Lower IOM Voltage, 12V (Controller B)	enclosure(7)	current
40	Power Supply 1 (Left) Current, 12V	power-supply(5)	current

connUnitSensor Index	connUnitSensorName	connUnitSensor Type	connUnitSensor Characteristic
41	Power Supply 1 (Left) Current, 5V	power-supply(5)	current
42	Power Supply 2 (Right) Current, 12V	power-supply(5)	current
43	Power Supply 2 (Right) Current, 5V	power-supply(5)	current

External Details For connUnitPortTable

Table 18: connUnitPortTable index and name values

connUnitPortIndex	connUnitPortName
1	Host Port 1 (Controller A)
2	Host Port 2 (Controller B)
3	Host Port 1 (Controller A)
4	Host Port 2 (Controller B)

Configuring SNMP Event Notification in WBI

1. Verify that the storage system's SNMP service is enabled. See Changing Management Interface Settings on page 49.
2. Configure and enable SNMP traps. See Configuring SNMP notification on page 52.
3. Optionally, configure a user account to receive SNMP traps. See Configuring User Accounts on page 53.

SNMP Management

You can manage storage devices using SNMP with a network management system such as HP OpenView, HP System Insight Manager (SIM), or HP Instant Support Enterprise Edition (ISEE). See their documentation for information about loading MIBs, configuring events, and viewing and setting group objects.

In order to view and set system group objects, SNMP must be enabled in the storage system. See Changing Management Interface Settings on page 49. To use SNMPv3, it must be configured in both the storage system and the network management system that intends to access the storage system or receive traps from it. In the storage system, SNMPv3 is configured through the creation and use of SNMP user accounts, as described in Configuring User Accounts on page 53. The same users, security protocols, and passwords must be configured in the network management system.

Enterprise Trap MIB

The following pages show the source for the enterprise traps MIB, `dhtraps.mib`. This MIB defines the content of the SNMP traps that a storage systems generate.

```
-- ------------------------------------------------------
-- Dot Hill Low Cost Array MIB for SNMP Traps
--
-- $Revision: 11692 $
--
-- Copyright 2005 Dot Hill Systems Corp.
-- All rights reserved. Use is subject to license terms.
--
-- ------------------------------------------------------
DHTRAPS-MIB
-- Last edit date: Nov 11th, 2005
DEFINITIONS ::= BEGIN
  IMPORTS
    enterprises
        FROM RFC1155-SMI
    TRAP-TYPE
        FROM RFC-1215
    connUnitEventId, connUnitEventType, connUnitEventDescr
        FROM FCMGMT-MIB;
    --Textual conventions for this MIB
----------------------------------------------------------------------
    -- formerly Box Hill
    dothill    OBJECT IDENTIFIER ::= { enterprises 347 }
-- Related traps
    dhEventInfoTrap TRAP-TYPE
        ENTERPRISE dothill
        VARIABLES { connUnitEventId,
                    connUnitEventType,
                    connUnitEventDescr }
        DESCRIPTION
            "An event has been generated by the storage array.
            Recommended severity level (for filtering): info"
        -- Trap annotations are as follows:
        --#TYPE "Informational storage event"
        --#SUMMARY "Informational storage event # %d, type %d, description: %s"
        --#ARGUMENTS {0,1,2}
        --#SEVERITY INFORMATIONAL
        --#TIMEINDEX 6
        ::= 1
    dhEventWarningTrap TRAP-TYPE
        ENTERPRISE dothill
        VARIABLES { connUnitEventId,
                    connUnitEventType,
                    connUnitEventDescr }
        DESCRIPTION
            "An event has been generated by the storage array.
            Recommended severity level (for filtering): warning"
        -- Trap annotations are as follows:
        --#TYPE "Warning storage event"
        --#SUMMARY "Warning storage event # %d, type %d, description: %s"
        --#ARGUMENTS {0,1,2}
        --#SEVERITY MINOR
        --#TIMEINDEX 6
        ::= 2
    dhEventErrorTrap TRAP-TYPE
        ENTERPRISE dothill
        VARIABLES { connUnitEventId,
                    connUnitEventType,
                    connUnitEventDescr }
        DESCRIPTION
            "An event has been generated by the storage array.
            Recommended severity level (for filtering): error"
        -- Trap annotations are as follows:
        --#TYPE "Error storage event"
        --#SUMMARY "Error storage event # %d, type %d, description: %s"
        --#ARGUMENTS {0,1,2}
        --#SEVERITY MAJOR
        --#TIMEINDEX 6
        ::= 3
    dhEventCriticalTrap TRAP-TYPE
        ENTERPRISE dothill
        VARIABLES { connUnitEventId,
                    connUnitEventType,
                    connUnitEventDescr }
        DESCRIPTION
            "An event has been generated by the storage array.
            Recommended severity level (for filtering): critical"
        -- Trap annotations are as follows:
        --#TYPE "Critical storage event"
        --#SUMMARY "Critical storage event # %d, type %d, description: %s"
        --#ARGUMENTS {0,1,2}
        --#SEVERITY CRITICAL
        --#TIMEINDEX 6
        ::= 4
END
```

Chapter 8: Using FTP

This chapter contains the following topics:

Using FTP

Although the WBI is the preferred interface for downloading log data and historical disk-performance statistics, updating firmware, installing a license, and installing a security certificate, you can also use FTP to do these tasks.

⚠ **Caution:** Do not attempt to do more than one of the operations in this appendix at the same time. They can interfere with each other and the operations may fail. Specifically, do not try to do more than one firmware update at the same time or try to download system logs while doing a firmware update.

Downloading System Logs

To help service personnel diagnose a system problem, you might be asked to provide system log data. You can download this data by accessing the system's FTP interface and running the `get logs` command. When both controllers are online, regardless of operating mode, `get logs` will download a single, compressed zip file that includes:

- Device status summary, which includes basic status and configuration data for the system
- Each controller's MC logs
- Each controller's event log
- Each controller's debug log
- Each controller's boot log, which shows the startup sequence
- Critical error dumps from each controller, if critical errors have occurred
- CAPI traces from each controller

Use a command-line-based FTP client. A GUI-based FTP client might not work.

To download system logs

1. In the WBI, prepare to use FTP:
   a. Determine the network-port IP addresses of the system's controllers. See Changing Network Interface Settings on page 60.
   b. Verify that the system's FTP service is enabled. See Changing Management Interface Settings on page 49.
   c. Verify that the user you will log in as has permission to use the FTP interface. See Modifying Users on page 55.
2. Open a Command Prompt (Windows) or a terminal window (UNIX) and navigate to the destination directory for the log file.
3. Enter:

   ```
   ftp controller-network-address
   ```

   For example:

   ```
   ftp 10.1.0.9
   ```

4. Log in as a user that has permission to use the FTP interface.
5. Enter:

   ```
   get logs filename.zip
   ```

   where `filename` is the file that will contain the logs. It is recommended to choose a filename that identifies the system, controller, and date.

   For example:

   ```
   get logs Storage2_A_20120126.zip
   ```

Wait for the message `Operation Complete` to appear.

6. Quit the FTP session.
7. If the problem to diagnose seems specific to user-interface behavior, repeat Step 3 through Step 6 on the partner controller to collect its unique MC log data.

Note: You must uncompress a zip file before you can view the files it contains. To examine diagnostic data, first view `store_yyyy_mm_dd__hh_mm_ss.logs`.

Transferring Log Data to a Log-collection System

If the log-management feature is configured in pull mode, a log-collection system can access the storage system's FTP interface and use the `get managed-logs` command to retrieve untransferred data from a system log file. This command retrieves the untransferred data from the specified log to a compressed zip file on the log-collection system. Following the transfer of a log's data, the log's capacity status is reset to zero indicate that there is no untransferred data. Log data is controller specific.

For an overview of the log-management feature, see About Managed Logs on page 26.

Use a command-line-based FTP client. A GUI-based FTP client might not work.

To transfer log data to a log-collection system

1. In the WBI, prepare to use FTP:
   a. Determine the network-port IP addresses of the system's controllers. See Changing Network Interface Settings on page 60.
   b. Verify that the system's FTP service is enabled. See Changing Management Interface Settings on page 49.
   c. Verify that the user you will log in as has permission to use the FTP interface. See Modifying Users on page 55.
2. On the log-collection system, open a Command Prompt (Windows) or a terminal window (UNIX) and navigate to the destination directory for the log file.
3. Enter:

   ```
   ftp controller-network-address
   ```

   For example:

   ```
   ftp 10.1.0.9
   ```
4. Log in as a user that has permission to use the FTP interface.
5. Enter:

   ```
   get managed-logs:log-type  filename.zip
   ```

where:

- `log-type` specifies the type of log data to transfer:
    - `crash1`, `crash2`, `crash3`, or `crash4`: One of the Storage Controller's four crash logs.
    - `ecdebug`: Expander Controller log.
    - `mc`: Management Controller log.
    - `scdebug`: Storage Controller log.
- `filename` is the file that will contain the transferred data. It is recommended to choose a filename that identifies the system, controller, log type, and date.

For example:

```
get managed-logs:scdebug Storage2-A_scdebug_2011_08_22.zip
```

Wait for the message `Operation Complete` to appear.

6. Quit the FTP session.

Note: You must uncompress a zip file before you can view the files it contains.

Downloading historical disk-performance statistics

You can access the storage system's FTP interface and use the `get perf` command to download historical disk-performance statistics for all disks in the storage system. This command downloads the data in CSV format to a file, for import into a spreadsheet or other third-party application.

The number of data samples downloaded is fixed at 100 to limit the size of the data file to be generated and transferred. The default is to retrieve all the available data (up to six months) aggregated into 100 samples. You can specify a different time range by specifying a start and end time. If the specified time range spans more than 100 15-minute samples, the data will be aggregated into 100 samples.

The resulting file will contain a row of property names and a row for each data sample, as shown in the following example. For property descriptions, see the topic about the `disk-hist-statistics` basetype in the CLI Reference Guide.

```
"sample-time","durable-id","serial-number","number-of-ios", ...
"2012-01-26 01:00:00","disk_1.1","PLV2W1XE","2467917", ...
"2012-01-26 01:15:00","disk_1.1","PLV2W1XE","2360042", ...
...
```

Use a command-line-based FTP client. A GUI-based FTP client might not work.

To retrieve historical disk-performance statistics

1. In the WBI, prepare to use FTP:

   a. Determine the network-port IP addresses of the system's controllers. See Changing Network Interface Settings on page 60.

   b. Verify that the system's FTP service is enabled. See Changing Management Interface Settings on page 49.

   c. Verify that the user you will log in as has permission to use the FTP interface. See Modifying Users on page 55.

2. Open a Command Prompt (Windows) or a terminal window (UNIX) and navigate to the destination directory for the log file.

3. Enter:

   ftp `controller-network-address`

   For example:

   ```
   ftp 10.1.0.9
   ```

4. Log in as a user that has permission to use the FTP interface.

5. Enter:

   get perf[:`date/time-range`**]** `filename`**.csv**

   where:

   - `date/time-range` is optional and specifies the time range of data to transfer, in the format: `start.yyyy-mm-dd.hh:mm.[AM|PM].end.yyyy-mm-dd.hh:mm.[AM|PM]`. The string must contain no spaces.
   - `filename` is the file that will contain the data. It is recommended to choose a filename that identifies the system, controller, and date.

   For example:

   ```
   get perf:start.2012-01-26.12:00.PM.end.2012-01-26.23:00.PM Storage2_A_
   20120126.csv
   ```

   Wait for the message `Operation Complete` to appear.

6. Quit the FTP session.

Updating Firmware

You can update the versions of firmware in controller modules, expansion modules (in drive enclosures), and disks.

ⓘ **Note:** To ensure success of an online update, select a period of low I/O activity. This helps the update complete as quickly as possible and avoids disruptions to host and applications due to timeouts. Attempting to update a storage system that is processing a large, I/O-intensive batch job will likely cause hosts to lose connectivity with the storage system.

⚠ **Caution:**
-If a disk group is quarantined, resolve the problem that is causing the disk group to be quarantined before updating firmware. See information about events 172 and 485 in the Event Descriptions Reference Guide, and Removing a vdisk from Quarantine on page 121.
-If any unwritten cache data is present, firmware update will not proceed. Before you can update firmware, unwritten data must be removed from cache. See information about event 44 in the Event Descriptions Reference Guide and information about the `clear cache` command in the CLI Reference Guide.
- If the system's health is Fault, firmware update will not proceed. Before you can update firmware, you must resolve the problem specified by the Health Reason value on the System Overview panel (Viewing Information About the System on page 126).

Updating Controller-module Firmware

A controller enclosure can contain one or two controller modules. In a dual-controller system, both controllers should run the same firmware version. Storage systems in a replication set must run the same firmware version. You can update the firmware in each controller module by loading a firmware file obtained from the enclosure vendor.

If you have a dual-controller system and the Partner Firmware Update (PFU) option is enabled, when you update one controller the system automatically updates the partner controller. If PFU is disabled, after updating firmware on one controller you must log into the partner controller's IP address and perform this firmware update on that controller also.

For best results, the storage system should be in a healthy state before starting firmware update.

ⓘ **Note:** For information about supported releases for firmware update, see the product's Release Notes.

To update controller-module firmware

1. Obtain the appropriate firmware file and download it to your computer or network.
2. In the WBI, prepare to use FTP:
   a. Determine the network-port IP addresses of the system's controllers.
   b. Verify that the system's FTP service is enabled.
   c. Verify that the user you will log in as has permission to use the FTP interface.
3. If the storage system has a single controller, stop I/O to disk groups before starting the firmware update.
4. Open a Command Prompt (Windows) or a terminal window (UNIX) and navigate to the directory containing the firmware file to load.
5. Enter:

   ```
   ftp controller-network-address
   ```

   For example:

   ```
   ftp 10.1.0.9
   ```

6. Log in as an FTP user.

7. Enter:

   ```
   put firmware-file flash
   ```

   For example:

   ```
   put T230R01-01.bin flash
   ```

⚠ **Caution:** Do not perform a power cycle or controller restart during a firmware update. If the update is interrupted or there is a power failure, the module might become inoperative. If this occurs, contact technical support. The module might need to be returned to the factory for reprogramming.

ⓘ **Note:** If you attempt to load an incompatible firmware version, the message `*** Code Load Fail. Bad format image. ***` is displayed and after a few seconds the FTP prompt is redisplayed. The code is not loaded.

   Firmware update typically takes 10 minutes for a controller having current CPLD firmware, or 20 minutes for a controller with downlevel CPLD firmware. If the controller enclosure has attached enclosures, allow additional time for each expansion module's enclosure management processor (EMP) to be updated. This typically takes 2.5 minutes for each EMP in a drive enclosure.

   ⓘ **Note:** If you are using a Windows FTP client, during firmware update a client-side FTP application issue can cause the FTP session to be aborted. If this issue persists try using the WBI to perform the update, use another client, or use another FTP application.

   If the Storage Controller cannot be updated, the update operation is cancelled. If the FTP prompt does not return, quit the FTP session and log in again. Verify that you specified the correct firmware file and repeat the update. If this problem persists, contact technical support.

   When firmware update on the local controller is complete, the message `Operation Complete` is printed, the FTP session returns to the `ftp>` prompt, and the FTP session to the local MC is closed.

   If PFU is enabled, allow an additional 10–20 minutes for the partner controller to be updated.

8. Quit the FTP session.

9. Clear your web browser's cache, then sign in to the WBI. If PFU is running on the controller you sign in to, a dialog box shows PFU progress and prevents you from performing other tasks until PFU is complete.

   ⓘ **Note:** After firmware update has completed on both controllers, if the system health is Degraded and the health reason indicates that the firmware version is incorrect, verify that you specified the correct firmware file and repeat the update. If this problem persists, contact technical support.

Updating expansion-module and drawer firmware

A drive enclosure can contain one or two expansion modules. Each expansion module contains an enclosure management processor (EMP). In an enclosure with drawers, each drawer contains two EMPs, which are also referred to as "modules." All modules of the same product model should run the same firmware version.

Expansion-module and drawer firmware is updated in either of two ways:

- When you update controller-module firmware, all expansion-module and drawer EMPs are automatically updated to a compatible firmware version.
- You can update the firmware in each expansion-module and drawer EMP by loading a firmware file obtained from the enclosure vendor.

You can specify to update all expansion modules or only specific expansion modules. If you specify to update all expansion modules and the system contains more than one type of enclosure, the update will be attempted on all enclosures in the system. The update will only succeed for enclosures whose type matches the file, and will fail for enclosures of other types.

To update expansion-module and drawer firmware

1. Obtain the appropriate firmware file and download it to your computer or network.
2. If you want to update all expansion modules, continue with the next step. Otherwise, in the WBI, determine the address of each expansion module to update:
   a. In the Configuration View panel, select a drive enclosure.
   b. In the enclosure properties table, note each EMP's bus ID and target ID values. For example, 0 and 63, and 1 and 63. Bus 0 is the bus that is native to a given controller, while bus 1 is an alternate path through the partner controller. It is recommended to perform update tasks consistently through one controller to avoid confusion.
3. In the WBI, prepare to use FTP:
   a. Determine the network-port IP addresses of the system's controllers.
   b. Verify that the system's FTP service is enabled.
   c. Verify that the user you will log in as has permission to use the FTP interface.
4. If the system has a single controller, stop I/O to disk groups before starting the firmware update.
5. Open a Command Prompt (Windows) or a terminal window (UNIX) and navigate to the directory containing the firmware file to load.
6. Enter:

   ```
   ftp controller-network-address
   ```

   For example:

   ```
   ftp 10.1.0.9
   ```

7. Log in as an FTP user.
8. Either:
   - To update all expansion modules, enter:

     ```
     put firmware-file encl
     ```

   - To update specific expansion modules, enter:

     ```
     put firmware-file encl:EMP-bus-ID:EMP-target-ID
     ```

     For example:

     ```
     put S110R01.bin encl:1:63
     ```

⚠ **Caution:** Do not perform a power cycle or controller restart during the firmware update. If the update is interrupted or there is a power failure, the module might become inoperative. If this occurs, contact technical support. The module might need to be returned to the factory for reprogramming.

It typically takes 2.5 minutes to update each EMP in a drive enclosure. Wait for a message that the code load has completed.

ⓘ **Note:** If the update fails, verify that you specified the correct firmware file and try the update a second time. If it fails again, contact technical support.

9. If you are updating specific expansion modules, repeat Step 8 for each remaining expansion module that needs to be updated.
10. Quit the FTP session.
11. Verify that each updated expansion module has the correct firmware version.

Updating Disk Firmware

You can update disk firmware by loading a firmware file obtained from your reseller.

A dual-ported disk can be updated from either controller.

ⓘ **Note:** Disks of the same model in the storage system must have the same firmware revision.

You can specify to update all disks or only specific disks. If you specify to update all disks and the system contains more than one type of disk, the update will be attempted on all disks in the system. The update will only succeed for disks whose type matches the file, and will fail for disks of other types.

To prepare for update

1. Obtain the appropriate firmware file and download it to your computer or network.
2. Check the disk manufacturer’s documentation to determine whether disks must be power cycled after firmware update.
3. If you want to update all disks of the type that the firmware applies to, continue with the next step. Otherwise, in the WBI, for each disk to update:
   a. Determine the enclosure number and slot number of the disk.
   b. If the disk is associated with a disk group and is single ported, determine which controller owns the disk group.
4. In the WBI, prepare to use FTP:
   a. Determine the network-port IP addresses of the system’s controllers.
   b. Verify that the system’s FTP service is enabled.
   c. Verify that the user you will log in as has permission to use the FTP interface.
5. Stop I/O to the storage system. During the update all volumes will be temporarily inaccessible to hosts. If I/O is not stopped, mapped hosts will report I/O errors. Volume access is restored after the update completes.

To update disk firmware

1. Open a Command Prompt (Windows) or a terminal window (UNIX) and navigate to the directory containing the firmware file to load.
2. Enter:

   ```
   ftp controller-network-address
   ```

   For example:

   ```
   ftp 10.1.0.9
   ```

3. Log in as an FTP user.
4. Either:
   - To update all disks of the type that the firmware applies to, enter:

     ```
     put firmware-file disk
     ```

   - To update specific disks, enter:

     ```
     put firmware-file disk:enclosure-ID:slot-number
     ```

     For example:

     ```
     put firmware-file disk:1:11
     ```

     Caution: Do not power cycle enclosures or restart a controller during the firmware update. If the update is interrupted or there is a power failure, the disk might become inoperative. If this occurs, contact technical support.

   It typically takes several minutes for the firmware to load. Wait for a message that the update has succeeded.

   Note: If the update fails, verify that you specified the correct firmware file and try the update a second time. If it fails again, contact technical support.

5. If you are updating specific disks, repeat Step 4 for each remaining disk to update.
6. Quit the FTP session.
7. If the updated disks must be power cycled:

   a. Shut down both controllers by using the WBI.

   b. Power cycle all enclosures as described in your product’s Setup Guide.

8. Verify that each disk has the correct firmware revision.

Installing a License File

1. Ensure that the license file is saved to a network location that the storage system can access.

2. Open a Command Prompt (Windows) or a terminal window (UNIX) and navigate to the directory containing the license file to load.
3. Log in to the controller enclosure that the file was generated for:

   ```
   ftp controller-network-address
   ```

   For example:

   ```
   ftp 10.1.0.9
   ```

4. Log in as an FTP user.
5. Enter:

   ```
   put license-file license
   ```

   For example:

   ```
   put certificate.txt license
   ```

   A message confirms whether installation succeeded or failed. If installation succeeds, licensing changes take effect immediately.

Installing a Security Certificate

The storage system supports use of unique certificates for secure data communications, to authenticate that the expected storage systems are being managed. Use of authentication certificates applies to the HTTPS protocol, which is used by the web server in each controller module.

As an alternative to using the CLI to create a security certificate on the storage system, you can use FTP to install a custom certificate on the system. A certificate consists of a certificate file and an associated key file. The certificate can be created by using OpenSSL, for example, and is expected to be valid. If you replace the controller module in which a custom certificate is installed, the partner controller will automatically install the certificate file to the replacement controller module.

To install a security certificate

1. In the WBI, prepare to use FTP:
   a. Determine the network-port IP addresses of the system’s controllers. See Changing Network Interface Settings on page 60.
   b. Verify that the system’s FTP service is enabled. See Changing Management Interface Settings on page 49.
   c. Verify that the user you will log in as has permission to use the FTP interface. See Modifying Users on page 55.
2. Open a Command Prompt (Windows) or a terminal window (UNIX) and navigate to the directory that contains the certificate files.
3. Enter:

   ```
   ftp controller-network-address
   ```

For example:

ftp 10.1.0.9

4. Log in as a user that has permission to use the FTP interface.
5. Enter:

   put `certificate-file-name` **cert-file**

   where `certificate-file-name` is the name of the certificate file for your specific system.
6. Enter:

   put `key-file-name` **cert-key-file**

   where `key-file-name` is the name of the security key file for your specific system.
7. Restart both Management Controllers to have the new security certificate take effect.

Downloading system heat map data

If requested by support engineers for analysis, you can download cumulative I/O density data, also known as heat map data, from the system.

To gather this data, access the storage system's FTP interface and use the get logs command with the `heatmap` option to download a log file in CSV format. The file contains data for the past seven days from both controllers.

1. In the WBI, prepare to use FTP:
   a. Determine the network-port IP addresses of the system's controllers. See Changing network interface settings.
   b. Verify that the system's FTP service is enabled. See Changing system services settings.
   c. Verify that the user you will log in as has permission to use the FTP interface. See Adding, Modifying, and Deleting Users.
2. Open a Command Prompt (Windows) or a terminal window (UNIX) and navigate to the destination directory for the log file.
3. Enter:

   ```
   ftp controller-network-address
   ```

   For example:
   ftp 10.1.0.9

4. Log in as a user that has permission to use the FTP interface.

5. Enter:

```
get logs:heatmap filename.csv
```

where: `filename` is the file that will contain the data.

For example:

`get logs:heatmap IO_density.csv`

Wait for the message `Operation Complete` to appear.

6. Quit the FTP session.

Chapter 9: Using SMI-S

This chapter contains the following topics:

Using SMI-S

This appendix provides information for network administrators who are managing the storage system from a storage management application through the Storage Management Initiative Specification (SMI-S). SMI-S is a Storage Networking Industry Association (SNIA) standard that enables interoperable management for storage networks and storage devices.

SMI-S replaces multiple disparate managed object models, protocols, and transports with a single object-oriented model for each type of component in a storage network. The specification was created by SNIA to standardize storage management solutions. SMI-S enables management applications to support storage devices from multiple vendors quickly and reliably because they are no longer proprietary. SMI-S detects and manages storage elements by type, not by vendor.

The key SMI-S components are:

- Web-based Enterprise Management (WBEM). A set of management and internet standard technologies developed to unify the management of enterprise computing environments. WBEM includes the following specifications:
  - CIM XML: defines XML elements, conforming to DTD, which can be used to represent CIM classes and instances
  - CIMxml Operations over HTTP/HTTPS: defines a mapping of CIM operations onto HTTP/HTTPS; used as a transport mechanism
- Common Information Model (CIM). The data model for WBEM. Provides a common definition of management information for systems, networks, applications and services, and allows for vendor extensions. SMI-S is the interpretation of CIM for storage. It provides a consistent definition and structure of data, using object-oriented techniques. The standard language used to define elements of CIM is MOF.
- Service Location Protocol (SLP). Enables computers and other devices to find services in a local area network without prior configuration. SLP has been designed to scale from small, unmanaged networks to large enterprise networks.

Embedded SMI-S Array Provider

The embedded SMI-S array provider provides an implementation of SMI-S 1.5 using `cim-xml` over HTTP/HTTPS. SMI-enabled management clients such as HP SIM or HP Storage Essentials can perform storage management tasks such as monitoring, configuring or event-management. The provider supports the Array and Server profiles with additional (or supporting) subprofiles. The Server profile provides a mechanism to tell the client how to connect and use the embedded provider. The Array profile has the following supporting profiles and subprofiles:

- Array profile
- Block Services package
- Physical Package package
- Health package
- Multiple Computer System subprofile
- Masking and Mapping profile
- FC Target Ports subprofile
- SAS Target Ports subprofile

- iSCSI Target Ports subprofile
- Disk Drive Lite profile
- Extent Composition subprofile
- Storage Enclosure profile
- Fan profile
- Power Supply profile
- Sensors profile
- Access Points subprofile
- Location subprofile
- Software Inventory subprofile
- Block Server Performance subprofile
- Copy Services subprofile
- Job Control subprofile
- Storage Enclosure subprofile (if expansion enclosures are attached)
- Disk Sparing subprofile
- Object Manager Adapter subprofile
- DMTF Device Tray profile (if disk drawers exist)
- Thin Provisioning profile
- Pools from Volumes profile

The embedded SMI-S provider supports:

- HTTP/HTTPS using SSL encryption on the default port 5989, or standard HTTP/HTTPS on the default port 5988. Both ports cannot be enabled at the same time.
- SLPv2
- CIM Alert and Lifecycle indications
- Full Disk Encryption (FDE) (for QXS-4/6 Series only)
- Microsoft Windows Server 2012 Server Manager and System Center Virtual Machine Manager

SMI-S Implementation

SMI-S is implemented with the following components:

- CIM server (called a CIM Object Manager or CIMOM), which listens for WBEM requests (CIM operations over HTTP/HTTPS) from a CIM client, and responds.
- CIM provider, which communicates to a particular type of managed resource (for example, storage systems), and provides the CIMOM with information about them. In theory, providers for multiple types of devices (for example, storage systems and Brocade switches) can be plugged into the same CIMOM.

However, in practice, all storage vendors provide the CIMOM and a single provider together, and they do not co-exist well with solutions from other vendors.

These components may be provided in several different ways:

- Embedded agent: The hardware device has an embedded SMI-S agent. No other installation of software is required to enable management of the device.
- SMI solution: The hardware or software ships with an agent that is installed on a host. The agent needs to connect to the device and obtain unique identifying information.

SMI-S Architecture

The architecture requirements for the embedded SMI-S Array provider are to work within the Management Controller (MC) architecture, use limited disk space, use limited memory resources and be as fast as a proxy provider running on a server. The CIMOM used is the open source SFCB CIMOM.

SFCB is a lightweight CIM daemon that responds to CIM client requests and supports the standard CIM XML over `http/https` protocol. The provider is a CMPI (Common Management Protocol Interface) provider and uses this interface. To reduce the memory footprint, a third-party package called CIMPLE (www.simplewbem.org) is used. For more information on SFCB go to http://sourceforge.net/projects/sblim/files/sblim-sfcb.

About the SMI-S provider

The GL105 provider is a SMI-S 1.5 provider which passes CTP 1.5 tests. Full provisioning is supported. CTP results can be found at http://www.snia.org/ctp/conformingproviders/dothill.html.

The SMI-S provider is a full-fledged embedded provider implemented in the firmware. It provides an industry-standard WBEM-based management framework. SMI-S clients can interact with this embedded provider directly and do not need an intermediate proxy provider. The provider supports active management features such as RAID provisioning.

QXS-3/4/6 Series CNC and SAS systems are supported.

The embedded CIMOM can be configured either to listen to secure SMI-S queries from the clients on port 5989 and require credentials to be provided for all queries, or to listen to unsecure SMI-S queries from the clients on port 5988. This provider implementation complies with the SNIA SMI-S specification version 1.5.0.

Note: Port 5989 and port 5988 cannot be enabled at the same time.

The namespace details are given below.

- Implementation Namespace - `root/dhs`
- Interop Namespace - `root/interop`

The embedded provider set includes the following providers:

- Instance Provider
- Association Provider
- Method Provider
- Indication Provider

The embedded provider supports the following CIM operations:

- getClass
- enumerateClasses
- enumerateClassNames
- getInstance
- enumerateInstances
- enumerateInstanceNames
- associators
- associatorNames
- references
- referenceNames
- invokeMethod

SMI-S Profiles

SMI-S is organized around profiles, which describe objects relevant for a class of storage subsystem. SMI-S includes profiles for arrays, FC HBAs, FC switches, and tape libraries. Profiles are registered with the CIM server and advertised to clients using SLP.

Table 19: Supported SMI-S profiles

Profile/subprofile/package	Description
Array profile	Describes RAID array systems. It provides a high-level overview of the array system.
Block Services package	Defines a standard expression of existing storage capacity, the assignment of capacity to Storage Pools, and allocation of capacity to be used by external devices or applications.
Physical Package package	Models information about a storage system’s physical package and optionally about internal sub-packages.

Profile/subprofile/package	Description
Health package	Defines the general mechanisms used in expressing health in SMI-S.
Server profile	Defines the capabilities of a CIM object manager based on the communication mechanisms that it supports.
FC Target Ports profile	Models the Fibre Channel-specific aspects of a target storage system.
SAS Target Ports subprofile	Models the SAS-specific aspects of a target storage system.
iSCSI Target Ports subprofile	Models the iSCSI-specific aspects of a target storage system.
Access Points subprofile	Provides addresses of remote access points for management services.
Fan profile	Specializes the DMTF Fan profile by adding indications.
Power Supply profile	Specializes the DMTF Power Supply profile by adding indications.
Profile Registration profile	Models the profiles registered in the object manager and associations between registration classes and domain classes implementing the profile.
Software subprofile	Models software or firmware installed on the system.
Masking and Mapping profile	Models device mapping and masking abilities for SCSI systems.
Disk Drive Lite profile	Models disk drive devices.
Extent Composition	Provides an abstraction of how it virtualizes exposable block storage elements from the underlying Primordial storage pool.
Location subprofile	Models the location details of product and its sub-components.
Sensors profile	Specializes the DMTF Sensors profile.
Software Inventory profile	Models installed and available software and firmware.
Storage Enclosure profile	Describes an enclosure that contains storage elements (e.g., disk or tape drives) and enclosure elements (e.g., fans and power supplies).
Multiple Computer System subprofile	Models multiple systems that cooperate to present a “virtual” computer system with additional capabilities or redundancy.
Copy Services subprofile	Provides the ability to create and delete local snapshots and local volume copies (clones), and to reset the synchronization state between a snapshot and its source volume.
Job Control subprofile	Provides the ability to monitor provisioning operations, such as creating volumes and snapshots, and mapping volumes to hosts.

Profile/subprofile/package	Description
Disk Sparing subprofile	Provides the ability to describe the current spare disk configuration, to allocate/de-allocate spare disks, and to clear the state of unavailable disk drives.
Object Manager Adapter subprofile	Allows the client to manage the Object Manager Adapters of a SMI Agent. In particular, it can be used to turn the indication service on and off.
DMTF Device Tray profile	Models enclosure drawers and their relationship to the disks & sensors. Also, enables service personnel to flash the LEDs on the drawers and stop and start the drawers using SMI-S.
Thin Provisioning profile	Specializes the Block Services Package to add support for thin provisioning of volumes. SMI-S does not support the creation of virtual pools. However, a client can create virtual volumes.
Pools from Volumes profile	Models a pool created from other volumes. This profile is used in conjunction with the Thin Provisioning profile to model virtual storage pools.

Block Server Performance Subprofile

The implementation of the block server performance subprofile allows use of the `CIM_BlockStorageStatisticalData` classes and their associations, and the `GetStatisticsCollection`, `CreateManifestCollection`, `AddOrModifyManifest` and `RemoveManifest` methods.

The Block Server Performance subprofile collection of statistics updates at 60-second intervals.

CIM

Supported CIM Operations

SFCB provides a full set of CIM operations including `GetClass`, `ModifyClass`, `CreateClass`, `DeleteClass`, `EnumerateClasses`, `EnumerateClassNames`, `GetInstance`, `DeleteInstance`, `CreateInstance`, `ModifyInstance`, `EnumerateInstances`, `EnumerateInstanceNames`, `InvokeMethod` (`MethodCall`), `ExecQuery`, `Associators`, `AssociatorNames`, `References`, `ReferenceNames`, `GetQualifier`, `SetQualifier`, `DeleteQualifier`, `EnumerateQualifiers`, `GetProperty` and `SetProperty`.

CIM Alerts

The implementation of alert indications allows a subscribing CIM client to receive events such as FC cable connects, Power Supply events, Fan events, Temperature Sensor events and Disk Drive events.

If the storage system's SMI-S interface is enabled, the system will send events as indications to SMI-S clients so that SMI-S clients can monitor system performance. For information about enabling the SMI-S interface, see SMI-S Configuration on page 239.

In a dual-controller configuration, both controller A and B alert events are sent via controller A's SMI-S provider.

The event categories in Table 20 below pertain to FRU assemblies and certain FRU components.

Table 20: CIM Alert indication events

FRU/Event category	Corresponding SMI-S class	Operational status values that would trigger alert conditions
Controller	DHS_Controller	Down, Not Installed, OK
Hard Disk Drive	DHS_DiskDrive	Unknown, Missing, Error, Degraded, OK
Fan	DHS_PSUFan	Error, Stopped, OK
Power Supply	DHS_PSU	Unknown, Error, Other, Stressed, Degraded, OK
Temperature Sensor	DHS_OverallTempSensor	Unknown, Error, Other, Non-Recoverable Error, Degraded, OK
Battery/Super Cap	DHS_SuperCap	Unknown, Error, OK
FC Port	DHS_FCPort	Stopped, OK
SAS Port	DHS_SASTargetPort	Stopped, OK
iSCSI Port	DHS_ISCSIEthernetPort	Stopped, OK

Life Cycle Indications

The SMI-S interface provides CIM life cycle indications for changes in the physical and logical devices in the storage system. The SMI-S provider supports all mandatory elements and certain optional elements in SNIA SMI-S specification version 1.5.0. CIM Query Language (CQL) and Windows Management Instrumentation Query Language (WQL) are both supported, with some limitations to the CQL indication filter. The provider supports additional life cycle indications that the Windows Server 2012 operating system requires.

Table 21: Life cycle indications

Profile or subprofile	Element description and name	WQL or CQL
Block Services	`SELECT * FROM CIM_InstCreation WHERE SourceInstance ISA CIM_StoragePool` Send life cycle indication when a vdisk is created or deleted.	Both
Block Services	`SELECT * FROM CIM_InstCreation WHERE SourceInstance ISA CIM_StorageVolume` Send life cycle indication when a volume is created or deleted.	Both
Block Services	`SELECT * FROM CIM_InstModification WHERE SourceInstance ISA CIM_LogicalDevice` Send life cycle indication when disk drive (or any logical device) status changes.	Both
Copy Services	`SELECT * FROM CIM_InstModification WHERE SourceInstance ISA CIM_StorageSynchronized AND SourceInstance.SyncState <> PreviousInstance.SyncState` Send life cycle indication when the snapshot synchronization state changes.	CQL
Disk Drive Lite	`SELECT * FROM CIM_InstCreation WHERE SourceInstance ISA CIM_DiskDrive` Send life cycle indication when a disk drive is inserted or removed.	Both
Job Control	`SELECT * FROM CIM_InstModification WHERE SourceInstance ISA CIM_ConcreteJob AND SourceInstance.OperationalStatus=17 AND SourceInstance.OperationalStatus=2` Send life cycle indication when a create or delete operation completes for a volume, LUN, or snapshot.	WQL
Masking and Mapping	`SELECT * FROM CIM_InstCreation WHERE SourceInstance ISA CIM_AuthorizedSubject` Send life cycle indication when a host privilege is created or deleted.	Both
Masking and Mapping	`SELECT * FROM CIM_InstCreation WHERE SourceInstance ISA CIM_ProtocolController` Send life cycle indication when create/delete storage hardware ID (add/remove hosts).	Both
Masking and Mapping	`SELECT * FROM CIM_InstCreation WHERE SourceInstance ISA CIM_ProtocolControllerForUnit` Send life cycle indication when a LUN is created, deleted, or modified.	Both
Multiple Computer System	`SELECT * FROM CIM_InstCreation WHERE SourceInstance ISA CIM_ComputerSystem` Send life cycle indication when a controller is powered on or off.	Both

Profile or subprofile	Element description and name	WQL or CQL
Multiple Computer System	`SELECT * FROM CIM_InstModification WHERE SourceInstance ISA CIM_ComputerSystem AND SourceInstance.OperationalStatus <> PreviousInstance.OperationalStatus` Send life cycle indication when a logical component degrades or upgrades the system.	WQL
Multiple Computer System	`SELECT * FROM CIM_InstModification WHERE SourceInstance ISA CIM_RedundancySet AND SourceInstance.RedundancyStatus <> PreviousInstance.RedundancyStatus` Send life cycle indication when the controller active-active configuration changes.	WQL
Target Ports	`SELECT * FROM CIM_InstCreation WHERE SourceInstance ISA CIM_FCPort` Send life cycle indication when a target port is created or deleted.	Both
Target Ports	`SELECT * FROM CIM_InstModification WHERE SourceInstance ISA CIM_FCPort AND SourceInstance.OperationalStatus <> PreviousInstance.OperationalStatus` Send life cycle indication when the status of a target port changes.	WQL

SMI-S Configuration

In the default SMI-S configuration:

- The secure SMI-S protocol is enabled, which is the recommended protocol for SMI-S.
- The SMI-S interface is enabled for the `manage` user.

Table 22 below lists the CLI commands relevant to the SMI-S protocol:

Table 22: CLI commands for SMI-S protocol configuration

Action	CLI command
Enable secure SMI-S port 5989 (and disable port 5988)	`set protocols smis enabled`
Disable secure SMI-S port 5989	`set protocols smis disabled`
Enable unsecure SMI-S port 5988 (and disable port 5989)	`set protocols usmis disabled`
Enable unsecure SMI-S port 5988	`set protocol usmis enabled`
See the current status	`show protocols`
Reset all configurations	`reset smis-configurations`

To configure the SMI-S interface for other users

1. Log in as `manage`
2. If the user does not already exist, create one using this command:

   ```
   create user level manage username
   ```
3. Type this command:

   ```
   set user username interfaces wbi,cli,smis,ftp
   ```

Listening for managed-logs notifications

For use with the storage system's managed logs feature, the SMI-S provider can be set up to listen for notifications that log files have filled to a point that are ready to be transferred to a log-collection system. For more information about the managed logs feature, see About Managed Logs on page 26.

To set up SMI-S to listen for managed logs notifications

1. In the CLI, enter this command:

   ```
   set advanced-settings managed-logs enabled
   ```
2. In an SMI-S client:
   a. Subscribe using the `SELECT * FROM CIM_InstCreation WHERE SourceInstance ISA CIM_LogicalFile` filter.
   b. Subscribe using the `SELECT * FROM CIM_InstDeletion WHERE SourceInstance ISA CIM_LogicalFile` filter.

Testing SMI-S

Use an SMI-S certified client for SMI-S 1.5. HP has clients such as HP SIM and HP Storage Essentials. Other common clients are Microsoft System Center, IBM Tivoli, EMC CommandCenter and CA Unicenter. Common WBEM CLI clients are Pegasus `cimcli` and Sblim's `wbemcli`.

To certify that the array provider is SMI-S 1.5 compliant, SNIA requires that the providers pass the Conformance Test Program (CTP) tests.

The `reset smis-configuration` command enables the restoration of your original SMI-S configuration.

Troubleshooting

Table 23 below provides solutions to common SMI-S problems.

Table 23: Troubleshooting

Problem	Cause	Solution
Unable to connect to the embedded SMI-S Array provider.	SMI-S protocol is not enabled.	Log in to the array as `manage` and type: `set protocol smis enabled.`
HTTP Error (Invalid username/password or 401 Unauthorized).	User preferences are configurable for each user on the storage system.	Check that the user has access to the `smis` interface and set the user preferences to support the `smis` interface, if necessary. See SMI-S configuration for instructions on how to add users. Also verify the supplied credentials.
Want to connect securely as user name `my_xxxx`.	Need to add user	Log in to the array as `manage`. Type `create user level manage my_xxxuser` and then type `set user my_xxxuser interfaces wbi,cli,smis`
Unable to discover via SLP.	SLP multicast has limited range (known as hops).	Move the client closer to the array or set up a SLP DA server or using unicast requests.
Unable to determine if SMI-S is running.	Initial troubleshooting.	Install wbemcli on a Linux system by typing `apt-get install wbemcli` Type `wbemcli -nl -t -noverify ein 'https://manage:!manage@:5989/root/dhs:cim_computersystem'`
SMI-S is not responding to client requests.	SMI-S configuration may have become corrupted.	Use the CLI command `reset smis-configuration`. Refer to the CLI Reference Guide for further information.

Chapter 10: Administering a Log-collection System

This chapter contains the following topics:

Administering a log-collection system

A *log-collection system* receives log data that is incrementally transferred from a storage system for which the managed logs feature is enabled, and is used to integrate that data for display and analysis. For information about the managed logs feature, see About Managed Logs on page 26.

Over time, a log-collection system can receive many log files from one or more storage systems. The administrator organizes and stores these log files on the log-collection system. Then, if a storage system experiences a problem that needs analysis, that system's current log data can be collected and combined with the stored historical log data to provide a long-term view of the system's operation for analysis.

The managed logs feature monitors the following controller-specific log files:

- Expander Controller (EC) log, which includes EC debug data, EC revisions, and PHY statistics
- Storage Controller (SC) debug log and controller event log
- SC crash logs, which include the SC boot log

- Management Controller (MC) log

Each log-file type also contains system-configuration information.

How log files are transferred and identified

Log files can be transferred to the log-collection system in two ways, depending on whether the managed logs feature is configured to operate in *push mode* or *pull mode*:

- In push mode, when log data has accumulated to a significant size, the storage system sends notification events with attached log files through email to the log-collection system. The notification specifies the storage-system name, location, contact, and IP address, and contains a single log segment in a compressed zip file. The log segment will be uniquely named to indicate the log-file type, the date/time of creation, and the storage system. This information will also be in the email subject line. The file name format is `logtype_yyyy_mm_dd__hh_mm_ss.zip`.
- In pull mode, when log data has accumulated to a significant size, the system sends notification events via email, SNMP traps, or SMI-S to the log-collection system. The notification will specify the storage-system name, location, contact, and IP address and the log-file type (region) that needs to be transferred. The storage system's FTP interface can be used to transfer the appropriate logs to the log-collection system, as described in Transferring Log Data to a Log-collection System on page 219.

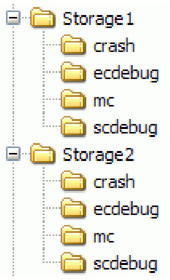
Log-file Details

- SC debug-log records contain date/time stamps of the form `mm/dd hh:mm:ss`.
- SC crash logs (diagnostic dumps) are produced if the firmware fails. Upon restart, such logs are available, and the restart boot log is also included. The four most recent crash logs are retained in the storage system.
- When EC debug logs are obtained, EC revision data and SAS PHY statistics are also provided.
- MC debug logs transferred by the managed logs feature are for five internal components: `appsv`, `mccli`, `logc`, `web`, and `snmpd`. The contained files are log-file segments for these internal components and are numbered sequentially.

Storing Log Files

It is recommended to store log files hierarchically by storage-system name, log-file type, and date/time. Then, if historical analysis is required, the appropriate log-file segments can easily be located and can be concatenated into a complete record.

For example, assume that the administrator of a log-collection system has created the following hierarchy for logs from two storage systems named Storage1 and Storage2:



In push mode, when the administrator receives an email with an attached `ecdebug` file from Storage1, the administrator would open the attachment and unzip it into the ecdebug subdirectory of the `Storage1` directory.

In pull mode, when the administrator receives notification that an SC debug log needs to be transferred from Storage2, the administrator would use the storage system's FTP interface to get the log and save it into the `scdebug` subdirectory of the `Storage2` directory.

Glossary

2U12	An enclosure that is two rack units in height and can contain 12 disks.
2U24	An enclosure that is two rack units in height and can contain 24 disks.
2U48	An enclosure that is two rack units in height and can contain 48 disks.
4U56	An enclosure that is four rack units in height and can contain 56 disks.
Additional Sense Code/Additional Sense Code Qualifier	*See* ASC/ASCQ.
Advanced Encryption Standard	*See* AES.
AES	Advanced Encryption Standard. A specification for the encryption of data using a symmetric-key algorithm.
Air Management Sled	*See* AMS.

Air Management Solution	*See* AMS.
allocated page	A page of storage-pool space that has been allocated to a volume to store data.
allocation rate	The rate, in pages per minute, at which a pool is allocating pages to its volumes because they need more space to store data.
ALUA	Asymmetric Logical Unit Access.
AMS	For a 2U12 or 2U24 enclosure, Air Management Sled. A drive blank designed to fill an empty disk slot in an enclosure to maintain optimum airflow through the chassis. For a 2U48 enclosure, Air Management Solution. A plastic insert designed to fill an empty disk bay (four disk slots) within a drawer to maintain optimum airflow through the chassis.
array	*See* storage system.
ASC/ASCQ	Additional Sense Code/Additional Sense Code Qualifier. Information on sense data returned by a SCSI device.
ATS	Automated tiered storage. A paged-storage feature that automatically uses the appropriate tier of disks to store data based on how frequently the data is accessed. This enables higher-cost, higher-speed disks to be used only for frequently needed data, while infrequently needed data can reside in lower-cost, lower-speed disks.
automated tiered storage	*See* ATS.
auto-write-through	*See* AWT.
available disk	A disk that is not a member of a disk group, is not configured as a spare, and is not in the leftover state. It is available to be configured as a part of a disk group or as a spare. *See also* compatible disk, dedicated spare, dynamic spare, and global spare.
AWT	Auto-write-through. A setting that specifies when the RAID controller cache mode automatically changes from write-back to write-through.
base volume	A virtual volume that is not a snapshot of any other volume, and is the root of a snapshot tree.
CAPI	Configuration Application Programming Interface. A proprietary protocol used for communication between the Storage Controller and the Management Controller in a controller module. CAPI is always enabled.
CHAP	Challenge-Handshake Authentication Protocol.
chassis	The sheetmetal housing of an enclosure.
child volume	The snapshot of a parent volume in a snapshot tree.

chunk size	The amount of contiguous data that is written to a disk group member before moving to the next member of the disk group.
CIM	Common Information Model. The data model for WBEM. It provides a common definition of management information for systems, networks, applications and services, and allows for vendor extensions.
CIM Query Language	*See* CQL.
CIMOM	Common Information Model Object Manager. A component in CIM that handles the interactions between management applications and providers.
CNC	Converged Network Controller. A controller module whose host ports can be set to operate in FC or iSCSI mode, using qualified SFP and cable options. Changing the host-port mode is also known as changing the ports’ personality.
comma separated values	*See* CSV.
Common Information Model	*See* CIM.
Common Information Model Object Manager	*See* CIMOM.
compatible disk	A disk that can be used to replace a failed member disk of a disk group because it both has enough capacity and is of the same type (enterprise SAS, for example) as the disk that failed. *See also* available disk, dedicated spare, dynamic spare, and global spare.
complex programmable logic device	*See* CPLD.
Configuration Application Programming Interface	*See* CAPI.
controller A (or B)	A short way of referring to controller module A (or B).
controller enclosure	An enclosure that contains one or two controller modules.

controller module	A FRU that contains the following subsystems and devices: a Storage Controller processor; a Management Controller processor; a SAS expander and Expander Controller processor; management interfaces; cache protected by a supercapacitor pack and nonvolatile memory (CompactFlash); host, expansion, network, and service ports; and midplane connectivity.
converged network controller	*See* CNC.
Coordinated Universal Time	*See* UTC.
CPLD	Complex programmable logic device. An electronic component used to build reconfigurable digital circuits. It can replace large numbers of logic gates.
CQL	CIM Query Language.
CRC	Cyclic Redundancy Check. A mathematical algorithm that, when implemented in software or hardware, can be used to detect errors in data.
CSV	Comma separated values. A format to store tabular data in plain-text form.
Cyclic Redundancy Check	*See* CRC.
DAS	Direct Attached Storage. A dedicated storage device that connects directly to a host without the use of a switch.
Data Encryption Standard	*See* DES.
deallocation rate	The rate, in pages per minute, at which a pool is deallocating pages from its volumes because they no longer need the space to store data.
dedicated spare	A disk that is reserved for use by a specific linear disk group to replace a failed disk. *See also* available disk, compatible disk, dynamic spare, and global spare.
default mapping	Host-access settings that apply to all initiators that are not explicitly mapped to that volume using different settings. *See also* explicit mapping and masking.
DES	Data Encryption Standard. An algorithm for the encryption of electronic data.
DHCP	Dynamic Host Configuration Protocol. A network configuration protocol for hosts on IP networks.
Direct Attached Storage	*See* DAS.

disk group	A set of disk drives that is configured to use a specific RAID type and provides storage capacity for a pool. *See also* linear disk group and virtual disk group.
Distributed Management Task Force	*See* DMTF.
DMTF	Distributed Management Task Force. An industry organization that develops and maintains standards for system management.
drain	Moving active volume data from a virtual disk group to other disk-group members within the same pool.
drawer	In a 2U48 enclosure, one of three FRUs that each holds up to 16 disks. In a 4U56 enclosure, one of two FRUs that each holds 28 disks.
drive enclosure	*See* expansion enclosure. *See also* JBOD.
drive spin down	*See* DSD.
DRM	Disaster recovery management. Storage-system firmware features that, when the Site Replication Adapter (SRA) feature is enabled, support the use of VMware's Site Recovery Manager to automate disaster-recovery failover and failback tasks. *See also* SRA.
DSD	Drive spin down. A power-saving feature that monitors disk activity in the storage system and spins down inactive disks based on user-selectable policies. Drive spin down is not applicable to disks in virtual pools.
dual-port disk	A disk that is connected to both controllers so it has two data paths, achieving fault tolerance.
Dynamic Host Configuration Protocol	*See* DHCP.
dynamic spare	An available compatible disk that is automatically assigned, if the dynamic spares option is enabled, to replace a failed disk in a disk group with a fault-tolerant RAID level. *See also* available disk, compatible disk, dedicated spare, and global spare.
EC	Expander Controller. A processor (located in the SAS expander in each controller module and expansion module) that controls the SAS expander and provides SES functionality. *See also* EMP, MC, and SC.
EMP	Enclosure management processor. An EC subsystem that provides SES data such as temperature, power supply and fan status, and the presence or absence of disks.
enclosure	A physical storage device that contains I/O modules, disk drives, and other FRUs.
enclosure management processor	*See* EMP.

Expander Controller	*See* EC.
expansion enclosure	An enclosure that contains one or two expansion modules. Expansion enclosures can be connected to a controller enclosure to provide additional storage capacity. *See also* JBOD.
expansion module	A FRU that contains the following subsystems and devices: a SAS expander and EC processor; host, expansion, and service ports; and midplane connectivity.
explicit mapping	Access settings for an initiator to a volume that override the volume’s default mapping. *See also* default mapping and masking.
failback	*See* recovery.
failover	In an active-active configuration, failover is the act of temporarily transferring ownership of controller resources from an offline controller to its partner controller, which remains operational. The resources include pools, volumes, cache data, host ID information, and LUNs and WWNs. *See* recovery.
fan module	The fan FRU used in 4U56 enclosures. There are two in each enclosure, separate from the PSUs.
FC	Fibre Channel interface protocol.
FC-AL	Fibre Channel Arbitrated Loop. The FC topology in which devices are connected in a one-way loop.
FDE (for QXS-4/6 Series only)	Full disk encryption. A method by which you can secure the data residing on a system. *See also* lock key, passphrase, repurpose, and SED.
Fibre Channel Arbitrated Loop	*See* FC-AL.
field-programmable gate array	*See* FPGA.
FPGA	Field-programmable gate array. An integrated circuit designed to be configured after manufacturing.
FRU	Field-replaceable unit. A part that can be removed and replaced by the user or support technician without having to send the product to a repair facility.
full disk encryption (for QXS-4/6 Series only)	*See* FDE.

global spare	A compatible disk that is reserved for use by any disk group with a fault-tolerant RAID level to replace a failed disk. *See also* available disk, compatible disk, dedicated spare, and dynamic spare.
HBA	Host bus adapter. A device that facilitates I/O processing and physical connectivity between a host and the storage system.
host	(v3) A user-defined group of initiators that represents a server or switch. (v2) An external port that the storage system is attached to. The external port may be a port in an I/O adapter in a server, or a port in a network switch. Product interfaces use the terms host and initiator interchangeably.
host bus adapter	*See* HBA.
host group	A user-defined group of hosts for ease of management, such as for mapping operations.
host port	A port on a controller module that interfaces to a host computer, either directly or through a network switch.
image ID	A globally unique serial number that identifies the point-in-time image source for a volume. All volumes that have identical image IDs have identical data content, whether they be snapshots or stand-alone volumes.
initiator	(v3) An external port to which the storage system is connected. The external port may be a port in an I/O adapter in a server, or a port in a network switch. (v2) *See* host.
I/O Manager	A MIB-specific term for a controller module.
I/O module	*See* IOM.
IOM	Input/output module. An IOM can be either a controller module or an expansion module.
IQN	iSCSI Qualified Name.
iSCSI	Internet SCSI interface protocol.
iSNS	Internet Storage Name Service.
JBOD	“Just a bunch of disks.” *See* drive enclosure.
large form factor	*See* LFF.
LBA	Logical Block Address. The address used for specifying the location of a block of data.

leftover	The state of a disk that the system has excluded from a disk group because the timestamp in the disk's metadata is older than the timestamp of other disks in the disk group, or because the disk was not detected during a rescan. A leftover disk cannot be used in another disk group until the disk's metadata is cleared; for information and cautions about doing so, see documentation topics about clearing disk metadata.
LFF	Large form factor.
linear	The storage-class designation for logical components such as volumes that do not use paged-storage technology to virtualize data storage. The linear method stores user data in sequential, fully allocated physical blocks, using a fixed (static) mapping between the logical data presented to hosts and the physical storage where it is stored.
linear disk group	A set of disk drives that is configured to use a specific RAID type. The number of disks that a linear disk group can contain is determined by its RAID level. Any supported RAID level can be used. When a linear disk group is created, a linear pool with the same name is also created to represent the volume-containment properties of the disk group. *See also* linear pool.
linear pool	A container for volumes that is composed of one linear disk group.
LIP	Loop Initialization Primitive. An FC primitive used to determine the loop ID for a controller.
lock key (for QXS-4/6 Series only)	A system-generated value that manages the encryption and decryption of data on FDE-capable disks. *See also* FDE and passphrase.
logical block address	*See* LBA.
Logical Unit Number	*See* LUN.
loop	*See* FC-AL.
Loop Initialization Primitive	*See* LIP.
LUN	Logical Unit Number. A number that identifies a mapped volume to a host system.
MAC address	Media Access Control Address. A unique identifier assigned to network interfaces for communication on a network.
Management Controller	*See* MC.
Management Information Base	*See* MIB.

map/mapping	Settings that specify whether a volume is presented as a storage device to a host system, and how the host system can access the volume. Mapping settings include an access type (read-write, read-only, or no access), controller host ports through which initiators may access the volume, and a LUN that identifies the volume to the host system. *See also* default mapping, explicit mapping, and masking.
masking	A volume-mapping setting that specifies no access to that volume by hosts. *See also* default mapping and explicit mapping.
master volume	A volume that is enabled for snapshots and has an associated snap pool.
MC	Management Controller. A processor (located in a controller module) that is responsible for human-computer interfaces, such as the WBI, and computer-computer interfaces, such as SNMP, and interacts with the Storage Controller. *See also* EC and SC.
Media Access Control Address	*See* MAC address.
metadata	Data in the first sectors of a disk drive that stores all disk-, disk-group-, and volume-specific information including disk group membership or spare identification, disk group ownership, volumes and snapshots in the disk group, host mapping of volumes, and results of the last media scrub.
MIB	Management Information Base. A database used for managing the entities in SNMP.
mount	To enable access to a volume from a host OS. *See also* host, map/mapping, and volume.
network port	The Ethernet port on a controller module through which its Management Controller is connected to the network.
network time protocol	*See* NTP.
NTP	Network time protocol.
object identifier	*See* OID.
OID	Object Identifier. In SNMP, an identifier for an object in a MIB.
orphan data	*See* unwritable cache data.
overcommit	A setting that controls whether a virtual pool is allowed to have volumes whose total size exceeds the physical capacity of the pool.
overcommitted	The amount of storage capacity that is allocated to volumes exceeds the physical capacity of the storage system.
page	A range of contiguous LBAs in a virtual disk group.

paged storage	A method of mapping logical host requests to physical storage that maps the requests to virtualized “pages” of storage that are in turn mapped to physical storage. This provides more flexibility for expanding capacity and automatically moving data than the traditional, linear method in which requests are directly mapped to storage devices. Paged storage is also called virtual storage.
parent volume	A volume that has snapshots (can be either a base volume or a base snapshot volume). The parent of a snapshot is its immediate ancestor in the snapshot tree.
partner firmware update	*See* PFU.
passphrase (for QXS-4/6 Series only)	A user-created password that allows users to manage lock keys in an FDE-capable system. *See also* FDE and lock key.
PCBA	Printed circuit board assembly.
PFU	Partner firmware update. The automatic update of the partner controller when the user updates firmware on one controller.
PGR	Persistent group reservations.
PHY	One of two hardware components that form a physical connection between devices in a SAS network that enables transmission of data.
physical layer	*See* PHY.
point-to-point	Fibre Channel Point-to-Point topology in which two ports are directly connected.
pool	*See* linear pool and virtual pool.
POST	Power-on self test. Tests that run immediately after a device is powered on.
Power-On Self Test	*See* POST.
power supply unit	*See* PSU.
primary system	For virtual replication, the storage system that contains a replication set's primary volume. See also replication set, secondary system.
primary volume	For virtual replication, the source volume in a replication set. This volume's data will be replicated to the secondary volume in the secondary system. See also replication set, secondary volume.
proxy volume	A virtual volume in the local system that represents a volume in a remote system. Proxy volumes are used internally by the controllers to perform actions such as transferring replication data.

PSU	Power supply unit. The power supply FRU.
quick rebuild	A feature for virtual storage that reduces the time that user data is less than fully fault-tolerant after a disk failure in a disk group. The quick-rebuild process rebuilds only data stripes that contain user data. Data stripes that have not been allocated to user data are rebuilt in the background.
RAID head	*See* controller enclosure.
read cache (for QXS-4/6 Series only)	A special disk group using SSDs that can be added to a virtual pool for the purpose of speeding up read access to data stored on spinning disks elsewhere in the pool. Read cache is also referred to as read flash cache.
read flash cache (for QXS-4/6 Series only)	*See* read cache.
recovery	In an active-active configuration, recovery is the act of returning ownership of controller resources to a controller (which was offline) from its partner controller. The resources include volumes, cache data, host ID information, and LUNs and WWNs. *See also* failover.
remote replication	Asynchronous (batch) replication of block-level data from a volume in a primary system to a volume in one or more secondary systems by creating a replication snapshot of the primary volume and copying the snapshot data to the secondary systems via Fibre Channel or iSCSI links. The capability to perform remote replication is a licensed feature (AssuredRemote).
remote syslog support	*See* syslog.
replication image	For linear storage, a conceptual term for replication snapshots that have the same image ID in primary and secondary systems. These synchronized snapshots contain identical data and can be used for disaster recovery.
replication-prepared volume	For linear storage, a volume created for the purpose of being the secondary volume in a replication set. Replication-prepared volumes are automatically created by the WBI Replication Setup Wizard, or they can be created manually in the CLI or the WBI.
replication set	For virtual replication, a container that houses the infrastructure upon which replications are performed. It defines a relationship between a primary and secondary volume for the purposes of maintaining a remote copy of the primary volume on a peer system. See primary volume and secondary volume.

replication snapshot	For linear storage, a special type of snapshot, created by the remote replication feature, that preserves the state of data of a replication set's primary volume as it existed when the snapshot was created. For a primary volume, the replication process creates a replication snapshot on both the primary system and, when the replication of primary-volume data to the secondary volume is complete, on the secondary system. Replication snapshots are unmappable and are not counted toward a license limit, although they are counted toward the system's maximum number of volumes. A replication snapshot can be exported to a regular, licensed snapshot. *See also* replication sync point.
replication sync point	The state of a replication snapshot whose corresponding primary or secondary snapshot exists and contains identical data. For a replication set, four types of sync point are identified: the only replication snapshot that is copy-complete on any secondary system is the “only sync point”; the latest replication snapshot that is copy-complete on any secondary system is the “current sync point”; the latest replication snapshot that is copy-complete on all secondary systems is the “common sync point”; a common sync point that has been superseded by a new common sync point is an “old common sync point.”
repurpose (for QXS-4/6 Series only)	A method by which all data on a system or disk is erased in an FDE-capable system. Repurposing unsecures the system and disks without needing the correct passphrase. *See also* FDE and passphrase.
RFC (for QXS-4/6 Series only)	Read flash cache. *See* read cache.
SAS	Serial Attached SCSI interface protocol or disk-drive architecture.
SC	Storage Controller. A processor (located in a controller module) that is responsible for RAID controller functions. The SC is also referred to as the RAID controller. *See also* EC and MC.
SCSI Enclosure Services	*See* SES.
secondary system	The storage system that contains a replication set's secondary volume. See also replication set, primary system.
secondary volume (linear replication)	For linear replication, the volume that is the destination for data in a replication set and that is not accessible to hosts. For disaster recovery purposes, if the primary volume goes offline, a secondary volume can be designated as the primary volume. The secondary volume exists in a secondary disk group in a secondary (or remote) storage system. The contents of a secondary volume are in a constant state of flux and are not in a consistent state while a replication is in process. Only snapshots that are associated with a secondary volume are data consistent.
secondary volume (virtual replication)	For virtual replication, the volume on the remote peer system that represent the copy created and maintained by a replication set. Certain operations on this volume are restricted but it may be snapped at any time to create writable volumes. See also primary volume, replication set.

secret	For use with CHAP, a password that is shared between an initiator and a target to enable authentication.
secure hash algorithm	*See* SHA.
secure shell	*See* SSH.
Secure Sockets Layer	*See* SSL.
SED (for QXS-4/6 Series only)	Self-encrypting drive. A disk drive that provides hardware-based data encryption and supports use of the storage system’s Full Disk Encryption feature. *See also* FDE.
SEEPROM	Serial electrically erasable programmable ROM. A type of nonvolatile (persistent if power removed) computer memory used as FRU ID devices.
Self-Monitoring Analysis and Reporting Technology	*See* SMART.
serial electrically erasable programmable ROM	*See* SEEPROM.
Service Location Protocol	*See* SLP.
SES	SCSI Enclosure Services. The protocol that allows the initiator to communicate with the enclosure using SCSI commands.
SFCB	Small Footprint CIM Broker.
SFF	Small form factor. A type of disk drive.
SHA	Secure Hash Algorithm. A cryptographic hash function.
SLP	Service Location Protocol. Enables computers and other devices to find services in a local area network without prior configuration.
Small Footprint CIM Broker	*See* SFCB.
small form factor	*See* SFF.

SMART	Self-Monitoring Analysis and Reporting Technology. A monitoring system for disk drives that monitors reliability indicators for the purpose of anticipating disk failures and reporting those potential failures.
SMI-S	Storage Management Initiative - Specification. The SNIA standard that enables interoperable management of storage networks and storage devices. The interpretation of CIM for storage. It provides a consistent definition and structure of data, using object-oriented techniques.
snap pool	A volume that stores data that is specific to snapshots of an associated master volume, including copy-on-write data and data written explicitly to the snapshots. A snap pool cannot be mapped.
snapshot	A point-in-time copy of the data in a source volume that preserves the state of the data as it existed when the snapshot was created. Data associated with a snapshot is recorded in both the source volume and in its associated snap pool. A snapshot can be mapped and written to. The capability to create snapshots is a licensed feature (AssuredSnap). Snapshots that can be mapped to hosts are counted against the snapshot-license limit, whereas transient and unmappable snapshots are not.
snapshot tree	A group of virtual volumes that are interrelated due to creation of snapshots. Since snapshots can be taken of existing snapshots, volume inter-relationships can be thought of as a “tree” of volumes. A tree can be 254 levels deep. *See also* base volume, child volume, parent volume, and source volume.
SNIA	Storage Networking Industry Association. An association regarding storage networking technology and applications.
source volume	A volume that has snapshots. Used as a synonym for parent volume.
sparse snapshot	A type of point-in-time copy that preserves the state of data at an instant in time by storing only those blocks that are different from an already existing full copy of the data.
SRA	Storage Replication Adapter. A host-based software component that allows VMware’s Site Recovery Manager to manage the storage-system firmware’s disaster recovery management (DRM) features, automating disaster-recovery failover and failback tasks. The SRA uses the CLI XML API to control the storage system. *See also* DRM.
SSD (for QXS-4/6 Series only)	Solid-state drive.
SSH	Secure Shell. A network protocol for secure data communication.
SSL	Secure Sockets Layer. A cryptographic protocol that provides security over the internet.
standard volume	A volume that can be mapped to initiators and presented as a storage device to a host system, but is not enabled for snapshots.

Storage Controller	*See* SC.
Storage Management Initiative - Specification	*See* SMI-S.
Storage Networking Industry Association	*See* SNIA.
storage system	A controller enclosure with at least one connected drive enclosure. Product documentation and interfaces use the terms storage system and system interchangeably.
syslog	A protocol for sending event messages across an IP network to a logging server.
thin provisioning	A feature that allows actual storage for a virtual volume to be assigned as data is written, rather than storage being assigned immediately for the eventual size of the volume. This allows the storage administrator to overcommit physical storage, which in turn allows the connected host system to operate as though it has more physical storage available than is actually allocated to it. When physical resources fill up, the storage administrator can add storage capacity on demand.
tier	A homogeneous set of disk drives, typically of the same capacity and performance level, that comprise one or more disk groups in the same pool. Tiers differ in their performance, capacity, and cost characteristics, which forms the basis for the choices that are made with respect to which data is placed in which tier. The predefined tiers are: • Performance, which uses SAS SSDs (high speed, low capacity) for QXS-4/6 Series only. • Standard, which uses enterprise-class spinning SAS disks (lower speed, higher capacity) • Archive, which uses midline spinning SAS disks (low speed, high capacity).
tier migration	The automatic movement of blocks of data, associated with a single volume, between tiers based on the access patterns that are detected for the data on that volume.
tray	*See* enclosure.
UCS Transformation Format - 8-bit	*See* UTF-8.
ULP	Unified LUN Presentation. A RAID controller feature that enables a host system to access mapped volumes through any controller host port. ULP incorporates Asymmetric Logical Unit Access (ALUA) extensions.

undercommitted	The amount of storage capacity that is allocated to volumes is less than the physical capacity of the storage system.
Unified LUN Presentation	*See* ULP.
unmount	To remove access to a volume from a host OS.
unwritable cache data	Cache data that has not been written to disk and is associated with a volume that no longer exists or whose disks are not online. If the data is needed, the volume's disks must be brought online. If the data is not needed it can be cleared, in which case it will be lost and data will differ between the host system and disk. Unwritable cache data is also called orphan data.
UTC	Coordinated Universal Time. The primary time standard by which the world regulates clocks and time. It replaces Greenwich Mean Time.
UTF-8	UCS transformation format - 8-bit. A variable-width encoding that can represent every character in the Unicode character set used for the CLI and WBI interfaces.
v2	The legacy interface for managing linear storage. This is the default for a system that has been upgraded from a previous release.
v3	The new interface for managing virtual and linear storage. This is the default for a new installation.
vdisk	A virtual disk comprising the capacity of one or more disks. The number of disks that a vdisk can contain is determined by its RAID level. *See* linear disk group.
vdisk spare	*See* dedicated spare.
virtual	The storage-class designation for logical components such as volumes that use paged-storage technology to virtualize data storage. *See* paged storage.
virtual disk	*See* vdisk.
virtual disk group	A set of disk drives that is configured to use a specific RAID type. A virtual disk group can use RAID 1, 5, 6, or 10. A virtual disk group can be added to a new or existing virtual pool. *See also* virtual pool.
virtual pool	A container for volumes that is composed of one or more virtual disk groups.
volume	A logical representation of a fixed-size, contiguous span of storage that is presented to host systems for the purpose of storing data.
volume copy	An independent copy of the data in a linear volume. The capability to create volume copies is a licensed feature (AssuredCopy) that makes use of snapshot functionality.
volume group	A user-defined group of volumes for ease of management, such as for mapping operations.
WBEM	Web-Based Enterprise Management. A set of management and internet standard technologies developed to unify the management of enterprise computing environments.

web-based interface/web-browser interface	*See* WBI.
WBI	Web-browser interface, called Storage Management Console. The primary interface for managing the system. A user can enable the use of HTTP, HTTPS for increased security, or both.
Web-Based Enterprise Management	*See* WBEM.
World Wide Name	*See* WWN.
World Wide Node Name	*See* WWNN.
World Wide Port Name	*See* WWPN.
WWN	World Wide Name. A globally unique 64-bit number that identifies a device used in storage technology.
WWNN	World Wide Node Name. A globally unique 64-bit number that identifies a device.
WWPN	World Wide Port Name. A globally unique 64-bit number that identifies a port.