HP StorageWorks

Enterprise Backup Solution design guide

Part number: 342250-005
Fifth edition: December 2005

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Contents

About this guide

This design guide provides information to help you design an HP StorageWorks Enterprise Backup Solution.

Intended audience

This guide is intended for use by system administrators implementing an EBS, who are experienced with the following:

- Tape backup technologies, tape libraries, and backup software
- SAN environments
- Fibre Channel

Prerequisites

Before you install your EBS hardware, make sure you consider the items below:

- Review of the EBS compatibility matrix to be sure that the components you have selected are listed
- Knowledge of the operating system(s)
- Knowledge of EBS hardware components listed in Chapter 1
- Knowledge of switch zoning and selective storage presentation

Related documentation

- In addition to this guide, HP provides corresponding information:
- EBS Compatibility Matrix
- Implementation Guides for supported backup applications
- Installation Guides for EBS hardware components

Document conventions and symbols

Table 1 Document conventions

Convention	Element
Medium blue text: Figure 1	Cross-reference links and e-mail addresses
Medium blue, underlined text (http://www.hp.com)	Web site addresses
Bold font	• 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
Italics font	Text emphasis
`Monospace font`	• File and directory names • System output • Code • Text typed at the command-line
`Monospace, italic font`	• Code variables • Command-line variables
`Monospace, bold font`	Emphasis of file and directory names, system output, code, and text typed at the command line

⚠ **WARNING!** Indicates that failure to follow directions could result in bodily harm or death.

△ **CAUTION:** Indicates that failure to follow directions could result in damage to equipment or data.

IMPORTANT: Provides clarifying information or specific instructions.

NOTE: Provides additional information.

TIP: Provides helpful hints and shortcuts.

Rack stability

⚠ **WARNING!** To reduce the risk of personal injury or damage to equipment:

- Extend leveling jacks to the floor.
- Ensure that the full weight of the rack rests on the leveling jacks.
- Install stabilizing feet on the rack.
- In multiple-rack installations, secure racks together.
- Extend only one rack component at a time. Racks may become unstable if more than one component is extended.

HP technical support

Telephone numbers for worldwide technical support are listed on the HP support web site: http://www.hp.com/support/.

Collect the following information before calling:

- Technical support registration number (if applicable)
- Product serial numbers
- Product model names and numbers
- Applicable error messages
- Operating system type and revision level
- Detailed, specific questions

For continuous quality improvement, calls may be recorded or monitored.

HP strongly recommends that customers sign up online using the Subscriber's choice web site: http://www.hp.com/go/e-updates.

- Subscribing to this service provides you with e-mail updates on the latest product enhancements, newest versions of drivers, and firmware documentation updates as well as instant access to numerous other product resources.
- After signing up, you can quickly locate your products by selecting **Business support** and then **Storage** under Product Category.

HP-authorized reseller

For the name of your nearest HP-authorized reseller:

- In the United States, call 1-800-345-1518.
- Elsewhere, visit the HP web site: http://www.hp.com. Then click **Contact HP** to find locations and telephone numbers.

Helpful web sites

For third-party product information, see the following HP web sites:

- http://www.hp.com
- http://www.hp.com/go/storage
- http://www.hp.com/support/
- http://www.docs.hp.com

1 Overview

The HP StorageWorks Enterprise Backup Solution (EBS) is an integration of data protection software and industry-standard hardware, providing a complete enterprise class solution. HP has joined with leading software companies to provide software solutions that support the backup and restore processes of homogeneous and heterogeneous operating systems in a shared storage environment.

EBS software partner's data protection solutions incorporate database protection, storage management agents, and options for highly specialized networking environments.

Data protection software focuses on data backup and restore using an automated LTO Ultrium, SuperDLT, or DLT tape library and Fibre Channel technology. The EBS combines the functionality and management of Fibre Channel Storage Area Network (SAN), data protection software, and scaling tools to integrate tape and disk storage subsystems in the same SAN environment.

Enterprise data backup and restore can be accomplished with different tape devices in various configurations, using a variety of transport methods such as the corporate communication network, a server SCSI bus, or a Fibre Channel infrastructure. EBS uses a storage area network (SAN) that provides dedicated bandwidth independent of the local area network (LAN). This independence allows single or multiple backup or restore jobs to run without the network traffic caused by data protection environments.

Depending on the backup software used, submitted jobs are run locally on the backup server to which the job was submitted. Data, however, is sent over the SAN to the tape library rather than over the LAN. This achieves greater speed and reduces network traffic. Jobs and devices can be managed and viewed from either the primary or any server or client connected within the EBS which has the supported data protection software solution installed. All servers within the EBS server group can display the same devices.

The first step in implementing an EBS solution is to consult the EBS Compatibility Matrix available at: http://www.hp.com/go/ebs

This EBS design guide is the second step in implementing your Enterprise Backup Solution. This guide describes the EBS hardware configurations currently supported and how to efficiently and effectively provide shared tape library backup in a heterogeneous SAN environment.

The third step in implementing your Enterprise Backup Solution is installing and configuring your backup application or backup software. Rules and recommendations for individual backup applications and software may be found in separate implementation guides.

For more information about EBS, go to http://www.hp.com/go/ebs.

Supported components

For complete EBS configuration support information, refer to the EBS Compatibility Matrix located at:

http://www.hp.com/go/ebs

Supported topologies

A Fibre Channel SAN supports several network topologies, including point-to-point and switched fabric. These configurations are constructed using switches and routers.

Direct Attach SCSI

Direct Attach SCSI (DAS) is the most common form of attachment to both disk and tape drives. DAS allows a single server to communicate directly to the given target device over a SCSI cable. DAS configurations do not allow for multihosting a single target device as the target device is dedicated to the server. DAS configurations are not covered in this document.

Point-to-Point

Point-to-Point, or Direct Attach Fibre (DAF), connections are direct Fibre Channel connections made between two nodes, such as a server and an attached tape library. This configuration requires no switch to implement. It is very similar to a SCSI bus model, in that the storage devices are dedicated to a server.

Switched fabric

A switched-fabric topology allows nodes to talk directly to each other through temporarily established direct connections. This provides simultaneous dedicated bandwidth for each communication between nodes.

Because of this, switched fabric topologies provide significantly more performance and scalability than arbitrated loop topologies.

Also, switched fabric topologies do not suffer from susceptibility to I/O interruptions due to errors, resets, or power failures from third party nodes. Because communications are established directly between nodes, interruption events are isolated by the fabric environment.

Finally, because many nodes never need to communicate with each other, such as between two hosts, interoperability issues are significantly reduced in a fabric topology as compared to loops. Nodes need only interoperate with the switch and the target node instead of every node on the loop or fabric.

Switched fabric configurations are implemented with Fibre Channel switches. Switches may be cascaded or meshed together to form larger fabrics.

NOTE: See Figure 14, Figure 15, and Figure 27 for an example of basic switched fabric, point-to-point, and direct attached SCSI configurations.

Platform and operating system support

Library sharing in a heterogeneous environment is supported. All platforms may be connected through one or more switches to a tape library. The switches do not need to be separated by operating system type, nor do they have to be configured with separate zones for each operating system.

The host server needs to detect all of the tape and robotic devices intended to be used; shared access to tape drives is handled by the backup application software running on each host.

While some operating systems found in enterprise data centers may not be supported on the storage network by EBS, it is still possible to back up these servers as clients over the LAN and still be supported. See Figure 14 for a diagram that includes LAN client connections. Refer to your ISV compatibility matrix for more information.

Use of native backup programs and commands

A limited number of backup programs and commands that are native to a particular operating system (such as `tar`, `cpio`, `dd`, `fbackup`, `NTBackup`, and so on) are verified for basic functionality with SCSI direct-attached autoloaders only. Tape libraries and virtual library systems are not tested. These programs and commands are limited in their ability to handle complicated backups and restores in multi-host, storage area networks (SANs). They are not guaranteed to provide robust error handling or performance throughput. Use of these programs and/or commands in a user developed script is not recommended for use with tape libraries in an Enterprise Backup Solution shared storage environment. Refer to the EBS compatibility matrix at http://www.hp.com/go/ebs for a list of tested and supported applications that are specifically designed for backup and restore operations.

2. Hardware Setup

Components

Table 2 provides a description of the key components comprising a SAN backup solution.

NOTE: For a complete listing of supported servers and hardware, refer to the HP Enterprise Backup Solutions compatibility matrix at http://www.hp.com/go/ebs.

For more information on HP StorageWorks libraries, see http://www.hp.com/go/tape.

Table 2 SAN backup components

Component	Description
Host Bus Adapter	Host bus adapters (HBAs) are used to connect servers to Fibre Channel topologies. They provide a similar function to SCSI host bus adapters or network interface cards (NIC). The device driver for an HBA is typically responsible for providing support for any of the Fibre Channel topologies – point-to-point, loop, or fabric. In most cases, the device driver also provides a translation function of presenting Fibre Channel targets as SCSI devices to the operating system. This provides compatibility with existing storage applications and file systems that were developed for SCSI devices.
Switch	Switches are the Fibre Channel infrastructure component used to construct fabrics. Switches may be cascaded together to configure larger fabrics. Switches typically have an Ethernet port for managing them over the network. This port provides status and configuration for the switch and individual ports.
Tape Library	The tape library and tape drives it contains provide the nearline storage for backup on the SAN. The tape library provides automated tape handling which becomes a key requirement when consolidating backup across multiple servers.
Fibre Channel Interface Controller	The controller (also referred to as a bridge or router) device provides connection between Fibre Channel networks and SCSI tape and robotic devices. This device is similar to a Fibre Channel disk controller for RAID subsystems. The controller acts as an interface to the SCSI device, and can send or receive SCSI commands through encapsulated Fibre Channel frames.
Fibre Channel Interface Manager	The Interface Manager card, in conjunction with HP StorageWorks Command View TL software, provides remote management of the library via a serial, telnet, or web-based GUI interface.
Cables and SFPs	Three types of cables exist to connect Fibre Channel devices together – copper cables, short-wave or multi-mode optical cables, and long-wave or single-mode optical cables. Each type of cable provides different maximum lengths, as well as cost. Fibre Channel devices have ports which either require a specific type of cable, or require a separate module referred to as an SFP (Small Form-factor Pluggable). An SFP-based port allows the customer to use any type of cable by utilizing the appropriate type of SFP with it. For example, Fibre Channel ports use fibre-optic SFP modules with LC connectors.
Data Protection Software	Data protection software is deployed on each of the hosts on a SAN that will perform backup. This typically requires installing server-type licenses and software on each of these hosts. Many of these backup applications also provide a separate module or option, which enables software to manage shared access to the tape drives on a SAN. This may need to be purchased in addition to the typical software licenses.
SAN Management Software	SAN Management software is used to manage resources, security, and functionality on a SAN. This can be integrated with host-based device management utilities or embedded management functionality such as switch Ethernet ports.

HP StorageWorks ESL E-Series tape libraries

The HP StorageWorks ESL E-Series enterprise tape library scales up to 712 LTO or 630 SDLT cartridge slots in a single library frame, 1410 LTO slots or 1248 SDLT slots in a dual frame. Offered with Ultrium 460, Ultrium 960, SDLT 320, and SDLT 600 tape technologies, the ESL E-Series offers storage density of up to 28.4 terabytes per square foot of floor space.

Each single library frame may contain up to 24 tape drives (four drives per drive cluster) as shown in Figure 1. Each library frame must contain at least one drive cluster. In a dual frame library, where two frames are joined into a single library using the Cross-Link Mechanism, the first frame may contain up to 20 drives and the second frame may contain up to 24 drives.

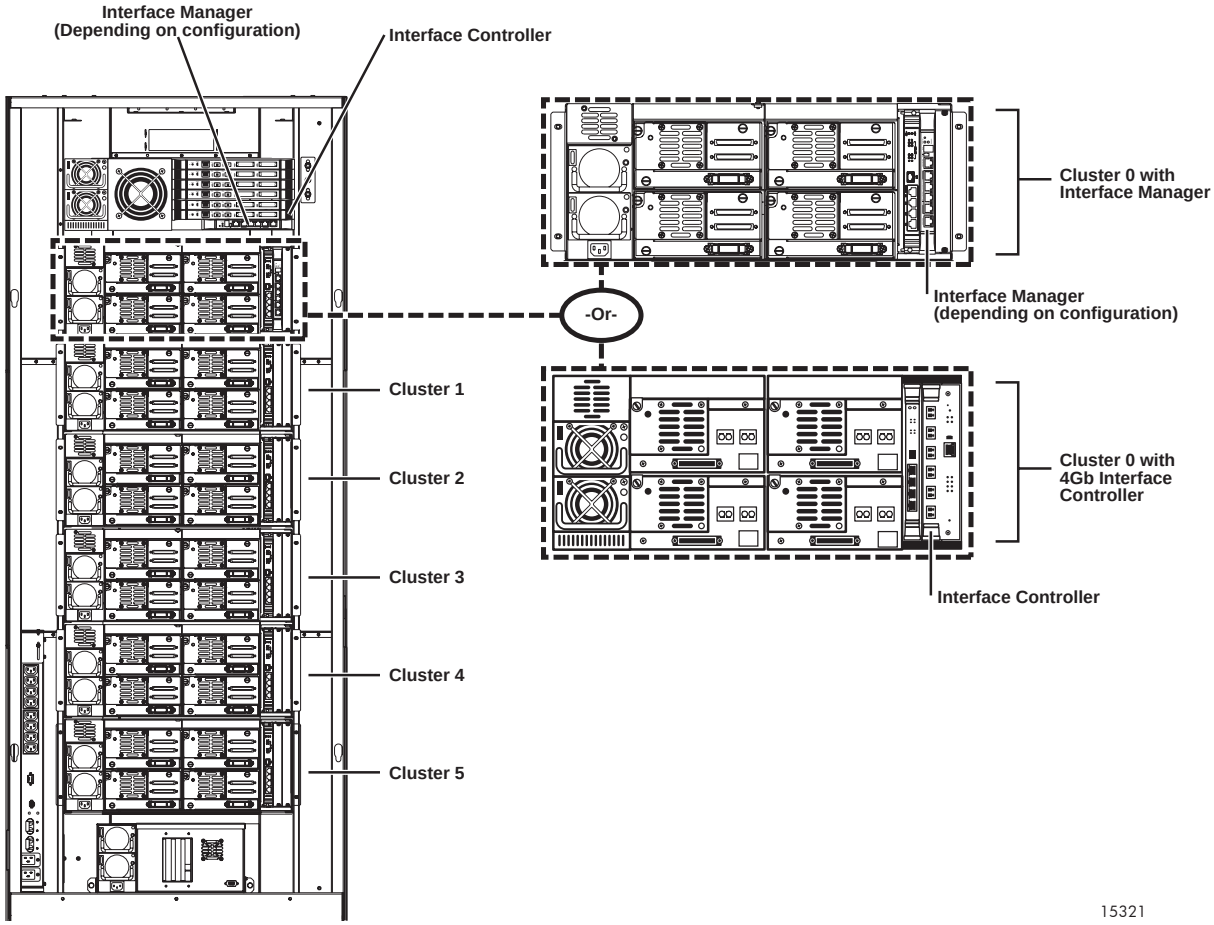
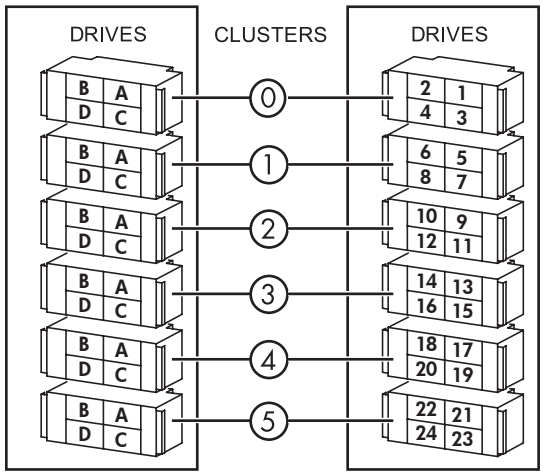


Figure 1 Drive cluster numbering

A drawing showing the cluster numbering and drive positioning is located inside the rear door. See Figure 2. Drive clusters are numbered starting at the top of the cabinet beginning with 0.



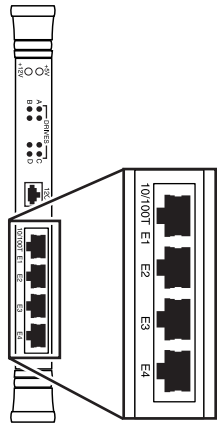


Figure 2 Cluster and drive numbering

Ethernet connections

Table 3 identifies the cluster controller Ethernet ports and shows the connection locations for the Ethernet cable in a multiple drive cluster configuration.

Table 3 Multiple drive clusters

10113

Drive cluster	Cluster controller Ethernet port	Ethernet cable
0	E1	Cabinet controller
	E2	Interface Manager card
	E3	Interface Controller
	E4	Daisy-chain to lower cluster controller
1	E1	Daisy-chain to upper cluster controller
	E2	e1200-160 robotics controller (if present)
	E3	Interface Controller
	E4	Daisy-chain to lower cluster controller
2-5	E1	Daisy-chain to upper cluster controller
	E2	Not used
	E3	Interface Controller
	E4	Daisy-chain to lower controller (not used for cluster 5)

SCSI connections

Connect the SCSI cables from the drives in drive cluster 0 (see Figure 1) to the e2400-160 interface controller in slot 0 (see Figure 4) of the card cage.

Drive SCSI cables are labeled A, B, C, and D on the drive end to indicate the drive location. See Figure 3. Drive SCSI cables are labeled 0, 1, 2, and 3 on the Fibre Channel interface controller end to indicate the SCSI port location. The most efficient order for making these connections is as follows:

1. Connect a SCSI cable from drive D to port 3 on the interface controller.

2. Connect a SCSI cable from drive B to port 1 on the interface controller.
3. Connect a SCSI cable from drive C to port 2 on the interface controller.
4. Connect a SCSI cable from drive A to port 0 on the interface controller.

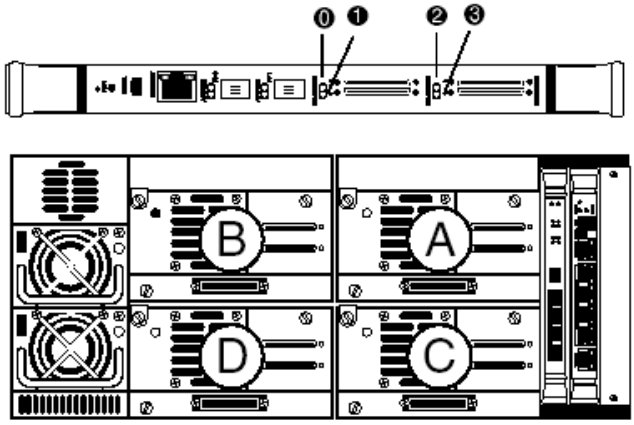


Figure 3 SCSI connections

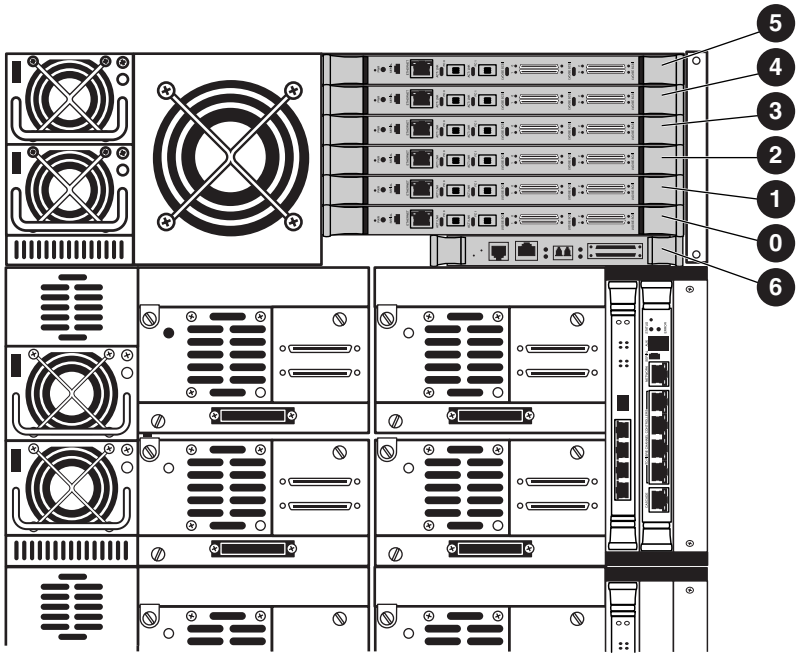


Figure 4 Identifying e2400-160/e2400-FC 2G Interface Controller slots

One Interface Controller, supporting up to four tape drives, is required per drive cluster. Each tape drive should be connected to its own port on the Interface Controller.

Use the top six slots, referenced in Figure 4 as 0 through 5, to match the numbering of the corresponding drive clusters. For example, drive cluster 0 should correspond to controller 0. Consequently, the 2Gb Interface Controllers (e2400-160 FC and e2400-FC 2G) should be installed beginning with the lowest available slot in the card cage. The 4Gb Interface Controller (e2400-FC 4G) should be installed in the rightmost two card slots of the drive cluster with which it is associated. Slot 6 contains either the e1200-160 robotics controller or the Interface Manager, depending upon the library configuration.

Setting the bar code length

To change the bar code length:

1. Access the front panel display and select **Menu**.
2. Select **Setup**.
3. Enter the password.
4. Scroll down to bar code length and enter the desired length. The default length is 6.

Creating multi-unit ESL E-Series Tape Libraries using the Cross Link Kit

HP StorageWorks ESL Cross Link Kit connects two 712e or 630e tape libraries together as a single tape library to scale up to 1410 LTO slots (564 TB) or 1248 SDLT slots (374 TB) and up to 44 tape drives.

The ESL E-Series Cross Link Kit requires specific software and firmware supplied on CD with the Cross Link Kit. Software licenses are required only on the first or primary library frame.

Small count tape libraries (322e, 286e) are only supported if upgraded to a fully populated tape library, and only if they are the first or primary tape library.

NOTE: The Cross Link Kit requires removal of one cluster of either tape drives or slots along the back wall of the first ESL cabinet. In an LTO library, the back wall clusters hold 14 slots. In an SDLT library, the back wall clusters hold 12 slots.

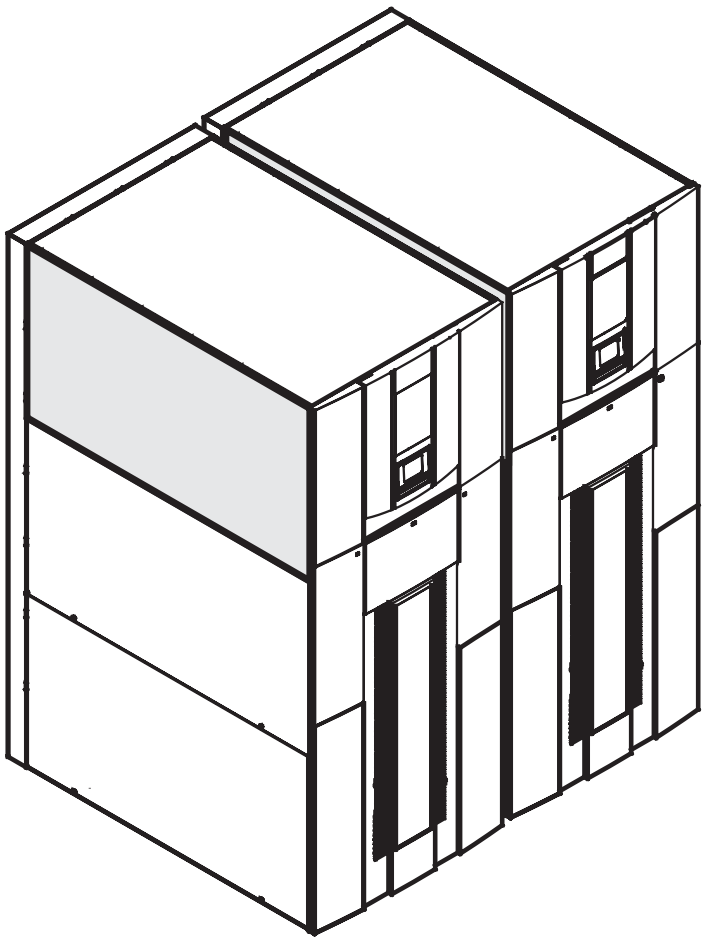


Figure 5 ESL E-Series tape libraries using the Cross Link Kit

HP StorageWorks EML E-series Tape Libraries

The HP StorageWorks EML E-series library is available in two models-the 103e, which is a 12U rack-mounted design containing up to four tape drives and 103 LTO tape slots, and the 245e, which is a 24U rack-mounted design holding up to eight drives and 245 LTO slots. Upgrade kits are available to fill out a 42U rack with a configuration that can contain up to 442 LTO slots and 16 tape drives.

The Fibre-Channel LTO drives are connected to a SAN fabric via e2400-FC 2G/4G interface controllers, which are in turn managed by the HP StorageWorks Interface Manager card. HP StorageWorks Command View TL is used to communicate with the interface manager via web browser for configuration.

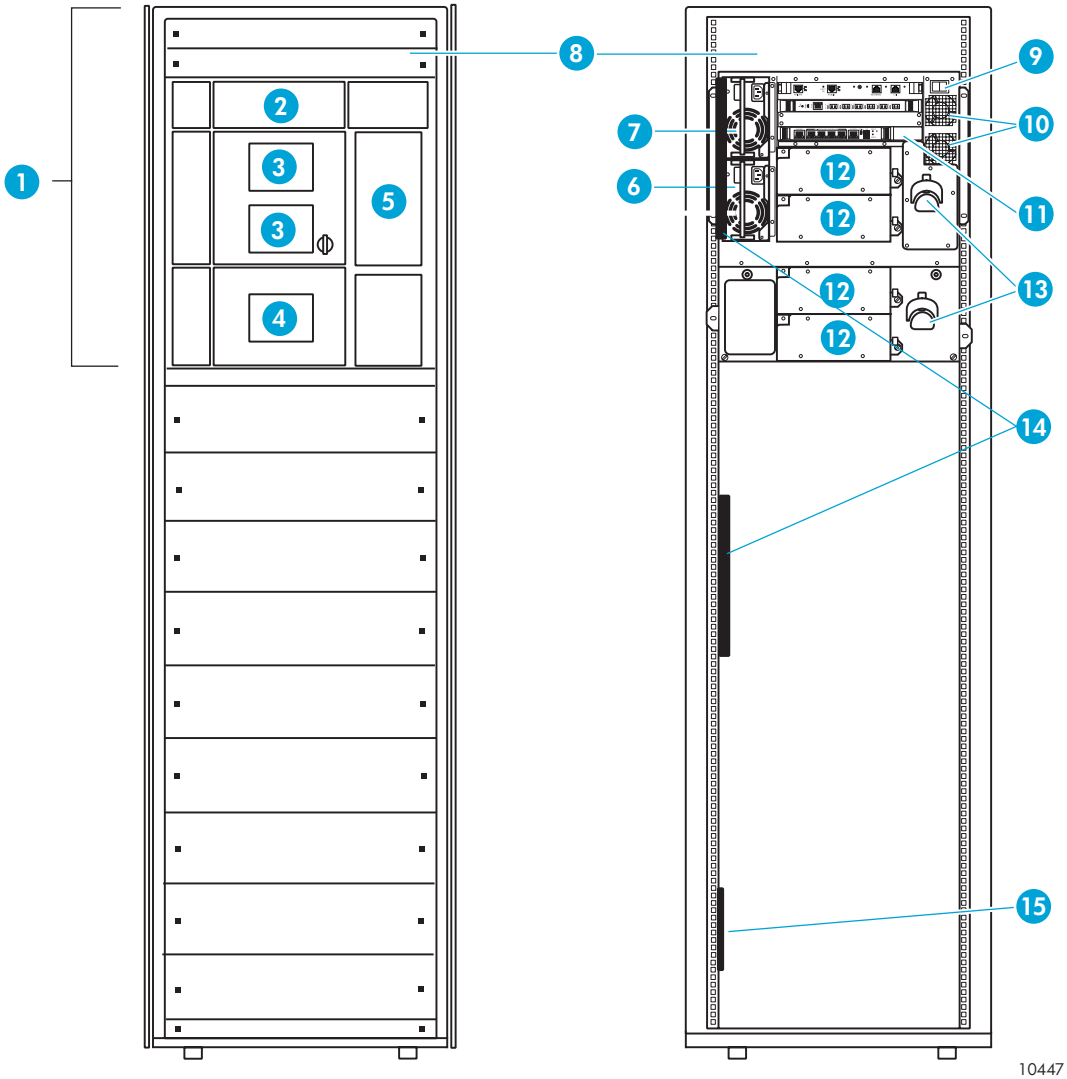


Figure 6 Enterprise Modular Library, model 103e

1 Base module
2 Robotics unit (parked)
3 Viewing window
4 Operator control panel
5 Load port (S-cartridge capacity)
6 Redundant module power supply (optional)
7 Module primary power supply
8 Customer reserved space (2U)
9 Library main power switch
10 Library fans
11 Base module card cage
12 Tape drives
13 Cable management features
14 Extension bars (power strips)
15 Power distribution units

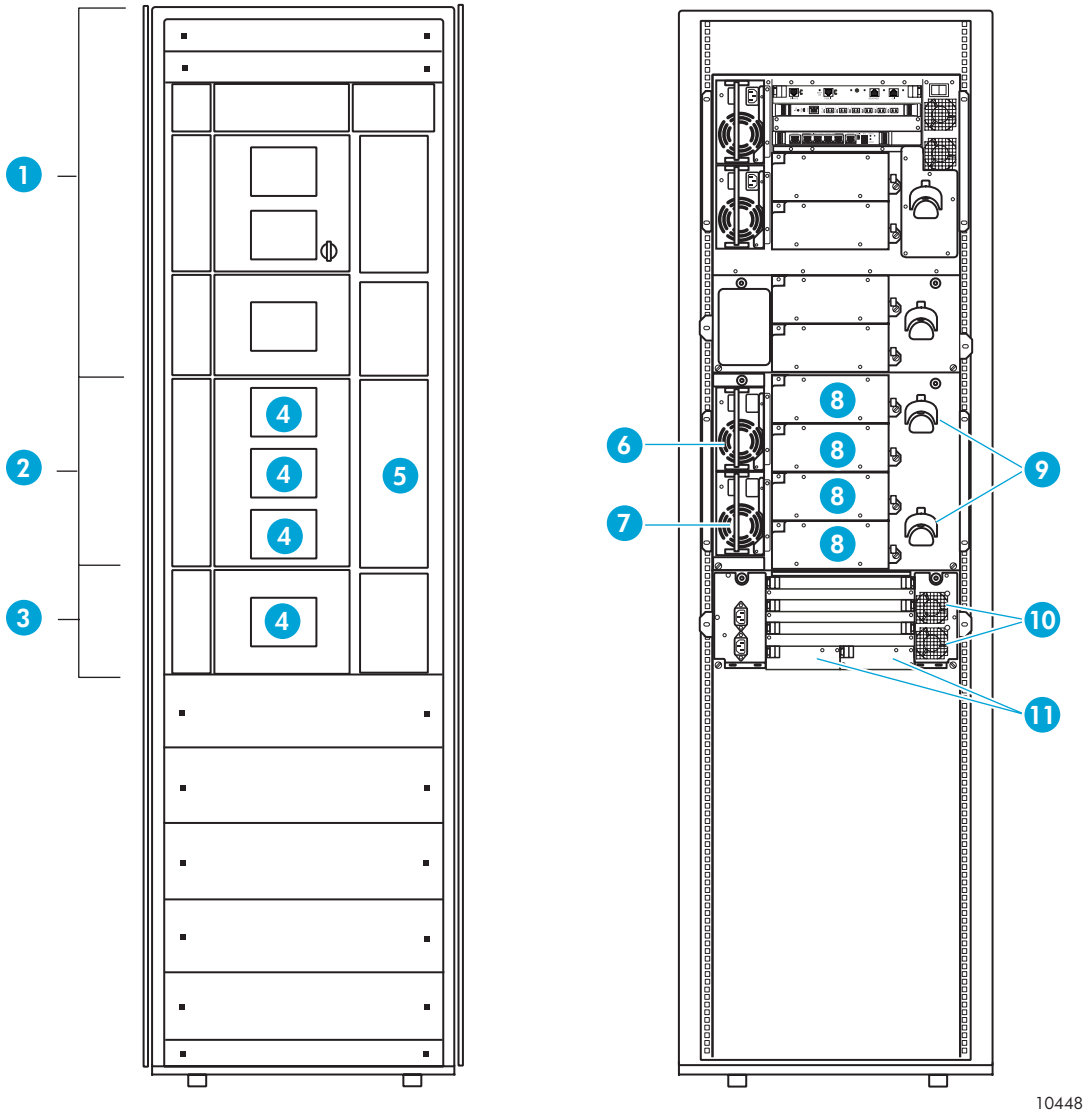


Figure 7 Enterprise Modular Library, model 245e

1	See model 103e (Figure 6)	2	Tape drive expansion module
3	Card cage expansion module	4	Viewing window
5	Load port (10-cartridge capacity)	6	Module primary power supply
7	Redundant module power supply (optional)	8	Tape drives
9	Cable management features	10	Card cage module fans
11	Redundant card cage power supplies		

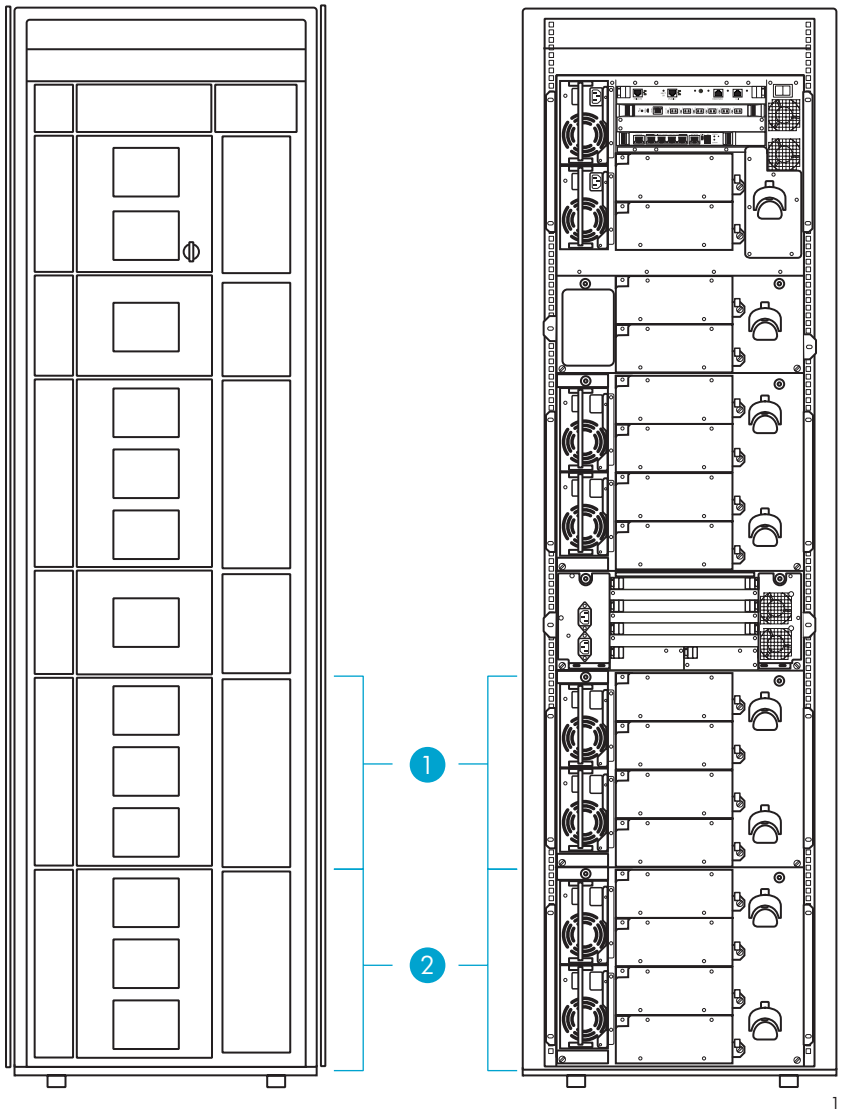


Figure 8 Example of a fully expanded Enterprise Modular Library

1 Tape drive expansion module **2** Capacity expansion module

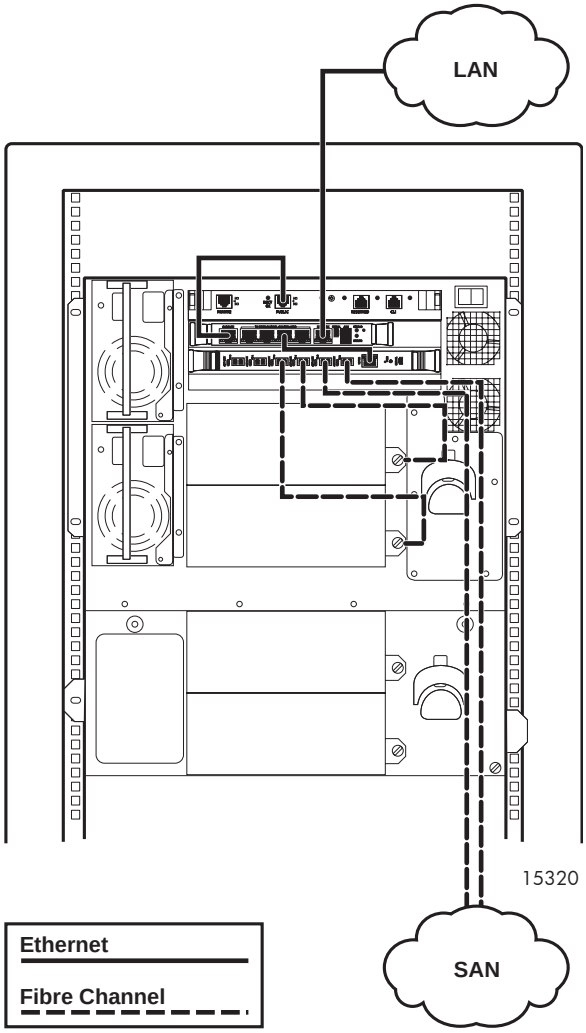


Figure 9 EML cabling

Figure 9 shows the back of an EML 103e library with the robotic controller card at the top, the Interface Manager (IM) card just below, the Interface Controller (IC) card, and the tape drive enclosures at the bottom. The tape drives are connected to the Interface Controller via fiber cable. The top-most drive (drive 0) should be connected to the tape drive 0 (TD 0) port on the IC, with the rest following in sequence. The Ethernet port on the IC is connected to the FC controller ports on the IM card. For better organization, connect each IC to the IM Ethernet ports in sequential order, although this is not required.

The IM is connected to the robotic controller via Ethernet from the IM Cascade port to the Public port on the robotic controller card.

After cabling the library as described above, the library can be powered on. When the initialization process is complete, do the following:

1. Access the library via the front touch panel to configure the network settings.
2. Select the Configuration tab.
3. Select **Library Configuration** and then **Change Network Settings**.
4. Enter the library administration password.
5. Choose either **DHCP** or **Manual** in the Address Config field. If Manual was selected, touch the IP address and change the address to the desired setting. Repeat this for the subnet mask, gateway, and DNS server, if applicable.
6. When complete, press **Save**. The EML is now accessible via the Command View TL browser interface for further configuration and monitoring.

Setting the bar code front panel display and host reporting configuration

HP StorageWorks EML E-Series Tape Libraries bar code reporting can be configured as six to eight characters and left or right aligned. If six characters with left alignment is chosen, any characters after the sixth are truncated. With six characters and right alignment, only the last six characters are shown with the beginning characters truncated.

The LTO labels have L1, L2, and L3 as the media identifiers for the respective LTO1, LTO2, and LTO3 cartridges. All cleaning cartridges should use the format CLN*xxx*L1 type of label, where *xxx* is a number between 000 and 999 for all types of LTO drives. WORM tape cartridges for LTO3 have media identifiers of LT. The length and justification of the bar code reporting format, as sent to the host and as viewed on the front panel, can be configured through the front panel configuration section.

To set the bar code front panel display and host reporting configuration on the EML library:

1. Access the EML front panel top display and select the Configuration tab.
2. Select the Library Configuration tab and enter the password (the default password for EML is 112233).
3. Select the Configure barcode reporting format tab.
4. Select **Format for Front Panel** and configure according to the requirements listed above.
5. Select **Format for Host Reporting** and configure according to the requirements listed above.

HP StorageWorks ESL9000 Series tape library

The HP StorageWorks ESL9000 Series tape library is an automated storage and retrieval library. It contains up to 8 drives and 322 cartridges for the ESL9322 Series, and up to 16 tape drives and 595 cartridges for the ESL9595 Series.

The ESL9000 Series tape library models support a wide range of storage and performance requirements.

Changing the SCSI ID settings on an ESL9000 Series tape library

The first step in installing the ESL9000 Series Tape library is changing the SCSI ID settings. SCSI settings should be unique for each SCSI bus. HP recommends that the SCSI IDs be sequential starting with 0.

NOTE: The following steps may not be necessary with newer libraries.

Use the control panel located on the tape library to change the SCSI ID settings.

1. Select **Standby** to take the library off-line.
2. Select **Operator** to enter the operator screen. The Operator screen is restricted for use by individuals with operator or service access privileges.
3. Type the password numbers on the keypad and press **Enter** when prompted for a password.

   NOTE: The default password is 1234.

4. Select **Configure Library**.
5. The Configure Library Menu displays a list of devices and current settings. To change the settings, select **Configure**.
6. The Configure Library Settings screen is displayed. Press **Select** until **Device** is highlighted.
7. Press the Left Arrow and Right Arrow buttons to select the device to be changed.

   NOTE: As the operator scrolls through the list of devices, the SCSI ID field simultaneously displays the SCSI ID settings of the currently selected device.

8. When the device has been highlighted, press **Select** one time to highlight the SCSI ID field.
9. Press the Left Arrow and Right Arrow buttons to scroll through the list of SCSI IDs.
10. When the desired setting is displayed, press **Change** to save the settings as part of the library configuration.
11. Repeat steps 7 through 10 to configure additional devices.

NOTE: The library must be power-cycled before new SCSI ID settings are effective.

NOTE: The default drive cable/library configuration should be used for the robot and drives, with the exception of the SCSI ID assignments.

Connecting SCSI cables

This section describes the supported SCSI cable configurations for the ESL9000 series tape libraries.

ESL9322 SCSI cable configurations

Figure 10 shows the SCSI ports as viewed from the rear of the ESL9322 tape library.

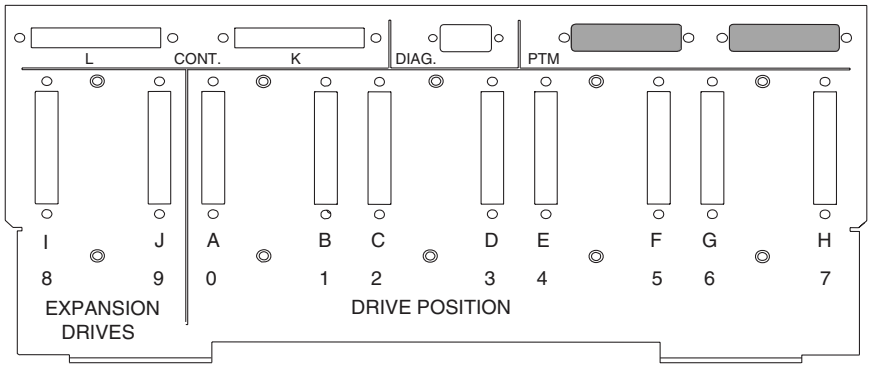


Figure 10 SCSI ports (ESL9322)

Looking from the back of the ESL9322 tape library, connect the SCSI cables and terminators as shown in Figure 11.

NOTE: ESL9322 series libraries are equipped with internal SCSI cables and terminators in place for a one drive per SCSI bus configuration. This is the recommended configuration (and the required configuration for Ultrium 460, Ultrium 960, and SDLT 600 drives) and ensures optimal performance.

Figure 11 shows the internal SCSI cabling. The connectors are on the SCSI ports that are shown in Figure 10.

NOTE: Drive numbering begins with 0. Consequently, the first drive is drive 0, the second drive is drive 1, and so on.

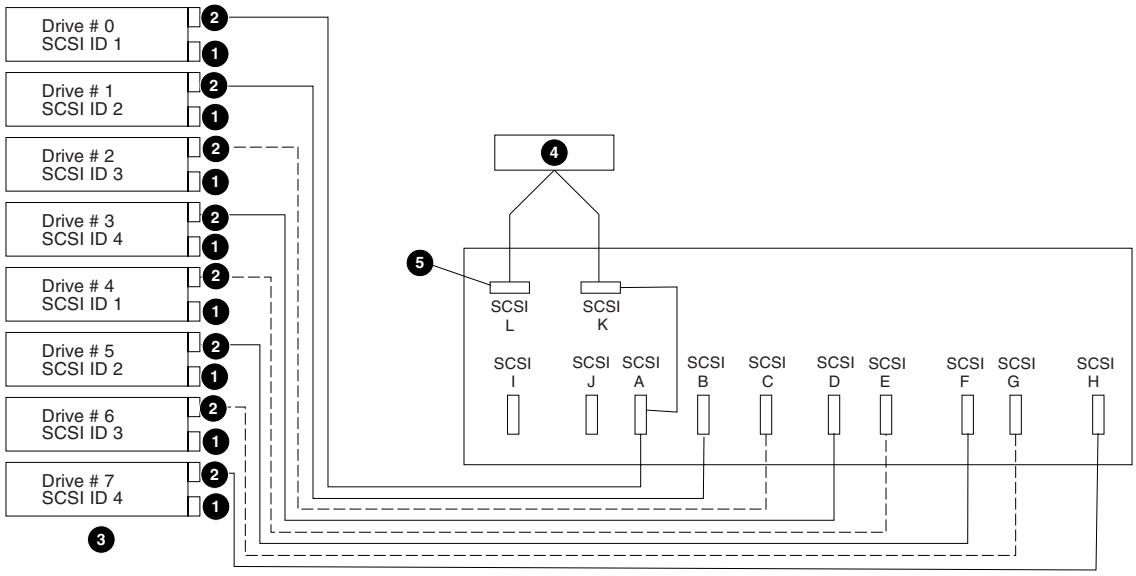


Figure 11 internal SCSI cabling configuration (ESL9322)

1 Terminators (8) **2** SCSI cables (8) **3** Drive column 1

4 Robotic controller **5** Host SCSI cable

Table 4 SCSI ports and device connections (ESL9322)

SCSI port identifier	Device connection
A	Drive 0
B	Drive 1
C	Drive 2
D	Drive 3
E	Drive 4
F	Drive 5
G	Drive 6
H	Drive 7
I	Not used
J	Not used
K	Robot
L	Host

ESL9595 SCSI cable configurations

Figure 12 shows the SCSI ports as viewed from the rear of the ESL9595 tape library.

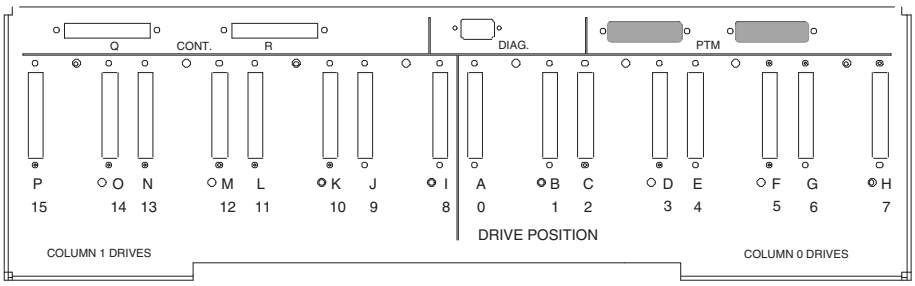


Figure 12 SCSI ports (ESL9595)

Looking from the rear of the library, connect the SCSI cables and terminators as shown in Figure 13.

NOTE: ESL9595 series libraries are equipped with internal SCSI cables and terminators in place for a one drive per SCSI bus configuration. This is the recommended configuration (and the required configuration for Ultrium 460, Ultrium 960, and SDLT 600 drives) and ensures optimal performance.

Figure 13 shows the internal SCSI cabling. The connectors are on the SCSI ports that are shown in Figure 12.

NOTE: Drive numbering begins with 0. Consequently, the first drive is drive 0, the second drive is drive 1, and so on.

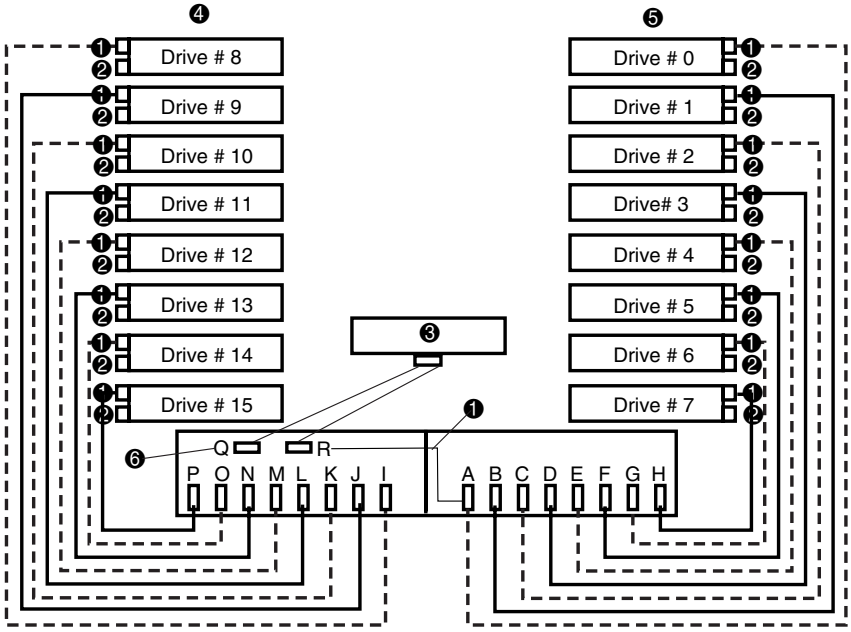


Figure 13 Internal SCSI cabling configuration (ESL9595)

1 SCSI cables (16)
2 Terminators (16)
3 Robotic controller
4 Drive column 1
5 Drive column 0
6 Host SCSI cable

Table 5 SCSI ports and device connections (ESL9595)

SCSI port identifier	Device connection
A	Drive 0
B	Drive 1
C	Drive 2
D	Drive 3
E	Drive 4
F	Drive 5
G	Drive 6
H	Drive 7
I	Drive 8
J	Drive 9
K	Drive 10
L	Drive 11
M	Drive 12
N	Drive 13
O	Drive 14
P	Drive 15
Q	Host
R	Robot

Default SCSI IDs

Table 6 lists the default SCSI IDs for the ESL9000 Series tape library.

NOTE: The ESL9322 holds a maximum of 8 tape drives, with tape drive 7 being the highest-numbered tape drive. The ESL9595 holds a maximum of 16 tape drives, with tape drive 15 being the highest-numbered tape drive.

Table 6 Default SCSI IDs

Drive number	Default SCSI ID
Tape library	0
Drive 0	1
Drive 1	2
Drive 2	3
Drive 3	4
Drive 4	1
Drive 5	2
Drive 6	3
Drive 7	4
Drive 8	1
Drive 9	2
Drive 10	3
Drive 11	4
Drive 12	1
Drive 13	2
Drive 14	3
Drive 15	4

Creating a multi unit tape library system

The HP StorageWorks ESL9000 Series pass-through mechanism (PTM) enables the transfer of a single tape cartridge between two HP StorageWorks ESL9000 Series Tape Libraries. The PTM can be used to connect up to five ESL9322/9326/9198 libraries or up to four ESL9595 libraries (one PTM for every two libraries) creating a multi unit tape library system.

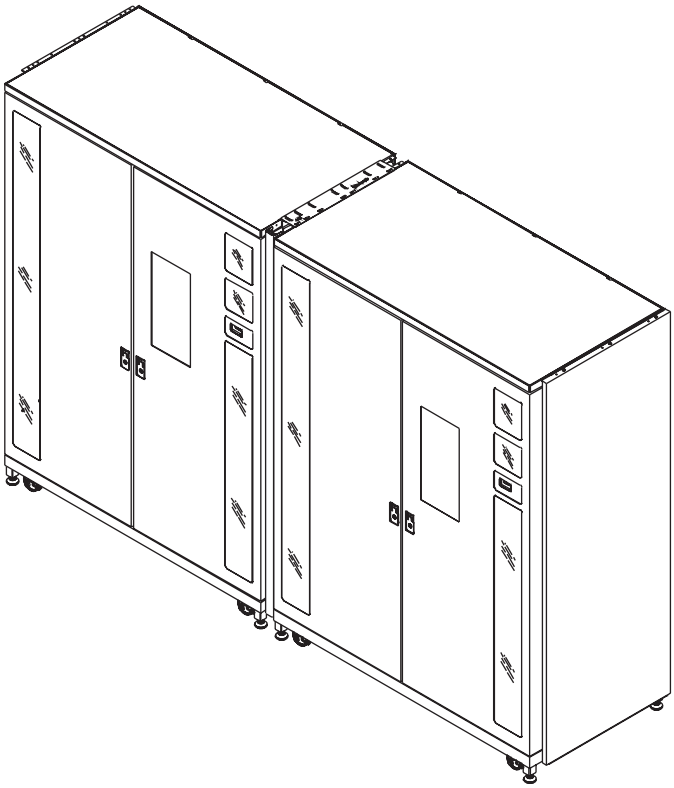


Figure 14 ESL9000 Series Libraries connected using a PTM

HP StorageWorks MSL5000 and MSL6000 Series tape libraries

Each of the tape drives and the library controller constitute an independent SCSI target. When any two or more devices are connected to the same SCSI bus, each separate SCSI device must be assigned a unique SCSI ID.

Connecting the MSL5000/6000 tape library

WARNING! Make sure the power to each component is off and the power cords are unplugged before making any connections.

NOTE: Read the documentation included with each component for additional operating instructions before installing.

Connect the Library to the router using a SCSI interface cable (refer to the *HP StorageWorks MSL5000 and 6000 Series Tape Library User Guide* for interface cable specifications). One router SCSI port supports up to two drives and one robotic device. Only one SCSI cable is needed for a single tape library module.

MSL5000/6000 Series library with one drive

When connecting one drive, use a LVD SCSI terminator to terminate the remaining SCSI port for drive 1.

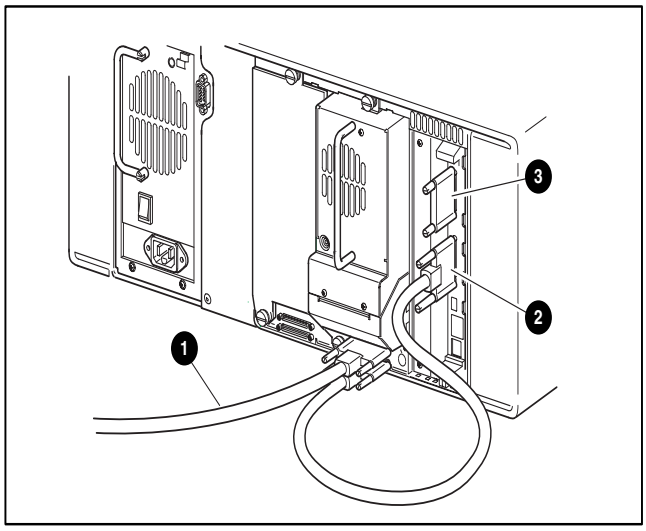


Figure 15 Cabling an MSL5026/6030 with a single-drive configuration

1 SCSI cable **2** SCSI jumper cable **3** Terminator

MSL5000/6000 Series library with two drives

When connecting two drives, use a SCSI jumper cable to connect drive 1 to drive 2. With a LVD SCSI terminator, terminate the remaining SCSI port for drive 2.

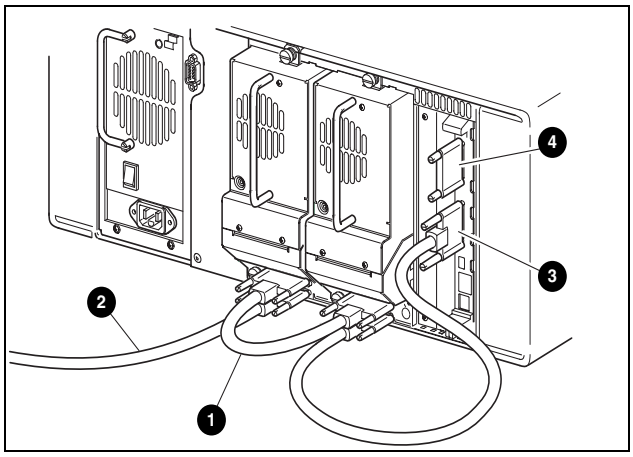


Figure 16 Cabling an MSL5026/6030 with a two-drive configuration

1 SCSI jumper cable
2 SCSI cable
3 SCSI jumper cable
4 Terminator

Four tape drives, dual host system

Figure 17 shows a typical SCSI cable configuration for a library with four tape drives installed using a dual host system.

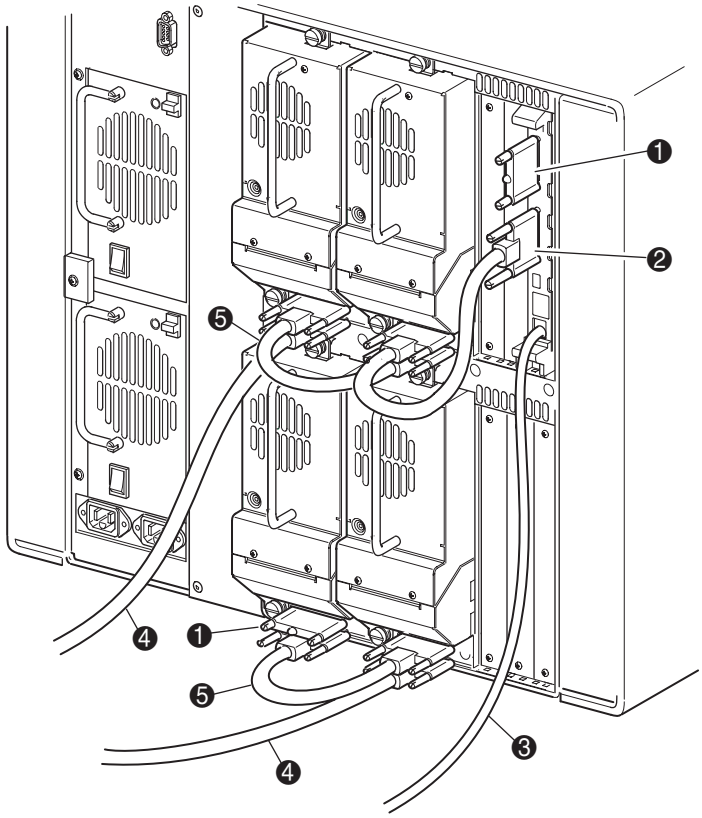


Figure 17 SCSI cable configuration (four tape drives, dual host system)

1 SCSI Terminator
2 0.5 m jumper cables
3 RS-232 diagnostic cable (for service only)
4 To Host System
5 0.25 m or 0.5 m jumper cable

NOTE: Daisy-chaining Ultrium 460, Ultrium 960, and SDLT 600 drives is not recommended due to degraded performance.

Creating a multi-stack unit

The MSL5000 and MSL6000 series libraries can be stacked in a scalable combination with additional MSL5000 or MSL6000 series libraries to form a multi-unit, rack-mounted configuration. Through use of a pass-thru mechanism (PTM), all multi-unit libraries in the stack can operate together as a single virtual library system. Stacked units are interconnected through their rear panel Ethernet connections and an external Ethernet hub mounted to the rack rails.

The external Ethernet hub also provides an additional connector when libraries are combined in their maximum stacked height.

- A maximum of eight libraries can be connected in this manner.
- Any combination of libraries, not exceeding 40U in total stacked height, can also be used.
- A multi-unit library system appears to the host computer system and library control software as a single library.
- For multi-unit applications, the top library becomes the primary master unit and all other lower libraries are slave units.

NOTE: The PTM continues to function each time a slave library is physically removed from the rack configuration during normal library operation.

The library robotics can pick and place tape cartridges into a movable elevator that encompasses the full length of the PTM. In this manner, individual tapes can be passed up or down between the libraries contained in the stack. Robotic access to the PTM is located at the rear of the unit, between the tape drives and the power supply. The library also supports fail-over protection for multi-unit, rack-mounted applications. For example, if the primary master library fails, you can invoke the library system fail-over mode. In this mode, one of the connected slave units serves as the secondary master library that now communicates with the host system through the SCSI interface. The PTM drive motor source power is relay-switched from the original primary master library to the newly assigned secondary master library.

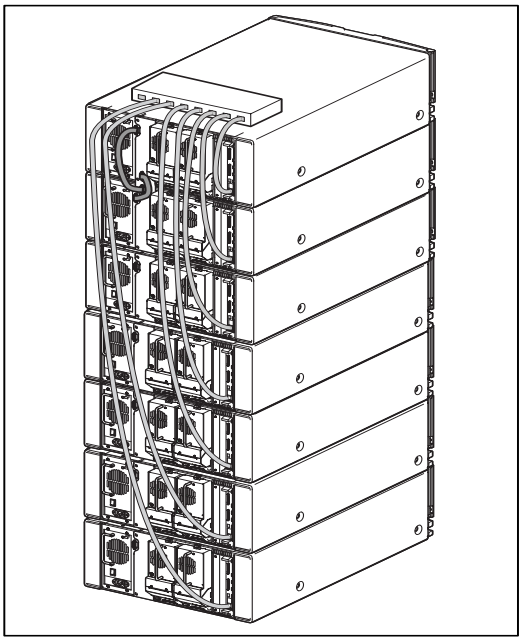


Figure 18 MSL5026/6030 stack configuration

Setting the bar code length

1. Access the front panel and select **Menu**.
2. Select **Edit Options**.
3. Select **Library**.
4. Enter password.
5. Scroll down to bar code options and enter the desired values. The default values are as follows:
   - Barcode label size = 8
   - Barcode alignment = Left Align
   - Barcode label check digit = Disabled
   - Barcode reader = Retries enabled

The HP StorageWorks Virtual Library System (VLS)

Integrating seamlessly into existing backup applications and processes, the HP StorageWorks 6000 Virtual Library System (VLS 6000) accelerates backup performance in complex SAN environments while improving overall reliability. Emulating popular tape libraries and tape drives, the VLS 6000 matches the existing data protection environment, removing the need to change backup software or monitoring policies. By emulating multiple tape drives simultaneously, more backup jobs can be done in parallel resulting in reduced backup times. Additionally, because the data resides on disk, single file restores are exceptionally fast.

The HP StorageWorks 6000 Virtual Library System (VLS) is a RAID 5, Serial ATA disk-based SAN backup device that emulates HP's physical tape libraries. This configuration allows disk-to-virtual tape (disk-to-disk) backups to be performed using existing backup application(s).

Features

- Emulates popular tape drives and libraries
- Up to 16 libraries and 64 drives emulated simultaneously within a single virtual library system
- Certified with popular backup software packages through HP StorageWorks Enterprise Backup Solution
- Over 575 MB/s throughput
- Scales capacity and performance
- Data compression
- Hot Swap array drives
- Redundant array power supplies and cooling
- RAID 5
- Mounts in a standard 19-inch rack

NOTE: With the HP VLS6000-series virtual library, bar code templates are created for use with the virtual cartridges on which data is stored. These bar codes can have as few as two characters or as many as 99, and they are completely configurable by the administrator.

When configuring the bar code templates, care should be taken to follow the requirements (if any) for bar code prefixes and length per the backup application. In addition, it is a good idea to use a bar code prefix that differs from any physical cartridge bar codes in a tape library to which data may be migrated behind the VLS. That way, physical and virtual cartridges can be easily recognized from within the backup application.

The following diagrams show the rack order and cabling configuration of the various VLS systems.

VLS6105 rack order

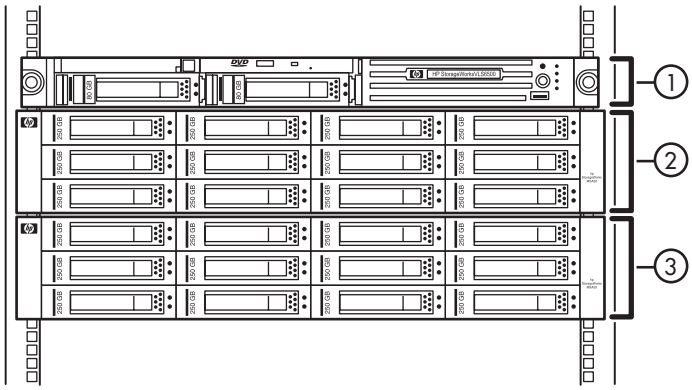


Figure 19 VLS6105 rack order

1 Node
2 Disk array 1
3 Disk array 2

VLS6510 rack order

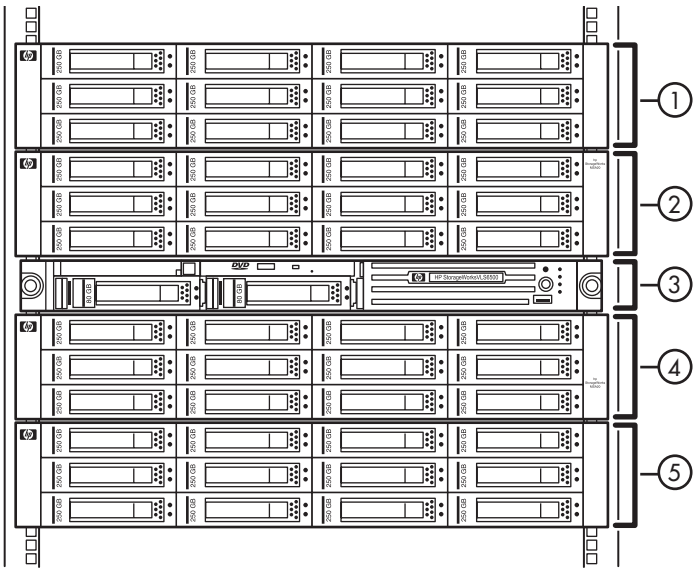


Figure 20 VLS6510 rack order

1 Disk array 3
2 Disk array 2
3 Node
4 Disk array 0
5 Disk array 1

VLS6840 rack order

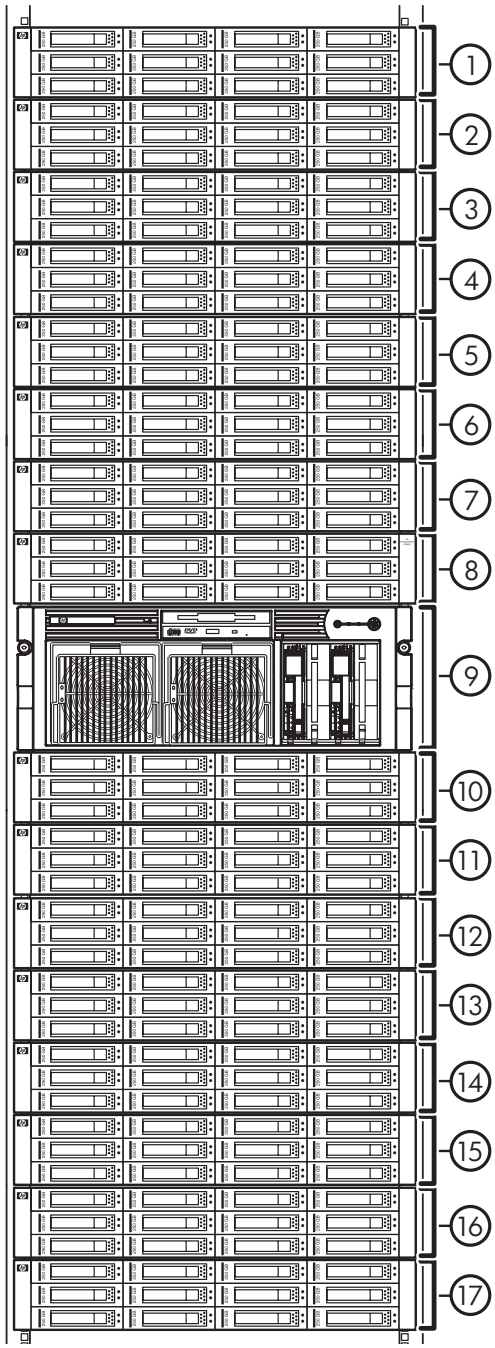


Figure 21 VLS6840 rack order

1	Disk array 15	**2**	Disk array 14
3	Disk array 13	**4**	Disk array 12
5	Disk array 11	**6**	Disk array 10
7	Disk array 9	**8**	Disk array 8
9	Node	**10**	Disk array 0
11	Disk array 1	**12**	Disk array 2
13	Disk array 3	**14**	Disk array 4
15	Disk array 5	**16**	Disk array 6
17	Disk array 7		

VLS6105 and VLS6510 cabling

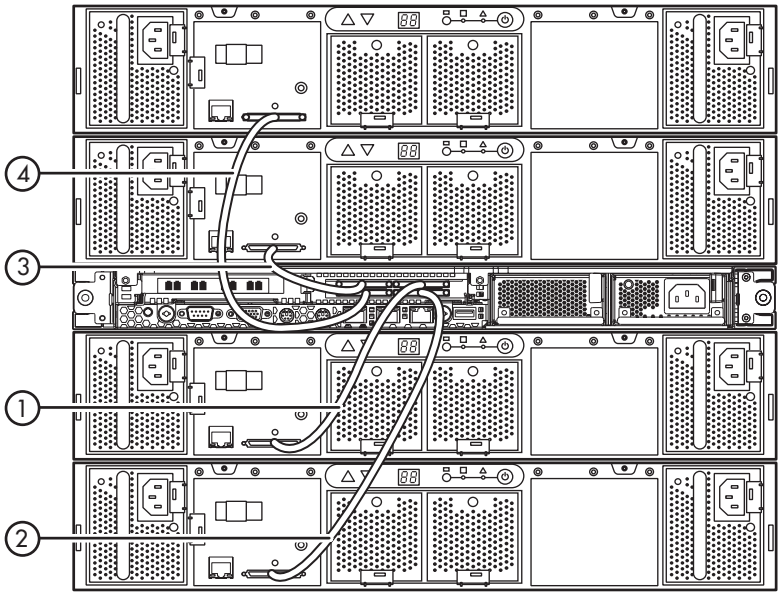


Figure 22 VLS6105 and VLS6510 cabling

1 VHDCI connector B2, connect to disk array 0
2 VHDCI connector B1, connect to disk array 1
3 VHDCI connector A1, connect to disk array 2
4 VHDCI connector A2, connect to disk array 3

VLS6840 cabling

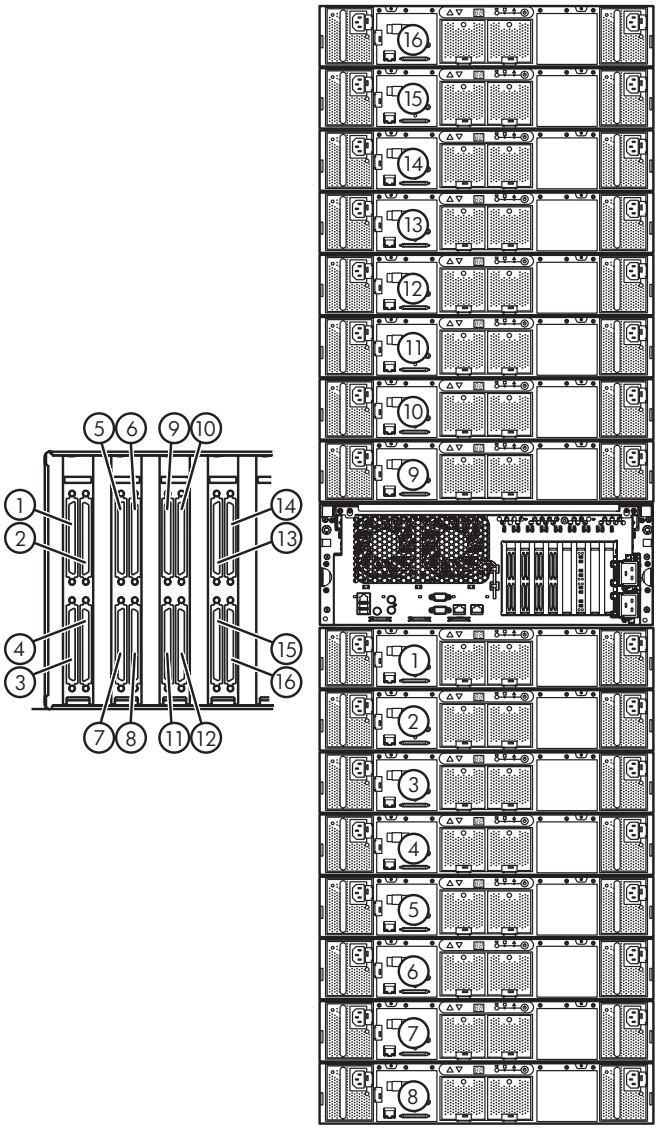


Figure 23 VLS6840 cabling

1	VHCDI connector slot 8, A1, connect to disk array 0	**2**	VHCDI connector slot 8, A2, connect to disk array 1
3	VHCDI connector slot 8, B1, connect to disk array 2	**4**	VHCDI connector slot 8, B2, connect to disk array 3
5	VHCDI connector slot 7, A1, connect to disk array 4	**6**	VHCDI connector slot 7, A2, connect to disk array 5
7	VHCDI connector slot 7, B1, connect to disk array 6	**8**	VHCDI connector slot 7, B2, connect to disk array 7
9	VHCDI connector slot 6, A1, connect to disk array 8	**10**	VHCDI connector slot 6, A2, connect to disk array 9
11	VHCDI connector slot 6, B1, connect to disk array 10	**12**	VHCDI connector slot 6, B2, connect to disk array 11
13	VHCDI connector slot 5, A1, connect to disk array 12	**14**	VHCDI connector slot 5, A2, connect to disk array 13
15	VHCDI connector slot 5, B1, connect to disk array 14	**16**	VHCDI connector slot 5, B2, connect to disk array 15

Tape drives and performance

Tape drives

HP tape drives have varying levels of performance. Factors such as file size (larger is better), directory depth, and data compressibility all affect system performance. Data interleaving during backup also affects restore performance. Use of the router and its connections to HP StorageWorks tape libraries is a simple way to scale backup performance.

Table 7 shows performance information for various tape drives.

Table 7 Tape drive throughput speed (native)

Tape drive	Throughput MB/s
Ultrium 960	80
Ultrium 460	30
Ultrium 230	15
SDLT 600	36
SDLT 320	16
SDLT 220	11
DLT8000	6

WORM technology

WORM (or Write Once, Read Many) storage is a data storage technology that allows information to be written to storage media a single time, and read many times, preventing the user from accidentally or intentionally altering or erasing the data. Driven by the recent growth of legislation in many countries, usage of WORM storage is increasing for archiving corporate data such as financial documents, emails, and health records. To meet the demands of this data growth, HP now supports WORM technology in the Ultrium 960 and SDLT600 tape drives. WORM tape drive technology is supported in a variety of HP StorageWorks Tape Libraries, and is supported by many backup applications. In addition to WORM media, the Ultrium 960 and SDLT600 tape drives are capable of reading and writing to standard Ultrium and SDLT media respectively. WORM media can be mixed with other traditional media by using mixed media solutions as documented by HP. For more information about support and compatibility please visit http://www.hp.com/go/tape or http://www.hp.com/go/ebs.

File (data) compression ratio

The more compressible the data, the faster the possible backup rate. The speed of the feed source must increase to prevent drive idle time. For example, an Ultrium 460 drive writes data at a maximum transfer rate of 30 MB/sec, which translates to 108 GB/hr. With 2:1 compression, the transfer rate increases to 216 GB/hr.

HP tests show that not all data can be compressed equally. The compression ratio affects the amount of data that can be stored on each tape cartridge, as well as the speed at which the tape drives can read or write the data.

Table 8 shows typical compression ratios of various applications.

Table 8 Typical file compression ratio

Data type	Typical compression
CAD	3:8:1
Spreadsheet/Word Processing	2:5:1
Typical File/Print Server	2:0:1
Lotus Notes Databases	1:6:1
Microsoft Exchange/SQL Server databases	1:4:1
Oracle/SAP databases	1:2:1

Ultrium performance

To optimize the performance of Ultrium tape drives in a Storage Area Network (SAN):

- Ensure the source of the data to be backed up can supply the data at a minimum of 30 MB/sec for Ultrium 230 and 15 MB/sec for Ultrium 215. For example, the Ultrium 230 would require a four to five disk RAID subsystem and 233 MHz or above RAID controller with a minimum 64K cache.
- Do not place more than three high performance tape drives on a single arbitrated loop or fabric loop. The topology cannot stream them all simultaneously.

To optimize the performance of Ultrium tape drives in a UNIX environment:

- Do not use the native backup applications. UNIX tar and cpio provide poor performance.
- Use a third-party backup application.
- Structure your file system so it can make use of the concurrency feature offered in almost all UNIX third-party backup applications.

  Concurrency is an alternative way of streaming high-performance tape drives. This means backing up multiple data sources simultaneously to a single tape drive. The format on tape is then an interleaf of the data on the disks. Verify that the backup software supports concurrency. HP OpenView Storage Data Protector, EMC Legato Networker, and Symantec NetBackup all support concurrency. This technique can also be applied to network backups where the backup jobs from independent hosts are interleaved as they are passed over the network and are written to tape.

NOTE: This technique will increase backup performance; however, restore performance will be negatively impacted. The files are not sequential. Rather, they are broken up and distributed across the tape.

HP StorageWorks Interface Manager and Command View TL

The HP StorageWorks Interface Manager provides the first step toward automating EBS. The Interface Manager card is a management card designed to consolidate and simplify the management of multiple Fibre Channel interface controllers installed in the library. It also provides SAN-related diagnostics and management for library components including interface controllers, drives, and robotics. The Interface Manager card, in conjunction with HP StorageWorks Command View TL software provides remote management of the library via a serial, telnet, or web-based GUI interface.

IMPORTANT: Command View TL, the Interface Manager card, and interface controllers have specific firmware dependencies. See the *Interface Manager Firmware Required Minimum Component* table in the EBS Compatibility Matrix.

NOTE: Some of the default host map settings that the Interface Manager applies to the library may not be appropriate for every datacenter. Due to the automation of the host mappings, certain customer data centers many need to customize the mapping for their EBS environment.

Library partitioning

Partitioning provides the ability to create separate, logical tape libraries from a single tape library. Logical libraries (partitions) behave like a physical library to backup and restore applications. The ESL9000, ESL E-Series, and the EML E-Series libraries all support partitioning. The advanced version of Secure Manager in conjunction with HP StorageWorks Command View TL is required to enable and configure partitioning in these libraries.

Mixed media support

Partitioning a library enables the user to use mixed media in a library with various backup applications. A library can consist of multiple drive and media types. Similar drive types and media can be grouped together as one partition, with a maximum of six partitions.

NOTE: For additional information, see the *HP StorageWorks Partitioning in an EBS Environment Implementation Guide* available on the HP web site: http://www.hp.com/go/ebs.

Command View TL/Secure Manager mapping algorithms

The Command View TL Secure Manager feature enables users to grant Fibre Channel host bus adapters access to devices in a tape library. Secure Manager automatically generates the Fibre Channel port LUN to target device mappings that will be presented to a specific host bus adapter (or host). Without Secure Manager, this process is manual, technical, and tedious if there are multiple interface controllers.

At a basic level, the process includes the following steps:

1. Determine which devices are connected to a FC interface controller.
2. Logically order the devices using device type and the logical tape drive location (or number).
3. The devices are then load balanced across the FC interface controller's host side Fiber Channel ports (if applicable).
4. For each Fibre Channel port, a sequential LUN value is given to each device assigned to that port.

The process is repeated for all FC interface controllers.

Mapping requirements lead to rules

The rules or algorithms that the Interface Manager uses to generate LUN maps are based on a list of requirements that were developed to ensure that the end resulting LUN maps will work well in nearly all SAN environments.

New requirements:

- Must have Basic Secure Manager functionality: All hosts with access privileges see all library devices.
- Must have Advanced Secure Manager functionality: Each host with access privileges can see any, or all, library devices.
- Mapping will automatically load balance to prevent overloading a single host-side FC port.
- Mapping will detect common cabling errors and automatically compensate for them.
- Active Fabric LUNs will be disabled where possible.
  - This simplifies the installation by only showing tape or robot devices in most cases.
- Mapping will automatically assign LUN numbers.
- Mapping changes will have as little impact as possible on host applications.
- All maps must be compatible with HP-UX, Windows, and Solaris.
  - This led to the requirement for always having a LUN 0, and for that LUN to be either a tape or robot.
- Map changes will not require a reboot to take effect.

Interface Manager modes: automatic and manual

The Interface Manager card operates in two different modes: automatic and manual. In automatic mode, the Interface Manager automatically configures and enforces a consistent configuration across all FC interface controllers including port settings and mapping. By enforcing this configuration, automatic mode greatly speeds up the mapping and port configuration process as well as eliminating the chance that a FC interface controller will be improperly set up.

There are some specific configurations that automatic mode will not currently address. For these cases, the Interface Manager provides a manual mode. However, as the name implies, manual mode fully relies on the user to correctly set up and maintain the fibre port and map settings, therefore manual mode requires more handling from the administrator and increases the chances that errors will be made in the FC interface controller configurations.

For simplicity and reliability, automatic mode is the recommended mode setting for nearly all installations. However, certain configurations require the library administrator to put the Interface Manager in manual mode.

The conditions where Manual mode is needed:

- FC interface controllers are connected to mixed topologies (e.g. connected to switches and directly to host HBAs).
- The FC interface controllers are connected to a mix of 2Gbit/s and 1Gbit/s switches.
- A specific operating system or software application is being used that has unique fibre LUN mapping requirements.
- The configuration requires that 3 or 4 tape drives be assigned to a single Fibre Channel port instead of 1 or 2.

NOTE: Any customization created in Manual mode will be lost when changing from Manual to Automatic mode.

Basic vs. Advanced Secure Manager

Command View TL provides a default implementation of Secure Manager known as Basic Secure Manager. Basic Secure Manager allows the library administrator to grant or deny a Fibre Channel host bus adapter access to all devices in a tape library. Also, in Basic Secure Manager, all hosts use the same device mapping. In Manual mode, changes made to the map from one host are seen by all the hosts that are assigned access to the library.

With the Secure Manager license installed, Advanced Secure Manager will be enabled. Advanced Secure Manager allows the library administrator to grant or deny hosts access to any combination of devices in the library. Unlike Basic Secure Manager, each host can have a unique map. For example, the master

server in a backup solution might be the only server that can control the library robotics. In this scenario, all backup servers may be granted access to the tape drives in the library, but will be denied access to the robotics controller. The master server would be granted access to the robotics controller and possibly one or more tape drives.

Interface Manager discovery

When the Interface Manager is initialized, all FC interface controllers register with the Interface Manager. The Interface Manager then interrogates each FC interface controller to determine which devices are available. If a tape drive is discovered, the tape drive is interrogated to determine drive attributes and device serial number.

NOTE: If the tape library robotics controller is not discovered by the Interface Manager, the discovery process cannot complete successfully. In this case, Secure Manager will be disabled until robotics connectivity is established. This is done because the Interface Manager must rely on the library controller to identify the drives belonging to the library and their logical positions.

After the robotics controller is discovered, the Interface Manager issues a "read element status" command to determine the drive configuration of the library. The Interface Manager uses the read element status data to determine the number of drives in the library, the logical position of each drive in the library, and the serial number for each drive. The Interface Manager can then correlate the serial numbers returned by the robotics controller with the serial number reported by each tape drive to determine the physical location of each tape drive in the library.

Example

The tape drive connected to SCSI Bus 0 on IC 1 reports a serial number of "XYZ." Also assume the robotics controller reports that the library has eight tape drives and logical tape drive 4 has a serial number of "XYZ." The Interface Manager can then use the serial number "XYZ" to identify the tape drive at SCSI Bus 0, IC 1 as logical tape drive 4. If the physical location for each reported tape drive is correlated to the logical drive number, then the Interface Manager discovery process completes successfully and Secure Manager will be available.

NOTE: Secure Manager is also available for target devices that were previously discovered but are currently offline. For example, if tape drive 2 was initially discovered and subsequently taken offline for repair, Secure Manager will operate with the previous device attributes until the drive is brought back online.

Secure Manager mapping rules

The Fibre Channel port LUN to TARGET device mapping created by Secure Manager is referred to as a Device Map in Command View TL. Secure Manager uses the following rules when creating and modifying a Device Map. Each rule is covered in more depth in the following sections.

1. Devices are ordered based on type and logical position (drive number).
2. Each map will start with LUN 0.
3. New maps remove gaps in the LUN map, but modified maps leave them.
4. If there is more than one FC port on a FC interface controller, then load balancing algorithms are used.
   a. The first two tape devices are assigned to the first FC port at the next available LUN. The next two tape devices are assigned to the second FC port at the next available LUN.
   b. If there are remaining tape devices, then the next two tape devices are assigned to the first FC port, and the next two to the second FC port. This is repeated until all tape devices are assigned.
5. Maintain FC Port/LUN Map after cabling change on same interface controller.
6. Advanced Secure Manager map creation performs Basic Secure Manager but then removes devices and gaps if necessary.
7. Maintain current FC Port/LUN assignments when adding devices in Advanced Secure Manager.

8. If devices are removed with Advanced Secure Manager any gap made is retained.
9. If devices are removed and added with Advanced Secure Manager, attempts are made to not disturb the other device mappings.
10. Active Fabric is the last LUN on a map of each FC port.
11. If an HBA has access to the robotics for a library partition, the logical robotics device will be added as the next available LUN on the IC physically connected to the robotics.
12. Maps for partitioned libraries still follow the load balancing rules based on the physical drive location.
13. The order each partition is mapped depends on the order that the HBA was added to partitions.

1. Devices are ordered based on type and logical position (drive number)

- Secure Manager uses the drives' logical position (drive number) as the basis for all mapping operations.
- Robotics are always first in the order of devices therefore they are always assigned LUN 0 in a non-partitioned library.
- Robotics are always assigned to FC Port 0.
- Drives have the next priority. They are ordered based on their logical position (the lower the logical position or drive number, the lower the assigned LUN).
- Active Fabric, if present, will be the last device in a map.

Table 9 Normal device ordering

LUN	FC Port 0
0	Robotics
1	Drive 1
2	Drive 2
3	AF

2. Each map will start with LUN 0

LUN maps always start with LUN 0. Therefore the first device in any map will be assigned to 0.

3. New maps remove gaps in the LUN map, but modified maps leave them

New maps are filled without any gaps in the LUN numbering sequence. If a particular host is denied access to a drive, a new LUN map for that host will NOT have an empty placeholder for that drive. Instead the next logical drive will receive the LUN number that would have been used by the inaccessible drive. See Table 10.

Modified maps do leave gaps in the LUN map. If a host previously could see all library devices and then later access was withdrawn for a device, and doing this created a gap in the LUN map, that gap would remain in order to maintain the addresses of the remaining devices in the map. See Table 10.

NOTE: Any changes to device access thereafter will follow the rules for modifying an existing map rather than the rules for creating new maps.

Table 10 New and Modified maps on a 1FC port FC interface controller for a host that cannot access drive 1

NEW	
LUN	**FC Port 0**
0	Robotics
1	Drive 2
2	

MODIFIED	
LUN	**FC Port 0**
0	Robotics
1	
2	Drive 2

The New map did not have access to drive 1 when the map was first created. The Modified map had access to drive 1 when the map was created but was modified to remove access to it.

4. If there is more than one FC port on a FC interface controller, load balancing algorithms are used

Tape devices attached to a particular FC interface controller are sorted in ascending order by logical position in the library. The first two tape devices are assigned to the first FC port at the next available LUNs. The next two tape devices are assigned to the second FC port at the next available LUNs. If there are more than two tape devices per FC port then the following tape devices are assigned in a similar fashion starting over at the first FC port.

Secure Manager takes the following steps when load balancing target devices across FC ports on a dual port FC interface controller (such as an e2400-160):

1. If the robotics controller is attached to the FC interface controller, it is mapped to FC port 0 at LUN 0.

Table 11 Load balancing with robotics and 4 tape drives on a 2 FC port FC interface controller

LUN	FC Port 0	FC Port 1
0	Robotics	Drive 3
1	Drive 1	Drive 4
2	Drive 2	

2. The tape devices attached to the FC interface controller are sorted in ascending order by logical position in the library.
3. The first two tape devices are assigned to the first FC port at the next available LUNs.

Table 12 Load balancing with 2 tape drives on a 2 FC port FC interface controller

LUN	FC Port 0	FC Port 1
0	Drive 1	
1	Drive 2	

NOTE: The drives are both assigned to FC Port 0 so that if drives 3 and 4 are added later, the maps will be contiguous.

4. Then next two tape devices are assigned to the second FC port at the next available LUNs.

Table 13 Load balancing with 3 tape drives on a 2 FC port FC interface controller

LUN	FC Port 0	FC Port 1
0	Drive 1	Drive 3
1	Drive 2	

Table 14 Load balancing with 4 tape drives on a 2 FC port FC interface controller

LUN	FC Port 0	FC Port 1
0	Drive 1	Drive 3
1	Drive 2	Drive 4

5. If there are remaining tape devices, then the next two tape devices are assigned to the first FC port, the next two to the second FC port. This is repeated until all tape devices are assigned.

Table 15 Load balancing with robotics and 8 tape drives on a 2 FC port FC interface controller

LUN	FC Port 0	FC Port 1
0	Robotics	Drive 3
1	Drive 1	Drive 4
2	Drive 2	Drive 7
3	Drive 5	Drive 8
4	Drive 6	

The above algorithms are applied to all FC interface controllers in the library.

5. Maintain FC Port/LUN Map after cabling change on same interface controller.

If a device's cable is moved from one port to another on the same FC interface controller, Secure Manager will attempt to maintain the current FC Port/LUN mapping for the device.

Because devices are mapped by logical position the Interface Manager can correct for devices that have been cabled to different ports on the FC interface controller at power up and FC interface controller reboot. This remapping is not available if the tape device has been moved to a different FC interface controller. The purpose of this feature is to maintain a consistent view of the devices for the hosts connected to the library.

6. Advanced Secure Manager map creation is done like Basic Secure Manager but then removes devices and gaps if necessary

Advanced Secure Manager mapping starts the same way as Basic Secure Manager LUN mapping. Then for each host that can't see the entire library, devices are removed from the map and any gaps they make will be removed.

The bottom line is that the same rules for creating maps apply to both Basic and Advanced Secure Manager.

- LUN numbers are only assigned to the devices the host can access.
- LUN numbers always start at 0 and are consecutive (no gaps).

NOTE: Any changes to device access thereafter will follow the rules for modifying an existing map rather than the rules for creating new maps.

Table 16 Advanced Secure Manager Mapping Step 1: Maps are created using the same rules as Basic Secure Manager

LUN	FC Port 0	FC Port 1
0	Robotics	Drive 3
1	Drive 1	Drive 4
2	Drive 2	

Table 17 Advanced Secure Manager Mapping Step 2: Devices the host cannot access are removed

LUN	FC Port 0	FC Port 1
0	~~**Robotics**~~	Drive 3
1	Drive 1	~~**Drive 4**~~
2	Drive 2	

Table 18 Advanced Secure Manager Mapping Step 3: Remove gaps in the map

LUN	FC Port 0	FC Port 1
0	Drive 1	Drive 3
1	Drive 2	
2		

7. Maintain current FC Port/LUN assignments when adding devices in Advanced Secure Manager

If an existing map is modified to add a device, previous FC Port/LUN assignments will be retained in an attempt to present a consistent device mapping to the host. The device map is not re-ordered when devices are added.

NOTE: Devices are added to the FC Port that they would have been assigned to using Basic Secure Manager Rules.

Single Fibre Channel Port Example

- Assume Advanced Secure Manager is enabled and that a host has initially been given access to the robotics and drives 2-4:

Table 19 Map for host with access to robotics and drives 2-4

LUN	FC Port 0
0	Robotics
1	Drive 2
2	Drive 3
3	Drive 4

- If the library administrator later grants the host access to Drive 1, the current FC Port/LUN mappings will be retained and the new Device Map will look like:

Table 20 Map for host given access to drive 1 after robotics and drives 2-4 were mapped

LUN	FC Port 0
0	Robotics
1	Drive 2
2	Drive 3
3	Drive 4
4	**Drive 1**

8. If modifying an existing map to remove device access with Advanced Secure Manager any gap made is retained

If Advanced Secure Manager is used to remove access to a device for a host with a preexisting map, any gap this change makes will be maintained.

Table 21 1 FC port Advance Secure Manager Device Access Removal: Removing device

LUN	FC Port 0
0	~~**Robotics**~~
1	Drive 1
2	Drive 2

Table 22 1 FC port Advance Secure Manager Device Access Removal: End result

LUN	FC Port 0
0	
1	Drive 1
2	Drive 2

Some operating systems have issues with non-contiguous LUN maps. Therefore it is recommended to avoid gaps in the LUN map if at all possible.

There are three methods of removing the gap(s) created by this process.

1. All hosts using this map need to be removed and re-added and a new map needs to be created.
2. Changing the Mode from Automatic to Manual and back to Automatic will clear out all customizations (not recommended unless the number of customizations is low).
3. Add access to a device connected to that FC interface controller and that would normally be mapped to that FC port and it will fill the first gap in the LUN order.

NOTE: Options 1 and 2 require the backup software to reconfigure the library. Option 3 should only require reconfiguring the software for the new device.

9. If devices are removed and added with Advanced Secure Manager, attempts are made to not disturb the other device mappings

If host access is changing to add and remove devices, efforts are made to not disturb the devices. If possible, the newly added device will fill the gap made by the removed device. This is done to retain the LUN assignments of the other devices. A device will only be added back to the FC port that it would have been assigned to in Basic Secure manager (i.e. Robotics and drives 1 and 2 will always be on FC port 0.

NOTE: When devices need to be removed and added, it is recommended to remove devices first and then add new devices second, to prevent or lessen the chance of creating gaps in LUN maps, which may create problems in some operating systems.

Table 23 Advance Secure Manager Device Access Change Step 1 (1FC Port): Remove devices

LUN	FC Port 0
0	~~**Robotics**~~
1	Drive 1
2	Drive 2

Table 24 Advance Secure Manager Device Access Change Step 2 (1 FC Port): Add devices to fill gaps if possible

LUN	FC Port 0
0	**Drive 3**
1	Drive 1
2	Drive 2

Example

A host has access to the robotics and drives 2, and 4.

Table 25 Map from 2 FC port IC with access to the robotics, and drives 2 and 4

LUN	FC Port 0	FC Port 1
0	Robotics	Drive 4
1	Drive 2	

Advanced Secure manager is used to remove access to the robotics.

Table 26 Robotics access is removed

LUN	FC Port 0	FC Port 1
0	~~Robotics~~	Drive 4
1	Drive 2	

Table 27 Access to drive 3 is added

LUN	FC Port 0	FC Port 1
0		Drive 4
1	Drive 2	**Drive 3**

10. Active Fabric is the last LUN on a map of each FC port

One Active Fabric (AF) controller LUN is included as the last LUN in each FC port map that has a drive with a Direct Backup (X-Copy) license. Active Fabric is used by L&TT to communicate with the FC interface controllers and by some software for X-Copy/Direct Backup (a licensed functionality) implementation.

IMPORTANT: **Active Fabric is NOT displayed in Secure Manager**. Active Fabric does not conform to the rules that other devices are governed by. It will always be the last LUN in the map for each FC port. If another device is added to the end of the list it will take the LUN currently occupied by AF and AF will take the LUN after the device. If the last device is removed, then AF will move to fill in the gap.

Table 28 Map of 4 drive library on a 2 FC port IC with Direct Backup enabled on Drive 3 or 4 and AF visible

LUN	FC Port 0	FC Port 1
0	Robotics	Drive 3
1	Drive 1	Drive 4
2	Drive 2	**AF**

Example

AF mapping when access to a device is added.

Table 29 LUN map where access to drive 2 is not granted and Direct Backup is enabled for drive 1

LUN	FC Port 0
0	Robotics
1	Drive 1
2	AF

Table 30 AF LUN map placement after adding drive 2

LUN	FC Port 0
0	Robotics
1	Drive 1
2	**Drive 2**
3	AF

Example

AF mapping when access to a device is removed.

Table 31 LUN map where access to drive 2 is being removed and direct backup is enabled for drive 1

LUN	FC Port 0
0	Robotics
1	Drive 1
2	~~Drive 2~~
3	AF

Table 32 AF map placement after drive 2 is removed

LUN	FC Port 0
0	Robotics
1	Drive 1
2	**AF**

11. If an HBA has access to the robotics for a library partition, the logical robotics device will be added as the next available LUN on the IC physically connected to robotics

Each partition of a partitioned library will have its own logical robotics device. This device will be mapped to the FC port 0 of the IC that is physically connected to the robotics. The logical robotics device will be first in order of devices for that partition but it will not have any priority over devices that have already been mapped to a particular HBA. In other words, it will have the highest priority in the new devices added to the map but it will not displace any device previously added to the map.

NOTE: When partitioning is in use, only logical (or virtual) robotics devices will be mapped. The physical (or actual) robotics device will not appear in any LUN map.

Table 33 A map for an HBA with access to the robotics and drives for Partition 1 and Partition 2

LUN	FC Port 0
0	Robotics (Partition 1)
1	Physical Drive 1 (Partition 1, Drive 1)
2	Physical Drive 2 (Partition 1, Drive 1)
3	Robotics (Partition 2)
4	Physical Drive 3 (Partition 2, Drive 1)
5	Physical Drive 4 (Partition 2, Drive 2)

Partition 1 has drives 1 and 2. Partition 2 has drives 3 and 4. All drives and robotics are connected to a 1 host port IC, and the HBA was given access to Partition 1 first.

Table 34 A map for an HBA with access to the robotics on two partitions

LUN	FC Port 0
0	Robotics (Partition 1)
1	Robotics (Partition 2)

The IC physically connected to the robotics has only one host port and is not connected to any drives.

NOTE: If a host has access to the robotics and drives for many partitions of a partitioned library then the map for the IC connected to the robotics could exceed 8 LUNs. If this occurs, then ensure that the HBA, OS, drive, and software have support for more than 8 LUNs.

12. Maps for partitioned libraries still follow the load balancing rules based on the physical drive location

The load balancing algorithms used to distribute traffic between FC Port 0 and FC Port 1 still use the same rules as non-partitioned libraries and are based on the physical instead of the logical partition drive numbering.

Table 35 A map for an HBA with access to the drives for Partition 1 and Partition 2

LUN	FC Port 0	FC Port 1
0	Physical Drive 1 (Partition 1, Drive 1)	Physical Drive 3 (Partition 2, Drive 1)
1	Physical Drive 2 (Partition 1, Drive 2)	Physical Drive 4 (Partition 2, Drive 2)

Partition 1 has physical drives 1 and 2. Partition 2 has physical drives 3 and 4. All drives are connected to a 2 FC port IC, and the HBA was given access to Partition 1 first.

Table 36 A map for an HBA with only access to Partition 2

LUN	FC Port 0	FC Port 1
0	—	Physical Drive 3 (Partition 2, Drive 1)
1	—	Physical Drive 4 (Partition 2, Drive 2)

Partition 2 has physical drives 3 and 4. Physical drives 3 and 4 are connected to a 2 host FC port IC. The physical robotics is connected to a different IC not represented in Table 36.

13. The order each partition is mapped depends on the order that the HBA was added to partitions

Because the mapping occurs when each HBA is added to a partition, the order that an HBA is added to partitions will govern the order in which each partition's devices show up in the maps for that HBA. For this reason, it is recommended that each HBA be added to partitions in order starting with partitions containing the lowest numbered physical drives and ending with the highest numbered physical drives.

Example

An HBA is added to Partition 1 and then Partition 2. Partition 1 contains physical drive 1. Partition 2 contains physical drive 2. The robotics, drive 1 and drive 2 are all connected to an IC with one host port.

Table 37 The HBA is granted access to Partition 1

LUN	FC Port 0
0	Robotics (Partition 1)
1	Physical Drive 1(Partition 1, Drive 1)

Table 38 The HBA is then granted access to Partition 2

LUN	FC Port 0
0	Robotics (Partition 1)
1	Physical Drive 1 (Partition 1, Drive 1)
2	Robotics (Partition 2)
3	Physical Drive 2 (Partition 2, Drive 1)

Example

An HBA is added to Partition 2 and then Partition 1. Partition 1 contains physical drive 1. Partition 2 contains physical drive 2. The robotics, drive 1 and drive 2 are all connected to an IC with one host port.

Table 39 The HBA is granted access to Partition 2

LUN	FC Port 0
0	Robotics (Partition 2)
1	Physical Drive 2 (Partition 2, Drive 1)

Table 40 The HBA is then granted access to Partition 1

LUN	FC Port 0
0	Robotics (Partition 2)
1	Physical Drive 2 (Partition 2, Drive 1)
2	Robotics (Partition 1)
3	Physical Drive 1 (Partition 1, Drive 1)

Basic Secure Manager and manual mapping

If Basic Secure Manager is used, all devices are included in the map. Every host that is granted access to the library has the same view of the devices. For example, if a device map is modified (manual mode) for a particular host all hosts will see the modifications.

Refer to the white paper, "Command View TL/Secure Manager Mapping Algorithms," available on the HP web site at: http://www.hp.com/go/ebs under Related Information.

Interface Manager card problems

Table 41 and Table 42 describe the status and network LEDs for the Interface Manager card.

Table 41 Status LED diagnostic codes

Red LED	Green LED	Description
On	Off	BIOS code failed to run.
Blinks 1x per 5 second interval	Off	Hardware POST failed. No firmware images are loaded.
Blinks 2x per 5 second interval	Off	No CompactFlash disk or valid boot sector image found. Be sure to transfer the memory module from the old card to the new card if the Interface Manager was replaced.
Blinks 3x per 5 second interval	Off	Specified firmware image files were not found. Neither the current nor the previous image was found.
Blinks 4x per 5 second interval	Off	Load or execute command failed (boot code remains at end of process). This indicates that load, decompress, or execution failed on both the current and previous image files.
Off	Blinks 1x per 5 second interval	Normal state. Load or execute command succeeded. Boot code successfully loaded, decompressed, and initiated execution of one of the image files.

Table 42 Network link activity/speed LEDs

LED	Status	Description
Link Activity LED (left side of each Ethernet port)	Off	Port disconnected / no link
	On	Port connected to another Ethernet device
	Flashing	Data is being transmitted / received
Link Speed LED (right side of each Ethernet port)	On	Port is operating at 100 Mbps
	Off	Port is operating at 10 Mbps, or port is not connected (see Link Activity LED)

Table 43 describes common symptoms relating to the Interface Manager card and how to resolve them.

Table 43 Common Interface Manager issues

Symptom	Possible Cause	Solution
Command View TL server does not detect the Interface Manager card	Bad network connection	• Verify that the Interface Manager card and the management station are correctly connected to the LAN. • Use LEDs to troubleshoot Ethernet cabling. • Ping the Interface Manager to verify network health.
	Interface Manager card not powered on or in ready state	• Power on the library. Observe status and link LEDs. • Interface Manager must be at firmware I120 or higher on an ESL E-series library. • Interface Manager must be at firmware I130 or higher if connected to an e2400-FC 2G.
	Incorrect IP address	• Verify that the correct IP address of the Interface Manager card is entered in Command View TL. • See the *HP StorageWorks ESL E-Series Unpacking and Installation Guide* for information on obtaining the correct IP address using the OCP. • Configure Command View TL with the correct IP address.See the *HP StorageWorks Interface Manager and Command View TL User Guide* for information on adding a library or visit http://www.hp.com/support/cvesl.
Interface Manager card does not detect one or more FC interface controllers	Bad network connection	• Verify that the Interface Manager card is properly connected to the FC interface controllers and that the cables are good. • Use LEDs to troubleshoot Ethernet cabling. • See the *HP StorageWorks ESL E-Series Unpacking and Installation Guide* for more information.
	Incorrect interface controller, or controller has less than minimum required firmware	Make sure that the e2400-160 interface controller has lettering to the side of the ports. If lettering is above or below the ports, then the wrong controller type was installed. Contact your service provider. Update the firmware to the latest version as indicated in the EBS compatibility matrix, and restore the defaults on the interface controller (e2400-160 or e1200-160).
	Defective Interface Manager card or FC interface controller	Observe status and link LEDs. Replace defective card or controller.
Interface Manager card does not detect drives or library	SCSI cables not connected properly	Check cabling connections.

Table 43 Common Interface Manager issues

Symptom	Possible Cause	Solution
	SCSI settings or termination not set properly	• Check the SCSI settings for the device. • Check that the SCSI bus is properly terminated and ensure the terminator LEDs indicate a normal state (green).
	Timing issues	Reset the corresponding FC interface controller.
	Drive not powered on or in ready state	• Make sure the drive is not set to off. • Troubleshoot the drive.
Command View TL does not run in the browser	Incompatible browser version or Java support not enabled	• Make sure you are using a minimum of Microsoft Internet Explorer v6.0 SP1 or later, or Netscape Navigator v6.2 or later. • Make sure that Java support is enabled in the browser.
	Java Runtime Environment (JRE) not installed	Download and install the Java 2 Platform, Standard Edition v1.42 or later from http://wwws.sun.com/software/download/technologies.html.
	Bad network connection or network down	• Check all physical network connections. If the connections are good, contact your network administrator. • Ping the management station. If pinging fails and the IP address is correct, contact your network administrator.
	Wrong IP address	Check the IP address of the management station. On the management station, open a command shell and enter ipconfig. You must use this IP address (or the network name of the management station) in the URL to access Command View TL.
	Management station not running, or Command View TL service not running on management station.	• Check to see if the management station is operational. • Use the Services applet to verify that the Command View TL service is running on the management station. Click **Start > Settings > Control Panel > Administrative Tools > Services**.

Fibre Channel Interface Controller and Network Storage Router

The HP StorageWorks FC Interface Controller and HP StorageWorks Network Storage Router (NSR) are Fibre Channel-to-SCSI routers that enable a differential SCSI tape device to communicate with other devices over a SAN.

Table 44 outlines the recommended maximum device connections per SCSI bus and per Fibre Channel port. The purpose of these recommendations is to minimize SCSI issues and maximize utilization of the Fibre Channel bandwidth.

NOTE: The interface manager uses custom algorithms to determine how devices are presented and mapped. See, "Command View TL/Secure Manager Mapping Algorithms" for additional information.

Table 44 Recommended maximum drive connections

Drive Type	Number of drives per SCSI bus	Number of drives per 1 Gb FC	Number of drives per 2 Gb FC	Number of drives per 4 Gb FC
Ultrium 960	1	1	1	2
Ultrium 460	1	1	2	2
Ultrium 230	2	2	4	4
SDLT 600	1	1	2	2
SDLT 320	2	2	4	4
SDLT 220	2	4	8	8

Common configuration settings

To provide connectivity between hosts and devices, the router must establish an address on each connected Fibre Channel network and SCSI bus. The following paragraphs discuss configuration settings that are commonly modified and are available in the Visual Manager UI and the Serial/Telnet UI. For procedural information on accessing and changing these settings, refer to the documentation that ships with the router.

SCSI bus configuration

The router provides the capability to reset SCSI buses during the router boot cycle. This allows devices on a SCSI bus to be in a known state. The reset option can be enabled/disabled during configuration of the router. The SCSI bus reset feature is enabled in the default configuration but should be disabled for configurations using multiple initiators, tape changers or other devices that have long reset cycles, or for environments that are adversely affected by bus resets.

The router negotiates the maximum values for transfer rates and bandwidth on a SCSI bus. If an attached SCSI device does not allow the full rates, the router will use the best rates it can negotiate for that device. Because negotiation is on a device-specific basis, the router can support a mix of SCSI device types on the same SCSI bus.

Fibre Channel port configuration

By default, the configuration of the Fibre Channel ports is set to N_Port, forcing the router to negotiate a fabric only mode. This minimizes conflicts when both the router and another Fibre Channel device, such as a switch, are using Auto Sensing for Fibre Channel ports.

NOTE: By default, the Fibre Channel port speed is set to 2 Gb/s. Changes to the Fibre Channel port speed must be manually set, such as for 1 Gb/s. If set incorrectly and the router is plugged into a Loop or Fabric, the unit may receive framing errors, which can be found in the trace logs, and the fiber link light will be off because of the incorrect Fibre Channel link speed.

Fibre Channel switched fabric configuration

When connected to a Fibre Channel switch, the router is identified to the switch as a unique device by the factory programmed World Wide Name (WWN).

Discovery mode

This feature makes it easy to discover attached Fibre Channel and SCSI target devices and automatically map them on the host side for the bus/port in question.

There are two discovery methods available:

- Manual discovery
- Auto discovery

Auto Discovery can be set to occur after reboot events (when the router reboots) or link-up events (for instance, when cables are attached). Auto Discovery can be disabled by setting the router to Manual Discovery.

Host device configuration

A host system using a Fibre Channel host bus adapter (HBA) will typically map devices into the existing device-mapping scheme used by that operating system. Refer to the HBA manual for the mapping table. Refer to the configuration chapter of the HBA manual for any important information regarding host configuration.

Logical Unit Management

Because SAN resources can be shared, it is possible for multiple hosts to have access to the same devices on the SAN. To prevent conflicts, the router provides LUN management as a means to restrict device access to certain hosts. LUN management goes beyond simple LUN masking, to prevent gaps in the list of LUNs presented to a host.

LUN management maps can be created for different views of the devices attached to the router. Each Fibre Channel host is assigned a specific map configuration. Not only can the administrator control which devices a host may access, but also which LUNs are used to access these devices.

For a Fibre Channel host, a map is a table of LUNs, where each entry is either empty or contains device address information needed for host/device communication.

For a SCSI host, a map contains a list of target IDs, each of which has its own table of LUNs with address information needed for host/device communication.

NOTE: The router can respond to multiple target ID's (also known as Alternate Initiator ID) on a SCSI bus. This feature is not currently supported with HP tape libraries.

Both Fibre Channel ports and SCSI buses have pre-defined maps.

There are four pre-defined maps:

- Indexed (default)
- Port 0 Device Map
- Auto Assigned
- SCC

When a host sends a command, the router will select which map to use, based on the port receiving the command and the ID of the host sending the command. For Fibre Channel ports, the host ID is the World Wide Name; for SCSI buses, the host ID is the Initiator ID (0 - 15). When a host is unknown or is not assigned a specific map, the router will use the default map.

Indexed maps

An indexed map is initially empty.

Port 0 device maps

The Port 0 device map should be used when editing and assigning oncoming hosts.

Auto assigned maps

An Auto Assigned map is built dynamically and contains all of the devices found during discovery. This map will change automatically any time the discovery process finds a change in the devices attached. This map cannot be modified by the user.

SCC maps

An SCC map is only available on Fibre Channel ports and contains only a single entry for LUN 0. This LUN is a router controller LUN. Access to attached devices is managed using SCC logical unit addressing.

Buffered tape writes

This option is designed to enhance system performance by returning status on consecutive write commands prior to the tape device receiving data. In the event that data does not transfer correctly, the router will return a check condition on a subsequent command.

Commands other than Write are not issued until status is received for any pending write, and status is not returned until the device completes the command. This sequence is appropriate for tasks such as file backup or restore.

Some applications require confirmation of individual blocks being written to the medium, such as for audit trail tapes or log tapes. In these instances, the Buffer Tape Writes option must be disabled.

Connecting the router

When physically connecting the tape library to the router, it is strongly recommended that the tape devices be connected in sequential order. For example, the library controller and the first pair of tape drives (drive0 and drive1) be connected to the first SCSI bus; the second pair of tape drives (drive2 and drive3) be connected to the second SCSI bus, and so on. Connecting the devices in this manner provides for a consistent view of the devices across platforms and, should problems arise, aides in the troubleshooting process.

Target and LUN shifting

Device binding can be helpful in resolving issues where device targets, and sometimes even LUNs, shift. For operating systems such as Windows and HP-UX, issues can arise when a given Target or LUN changes in number. This can be caused by something as simple as plugging or unplugging another target (typically a disk or tape controller) into the SAN. In most cases this can be controlled through the use of good zoning or persistent binding.

The Windows operating system can still have issues even when zoning and binding are used. The cause of many of these issues is due to the way that Windows enumerates devices. Windows enumerates devices as they are discovered during a scan sequence. They are enumerated with device handles such as \\Tape0, \\Tape1, and so on. The Windows device scan sequence goes in the order of Bus, Target, and LUN. Bus is the HBA PCI slot, then Target, which is representative of a WWN, and LUN, which is representative of a device behind the WWN. The order will be the lowest Bus, then a target and its LUNs, then on to the next target, until it sees no more on that HBA. Then on to the next HBA, and its targets and LUNs. A common cause for device shifting is when the tape device is busy and cannot respond in time for the OS to enumerate it. Each device after that shifts up a number. See Table 45 and Table 46.

Table 45 Scenario 1 - All devices accounted for on scan

Bus	Target	LUN	Device name	Device in tape library
0	1	0	Changer0	Robot on NSR port 0
0	1	1	Tape0	Drive 1 on NSR port 0
0	1	2	Tape1	Drive 2 on NSR port 0
0	2	1	Tape2	Drive 3 on NSR port 1
0	2	2	Tape3	Drive 4 on NSR port 1

Note that the target persistency in the Emulex *lputilnt.exe* utility would help to make sure that NSR port 0 was Target ID 1, and the same for NSR port 1 for Target ID 2. The same applies to LUN binding in the Emulex full port driver utility.

Some backup applications call the tape device by using the Windows device name. As noted, the device name may shift and cause a problem for the backup application. Some applications monitor for this condition and adjust accordingly. Other applications must wait for a reboot and scan of devices, or the application must be manually reconfigured to match the current device list.

What neither of the binding utilities do is affect Window's device numerology. For example, let's say that your server boots, and Drive 2 on NSR port 0 was busy or offline when the server was scanning. Now the handles will be as follows:

Table 46 Scenario 1 - All devices accounted for on scan

Bus	Target	LUN	Device name	Device in tape library
0	1	0	Changer0	Robot on NSR port 0
0	1	1	Tape0	Drive 1 on NSR port 0
0	1	2		Busy or off line
0	2	1	Tape1	Drive 3 on NSR port 1
0	2	2	Tape2	Drive 4 on NSR port 1

Notice that Drive 3 and Drive 4 have different Windows device names.

Network Storage Routers have limited initiators for single- and dual-port routers

The number of active initiators is 128 for a dual FC port Network Storage Router (NSR), and 64 for a single FC port NSR on firmware v5.6.69 or newer.

An initiator is one that has logged into the router but does not have to be transmitting data or be currently logged in. The initiator count includes: hosts, switches, array controllers, and FC router ports. Each instance of the initiator counts toward this maximum. For example, an initiator visible by two FC router ports increases the FC active initiator count by two.

When the maximum number of active initiators is exceeded, the router will allow a new FC initiator to log into the router by accepting PLOGI (Port Login), or PRLI (Process Login) commands. However, if a SCSI command is sent to the router from that FC initiator, it will be rejected with a `Queue Full` response. If commands from an FC initiator are consistently being rejected with a `Queue Full` response, the router environment should be examined to see if the number of active FC Initiators exceeds the maximum of 128 on a dual FC port router, or 64 on a single FC port router.

To prevent issues with too many active initiators logging into the NSR, limit the number of initiators by creating a FC switch zone that has less than 64 initiators for a single FC port router, or less than 128 initiators for a dual FC port router.

Fibre Channel switches

Only short-wave optical cables are supported for connection between hosts and switches, and tape libraries with their FC bridges. But, short-wave optical cables may be used for any connection through out the topology.

Long-wave optical cables and other protocols such as Fibre Channel over IP (FCIP) can provide long distance connections between FC switches (ISLs). This allows customers to connect SANs across different rooms or buildings on a site, or across multiple sites where a long-wave fibre cable is available or where FCIP bridges are used. EBS supports most ISL types that HP supports in its storage environments. Table 47

lists supported Fibre Channel interconnect types for EBS. Refer to the *HP StorageWorks SAN Design Guide* for additional information on supported Fibre Channel and FCIP devices.

Table 47 Storage product interconnect/transport support

Interface/transport	ISLs only
4 Gbps Fibre Channel via 50 micron multi-mode fiber optic cable and short-wave SFPs. Up to 150 meters per cable segment.	
4 Gbps Fibre Channel via 62.5 micron multi-mode fiber optic cable and short-wave SFPs. Up to 70 meter per cable segment.	
2 Gbps Fibre Channel via 50 micron multi-mode fibre optic cable and short-wave SFPs. Up to 300 meters per cable segment.	
2 Gbps Fibre Channel via 62.5 micron multi-mode fibre optic cable and short-wave SFPs. Up to 150 meters per cable segment.	
2 Gbps Fibre Channel via 9 micron single-mode fibre optic cable and long-wave SFPs. Up to 10 kilometers per cable segment.	X
2 Gbps Fibre Channel via 9 micron single-mode fibre optic cable and extended reach SFPs. Up to 35 kilometers per cable segment.	X
1 Gbps Fibre Channel via 50 micron multi-mode fibre optic cable and short-wave GBICs. Up to 500 meters per cable segment.	
1 Gbps Fibre Channel via 62.5 micron multi-mode fibre optic cable and short-wave GBICs. Up to 200 meters per cable segment.	
1 Gbps Fibre Channel via 9 micron single-mode fibre optic cable and long-wave GBICs. Up to 35 kilometers per cable segment depending on the switch series used.	X
1 Gbps Fibre Channel via 9 micron single-mode fibre optic cable and very long distance GBICs. Up to 100 kilometers per cable segment.	X

NOTE: Refer to the EBS Compatibility Matrix and the *HP StorageWorks SAN Design Guide* for updates regarding support of additional interconnect types.

NOTE: Refer to the HP StorageWorks SAN Design guide for maximum supported distances across SAN. Depending on the total length across the SAN, backup and restore speeds may vary. The longer the total length across the SAN, the more buffering is needed to stream data without performance impacts. For some adapters backup restore speeds will be slow across long connections.

EBS and the Multi-Protocol Router

The StorageWorks Enterprise Backup Solution is the foundation for consolidated Fibre Channel tape storage solutions. These solutions provide tape storage that is easy to manage and grow while reducing a customer's total cost of ownership. Figure 24 presents a logical view of the Enterprise Backup Solution using the Multi-Protocol (MP) Router. Please note that the tape library on fabric 3 is being shared by hosts from all 3 independent fabrics (represented by blue lines and blue halos). Visit www.hp.com/go/ebs for compatibility, design and implementation information.

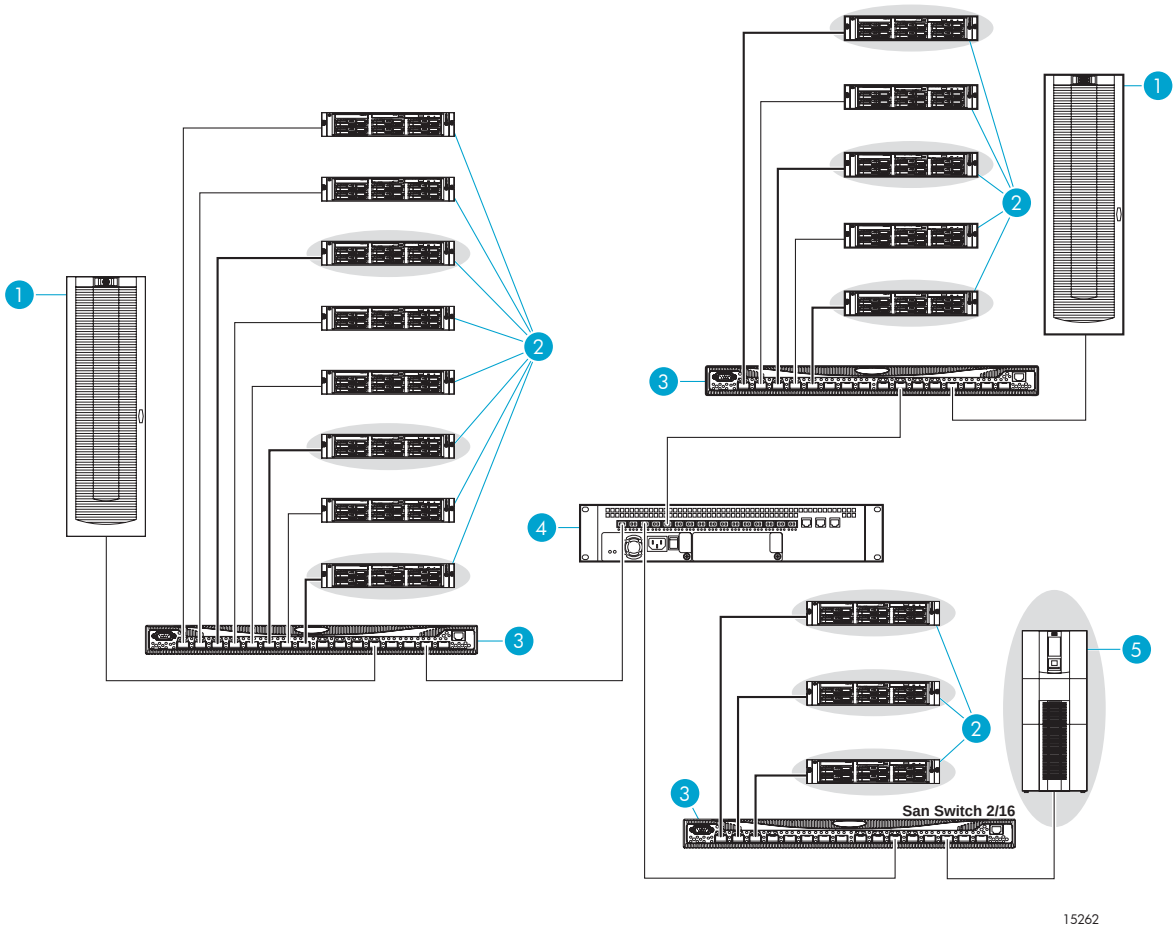


Figure 24 EBS using MP Router

1 Disk arrays
2 Servers
3 Fibre Channel switches
4 MP router
5 Tape library with Fibre Channel interconnect

The MP Router simplifies SAN design, implementation, and management through centralization and consolidation, providing a seamless way to connect and scale across multiple SAN fabrics without the complexity of merging them into a single large fabric. One of the benefits of SAN connectivity using the MP Router is that SAN troubleshooting and fault isolation is simplified within smaller environments, increasing data availability. Another benefit is that there is no need to resolve zoning or naming conflicts between SAN islands, which simplifies the consolidation process.

With the MP Router it is possible to create logical SANs (LSANs) that enable selective connectivity between devices residing in different SAN fabrics. Selective sharing of devices using the MP Router is useful for SAN islands that are geographically separated and/or managed by different organizations. Improved asset utilization can be realized by implementing the Multi-Protocol Router through more efficient storage resource sharing—for example, sharing tape libraries across multiple SAN fabrics or seamlessly moving storage from a SAN fabric that has a storage surplus to a SAN fabric that has a storage deficit.

Benefits of Tape Consolidation:

- Centralize backup of multiple SANs fabrics in a single location to maximize value of backup devices and resources
- Increase utilization of high-end backup resources
- Leverage off-peak network connectivity
- Reduce management overhead requirements
- Increase asset utilization

NOTE: The MPR is only supported in EBS configurations for bridging SAN islands. Connecting a library or host directly to an MPR is not supported.

Fibre Channel Host Bus Adapters

Fibre Channel host bus adapters (HBAs) provide:

- High speed connections from the server (host) to the SAN.
- Direct interface to fiber optic cables through standard Gigabaud Link Modules (GLMs) or Small Form-factor Pluggables (SFPs).
- Support for Fibre Channel switched fabric connections or Direct Attached Fibre (DAF).

The Fibre Channel HBA provides a high-speed connection between a server and the EBS.

NOTE: Refer to the Fibre Channel HBA documentation for installation instructions for option boards.

HBAs and performance

With today's high performance tape drives bottlenecks can exist in many different components on the SAN, including HBAs. It is important to understand the performance characteristics of backups and restores as they come from a Fibre Channel disk array, through the host, and to the tape devices. Often times performance can be improved by adding HBAs to the host to allow for more maximized throughput from the disk array controller to the tape controller (router) through the SAN. It is important to know what the maximum sustained feed speeds are from the disk and tape controllers so that HBAs can be matched to meet the performance needs.

For example, if sharing one 2Gbps FC HBA (max 200MB/s) for both disk and tape and the disk is sending 128MB/s sequential data to an LTO3 tape drive, there will only be 72MB/s bandwidth remaining for the tape drive to utilize. In this example, since LTO3 tape drives have a native speed of 80MB/s (160MB/s compressed) and the single FC HBA throughput has been reached, backups will run slower than the full rated speed of the LTO3 drives. As a best practice, use a dedicated 2Gbps FC HBA for each LTO3 tape drives.

NOTE: Refer to the *Getting the most performance from your HP StorageWorks Ultrium 960 tape drive* white paper located at http://www.hp.com/go/storage, under white papers.

Third-party Fibre Channel HBAs

Third-party HBAs, such as the Emulex LP982, may be supported in order to allow connectivity to EBS in SANs that include third-party disk arrays.

For a complete listing of supported servers and hardware, refer to the HP Enterprise Backup Solutions compatibility matrix at http://www.hp.com/go/ebs.

RAID array storage

The EBS supports several RAID (Redundant Array of Independent Disks) Array systems. RAID technology coordinates multiple disk drives to protect against the loss of data availability if one of them fails. RAID technology can help a storage system provide on-line data access that does not break down (highly available system) when it is coupled with other technologies, such as:

- Uninterruptible power control systems
- Redundant power supplies and fans
- Intelligent controllers that can back each other up
- Operating environments that can detect and respond to storage systems recovery actions

For a complete listing of supported RAID Arrays, refer to the HP Enterprise Backup Solutions compatibility matrix at http://www.hp.com/go/ebs.

Raid arrays and performance

With today's high performance tape drives bottlenecks can exist in many different components on the SAN, including RAID array controllers. It is important to understand the performance characteristics of backups and restores as they come from a Fibre Channel disk array, through the host, and to the tape devices. Often times performance can be improved by pulling data from multiple RAID array controllers to the host and then the tape controller (router) through the SAN. It is important to know what the maximum sustained feed speeds are from the HBAs and tape controllers so that disk controllers can be matched to meet the performance needs.

Third-party RAID array storage

To minimize any conflicts between a third-party disk array and the HP tape library, HP recommends the following configuration guidelines:

- Use a separate HBA for connectivity to the HP tape library. See the EBS compatibility matrix for supported HBAs.
- If the same HBA must be used, ensure that the driver is supported for both the disk array and the HP tape library. Also, zoning should be used to separate the third-party disk array from the HP tape library.

EBS power on sequence

To ensure proper solution start-up, power on the equipment using the sequence shown in Table 48.

NOTE: This sequence is for initial start up. After the fabric is up and running, the general rule is to boot the online and nearline devices (disks and tapes and their controllers) before booting servers. It may be necessary to reboot servers if online or nearline devices are rebooted without the server being rebooted.

Table 48 EBS power on sequence

Sequence	Component	Instructions
1	SAN switch	Wait at least 60 seconds for the self-initialization to complete.
2	Online storage	Wait for the self-initialization to be complete.
3	Tape library	Wait for the self-initialization to be complete.
4	Router	If using a router that is not embedded in a tape library, wait approximately 60 seconds for the controller to initialize.

Table 48 EBS power on sequence

Sequence	Component	Instructions
5	Servers	Power up each of the servers.
6	Data protection software	Launch the data protection software application on the primary server and then on each secondary server. Wait for each application to load completely before starting the next application.

3 Zoning

Zoning is a fabric management service used to create logical device subsets within a SAN. Zoning enables resource partitioning for management and access control.

One or more Fibre Channel switches create the Fibre Channel fabric, an intelligent infrastructure that serves as a backbone for deploying and managing information technology (IT) resources as a network. Use zoning to arrange fabric connected devices into logical groups over the physical fabric configuration.

Zoning provides automatic and transparent management for the SAN, and allows you the flexibility to allocate pools of storage in the SAN to meet different closed user group objectives. By creating zones of storage and computers, you can set up barriers between different operating environments to:

- Deploy logical fabric subset
- Create, test, and maintain separate areas within the fabric

Zoning also provides the following benefits:

- Increases environmental security
- Optimizes IT resources
- Customizes environments
- Easily manages a SAN

Zoning refers to the ability to partition the switch into multiple logical SANs. This feature is primarily supported for disk and tape configurations. Shared access to tape drives is handled by the backup application software running on each host. As such, generally any tape-related zones need to be configured to allow all hosts to see all tape drives and libraries.

Overlapping zones refer to a configuration where a single switch port or device WWN participates in more than one zone.

Emulated Private Loop

Emulated Private Loop (EPL) is a feature that allows a switch to emulate a hub and provide private arbitrated loop connectivity for non-public hosts or devices. Brocade refers to this feature in their switches as Quickloop.

Because of the potential for LIPs to interrupt an I/O during a backup, this feature is NOT supported for tape devices.

Increased security

The Fibre Channel fabric provides fast, reliable, and seamless information access within the SAN. Zoning segments the fabric into zones that are comprised of selected storage devices, servers, and workstations. Since zone members can only see other members in the same zone, access between computers and storage can be controlled.

Optimized resources

Zoning helps to optimize IT resources in response to user demand and changing user profiles. It can be used to logically consolidate equipment for convenience. Zoning fabric characteristics are the same as other fabric services:

- Administration from any fabric switch
- Automatic, transparent distribution of zone definitions throughout the fabric—A single failure cannot interrupt zoning enforcement to other SAN connections.
- Automatic service scaling with fabric size—There is no requirement to upgrade systems as switches are added and connectivity increases.
- Automatic, transparent deployment—There is no requirement for human intervention unless the zoning specification must change.

Customized environments

Zoning enables customization of a SAN environment. With zoning, users can:

- Integrate support for heterogeneous environments by isolating systems that have different operating environments or uses
- Create functional fabric areas by separating test or maintenance areas from production areas
- Designate closed user groups by allocating certain computers and storage, such as RAID disks, arrays, and tapes, to a zone for exclusive use on computers that are zone members
- Simplify resource utilization by consolidating equipment logically for convenience
- Facilitate time-sensitive functions by creating a temporary zone to back up a set of devices that are members of other zones
- Secure fabric areas by controlling port-level access

Zoning components

Zoning is comprised of the three components.

Table 49 Zoning components

Component	Description
Zone Configuration	A set of zones. When zoning is enabled, one zone configuration is in effect.
Zone	A set of devices that access one another. All computers, storage, and other devices connected to a fabric can be configured into one or more zones.
Zone member	A device located within a zone.

EBS zoning recommendations

Due to complexities in multi-hosting tape devices on SANs, it is best to make use of zoning tools to help keep the backup/restore environment simple and less susceptible to the effects of changing or problematic SANs.Zoning provides a way for servers, disk arrays, and tape controllers to only see what hosts and targets they need to see and use. The benefits of zoning in EBS include but are not limited to:

- The potential to greatly reduce target and LUN shifting
- Limiting unnecessary discoveries on the NSR or FC Interface Controllers
- Reducing stress on backup devices by polling agents
- Reducing the time it takes to debug and resolve anomalies in the backup/restore environment
- The potential for conflict with untested third-party products

Zoning may not always be required for configurations that are already small or simple. Typically the bigger the SAN is, the more zoning is needed. HP recommends the following for determining how and when to use zoning.

- Small fabric (16 ports or less)—may not need zoning.

  If no zoning is used, it is recommended that the tape controllers reside in the lowest ports of the switch.
- Small to medium fabric (16 - 128 ports)—use host-centric zoning

  Host-centric zoning is implemented by creating a specific zone for each server or host, and adding only those storage elements to be utilized by that host. Host-centric zoning prevents a server from detecting any other devices on the SAN or including other servers, and it simplifies the device discovery process.
- Large fabric (128 ports or more)—use host-centric zoning and split disk and tape targets

  Splitting disk and tape targets from being in the same zone together will help to keep the tape controllers free from discovering disk controllers which it doesn't need to see, unless extended copy or 3PC data movement is required.

NOTE: Overlapping zones are supported.

4 Configuration

Basic storage domain configurations

The basic EBS storage domain can be configured in many different ways. It can be a small configuration with direct-attached devices as in Direct-Attached SCSI and Direct-Attached Fibre or it can consist of a heterogeneous connection of multiple HP PA-RISC servers, HP IA-64 servers, HP AlphaServers, HP ProLiant servers, HP ProLiant Storage Servers, HP Netservers, Sun Enterprise servers, IBM RS/6000 servers, and other third-party x86 servers sharing multiple libraries and RAID array storage systems. Refer to the EBS Compatibility Matrix located at: http://www.hp.com/go/ebs.

While some operating systems found in enterprise data centers may not be supported on the storage network by EBS, it is still possible to back up these servers as clients over the LAN and still be supported. Refer to your ISV compatibility matrix for more information.

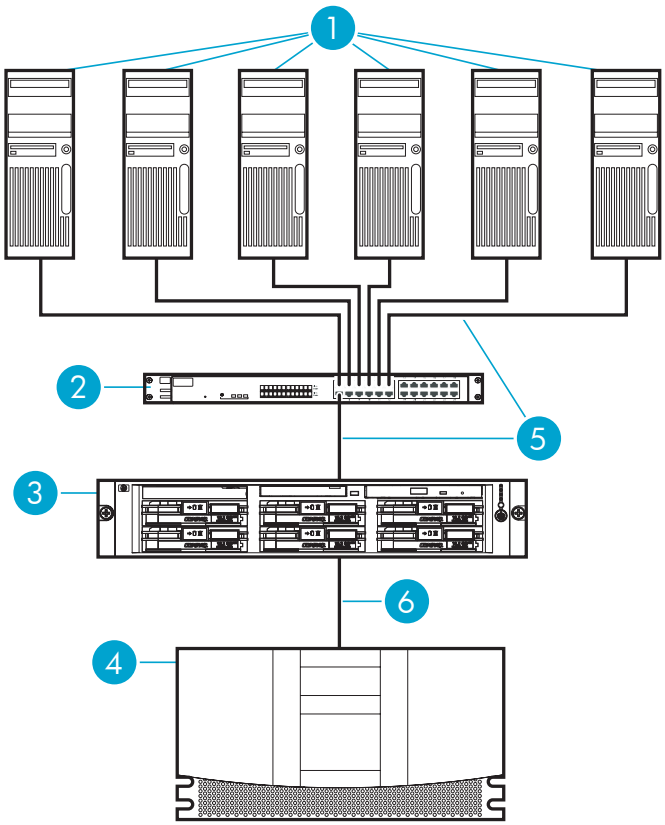


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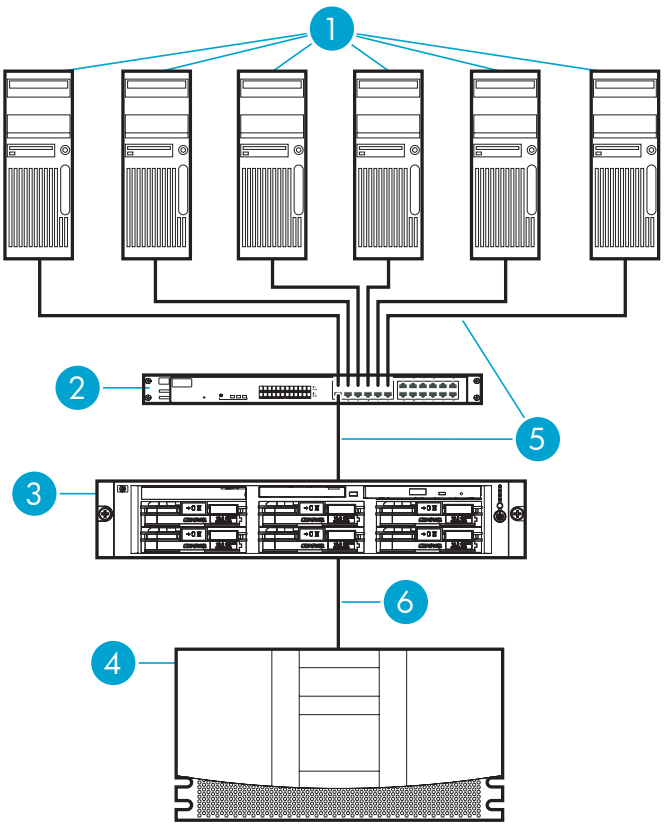
Figure 25 Basic direct attach storage (DAS) configuration

1 LAN clients
2 Ethernet switch
3 Backup server
4 Tape library
5 Ethernet connection
6 SCSI connection



15261

Figure 26 Basic point-to-point direct attached fibre (DAF) configuration

1	LAN clients	2	Ethernet switch
3	Backup server	4	Tape library with Fibre Channel Interface Controller
5	Ethernet connection	6	Fibre Channel connection

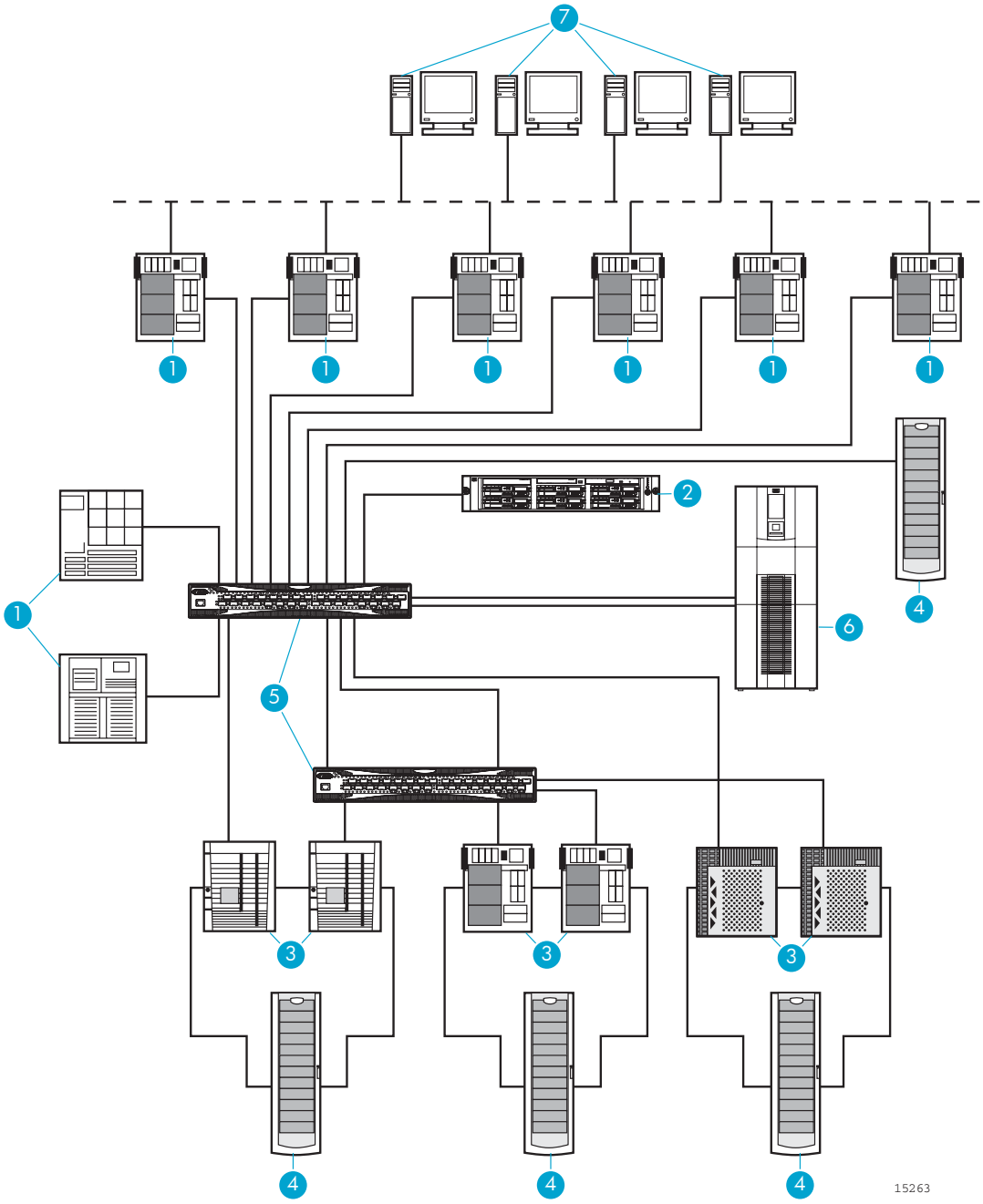


Figure 27 Basic Storage Domain configuration on switched fabric

1 Server
2 NAS or ProLiant Storage Server
3 Cluster server
4 RAID array
5 SAN switch
6 HP StorageWorks tape library with FC interface controllers
7 LAN clients

Nearline configuration information

The Enterprise Backup Solution (EBS) supports several operating systems (OSs). This section provides an overview for configuring the EBS using the following OSs:

- HP-UX
- Microsoft® Windows
- NAS or ProLiant Storage Server devices using Microsoft Windows Storage Server 2003

- Tru64 UNIX®
- Linux
- NetWare
- Sun Solaris
- IBM AIX

Setting up routers in the SAN environment

Set up the qualified tape library and router. Refer to the following section to complete the setup.

With the release of the Interface Manager card, many of the steps to configure the Fibre Channel interface controllers are now automated. See the previous sections regarding the Interface Manager card and Fibre Channel interface card, as well as the user guides for each.

About Active Fabric and SCC LUNs

Some operating systems such as Windows NT 4.0 require that a controller LUN (or Active Fabric LUN) be presented at Fibre Channel LUN 0, by the Fibre Channel to SCSI tape router, to ensure proper discovery of FC devices. With most operating systems such as Windows 2000/2003 this restriction is no longer necessary and the default maps created by the Interface Manager card or the bridge/router can be used where the Controller LUN is presented at the end of the list of devices.

The HP-UX operating system can experience issues in configuring tape devices when a controller LUN (or Active Fabric LUN) is presented at Fibre Channel LUN 0, by the Fibre Channel to SCSI tape router. The fcparray driver within HP-UX may recognize the NSR or other Fibre Channel controllers as disk controllers and create 16 ghost devices for each tape device. It is recommended that FC interface controller maps for HP-UX hosts do not have a controller LUN at Fibre Channel LUN 0.

Configuring the router for systems without the Interface Manager

To configure the router, perform the following steps. Refer to the FC Interface Controller User Guide or Network Storage Router User Guide for complete installation instructions.

1. Power up the HP qualified tape library and wait for it to initialize.
2. After the tape library has initialized and is online, power on the properly cabled router and wait for it to initialize.
3. Use Internet Explorer or Netscape to access the router Visual Manager user interface. Enter the IP address of the router network interface in the address field.

NOTE: See the router user guide for instructions on Ethernet connectivity.

4. Verify that the minimum supported firmware level is installed. The firmware level is listed on the main router Visual Manager user interface page in the **PLATFORM** section.
5. Verify that all tape and robotic devices in the tape library are recognized by the router. In the router Visual Manager user interface, select **Discovery** from the main menu to display all devices recognized by each Fibre Channel (FC) module and SCSI module in the router.
6. Verify the router is logged into the Fibre Channel switch. Ensure that the router logs into the switch as an F-Port. This can be done by running a telnet session to the switch or browsing to the switch with a web browser.

7. Set up selective storage presentation by using the FC port map settings. These maps give the user the ability to selectively present tape and robotic devices to hosts on the SAN. See chapter 2 for additional information on mapping. Also refer to the FC interface controller user guide or Network Storage Router user guide for complete instructions on creating maps for presenting to specific hosts.

   At this point in the procedure:

   a. The tape library should be online and properly configured on the router with all devices showing as mapped or attached.
   b. The router should be logged into the Fibre Channel switch as an F-Port.
   c. The host should be logged into the Fibre Channel switch as an F-Port. In some cases with ProLiant blade servers, the host may be logged in as a Public Loop or L-port.
   d. For cascaded or meshed switches, verify that all ISL links are logged in as E-Ports.

Configuring the router in a DAF environment

1. Set the Fibre Channel port Performance Mode (1GB or 2GB, depending on the hardware to which the router is connected). The router is not auto-switching.
2. Configure Mapping.
3. Active Fabric (AF) should be the last LUN used on the map.
4. Set Port Mode to Auto Sense.
5. Set Hard AL_PA to Enable.
6. Click Set AL_PA to select any available AL_PA. The only remaining AL_PA should be the host bus adapter (HBA). Using a high number will avoid potential conflicts.
7. Reboot the router.

Setting up a dual SAN

1. Install HP Storageworks E2400 controller cards. One controller card will be exclusively for robotic controller access for dual SANs. The remaining E2400 controller cards will be for drive access.

   Because the E2400 controller card sees two SANs, differentiate which Fiber channel port will be assigned to SAN 1 or SAN2

   Each E2400 only supports up to 4 drives per drives cluster; therefore, assign drives to the controller cards accordingly.
2. Use HP Storageworks Command view TL to grant robot and drive access to hosts contained in each SAN.
3. Verify that the host operating system will detect library and tape drives.
4. Install and configure the backup application.

HP-UX

The configuration process for HP-UX involves:

- Upgrading essential EBS hardware components to meet the minimum firmware and device driver requirements.

NOTE: Refer to the EBS Compatibility Matrix for all current and required hardware, software, firmware, and device driver versions including Hardware Enablement Kits and Quality Packs on the HP web site:
http://www.hp.com/go/ebs

- Installing the minimum patch level support. Refer to the following web site to obtain the necessary patches:
  www.hp.com/support

NOTE: Refer to the installation checklist at the end of this section to ensure all of the hardware and software is correctly installed and configured in the SAN.

Initial requirement (HP-UX 11.11 on PA-RISC)

HP currently supports HP-UX 11.11 in an EBS environment using an HP AB465A, A9782A, A9784A, A5158A, A6795A, or A6826A FC HBA. Please contact HP or your HP reseller for information on how to acquire this card.

The following OS software bundle is required for the AB465A, A9782A, A9784A, A5158A, A6795A, and A6826A adapters:

- FibreChanl-00 11.11.12 HP-UX (B11.11 PA) and all patches the bundle requires per bundle installation instructions.

The following OS software bundle is required for the AB465A, A9782A, A9784A, and A6826A adapters:

- FibreChanl-01 11.11.04 HP-UX (B11.11 PA) and all patches the bundle requires per bundle installation instructions.

After the hardware is installed, proceed with the following steps:

1. Check for support of the HBA in the currently installed Fibre Channel bundle (refer to the EBS Compatibility Matrix for supported revisions):

   ```
   # /usr/sbin/swlist -l bundle | egrep -i "AB465A|A9782A|A9784A|A5158A|A6795A|
   A6826A"
   ```

2. The drivers stape, sctl, and schgr must all be installed in the kernel. To see if these drivers are installed, enter the following command:

   ```
   # egrep "stape|sctl|schgr" /stand/system
   ```

   The output should display as follows:

   ```
   schgr
   sctl
   stape
   ```

   If one or more of the above drivers are missing, they must be added. If they are all installed, proceed to the next section, "Configuring the SAN."

3. Go to the directory /stand/build using the cd command:

   ```
   # cd /stand/build
   ```

4. Create a new system file from the currently configured system.

   ```
   # /usr/lbin/sysadm/system_prep -s system
   ```

5. Insert the drivers that are missing into the Drivers and Subsystems section of new system file using the vi editor. Drivers are normally listed in alphabetical order in the file. Insert in alphabetical order or add to the end of the Drivers and Subsystems section as follows:

```
stape
sctl
schgr
```

6. Compile the new Kernel:

```
# /usr/sbin/mk_kernel -s ./system
```

7. Move the new kernel into place, save the old kernel, and reboot the server:

```
# mv /stand/system /stand/system.old
# mv /stand/vmunix /stand/vmunix.old
# mv /stand/build/system /stand
# mv /stand/build/vmunix_test /stand/vmunix
# /usr/sbin/shutdown -r now
```

The HP-UX 11iv1 Quality Pack (GOLDQPK11i) June 2005 (B.11.11.0506.4) and Hardware Enablement Pack (HWEable11i) December 2004 (B11.11.0412.5) contains required software bundles.

This patch and installation instructions are provided at the HP-UX support website:

http://www.software.hp.com/SUPPORT_PLUS/qpk.html

Initial requirement (HP-UX 11.23 on IA-64 and PA-RISC)

HP currently supports HP-UX 11.23 in an EBS environment using an HP AB465A, A9782A, A9784A, A6795A or A6826A FC HBA. Please contact HP or your HP reseller for information on how to acquire these cards.

The following OS software bundles are required for the AB465A, A9782A, A9784A, A67956A, and A6826A adapters:

- FibreChanl-00 11.23.03 HP-UX (B11.23 IA PA) and all patches the bundle requires per bundle installation instructions.

The following OS software bundles are required for the AB465A, A9782A, A9784A, and A6826A adapters:

- FibreChanl-01 11.23.02 HP-UX (B11.23.IA) and all patches the bundle requires per bundle installation instructions.

  -or-

- FibreChanl-01 11.23.03 HP-UX (B11.23 PA) and all patches the bundle requires per bundle installation instructions.

Patches and installation instructions are provided at the HP-UX support web site:

http://www.software.hp.com/

After the hardware is installed, proceed with the following steps:

1. Check for support of the HBA in the currently installed FibrChanl bundle (refer to the EBS Compatibility Matrix for supported revisions):

```
# /usr/sbin/swlist -l bundle | egrep -i "AB465A|A9782A|A9784A|A6795A|A6826A"
```

2. The drivers stape, sctl, and schgr must all be installed in the kernel. To see if these drivers are installed, enter the following command:

```
# /usr/sbin/kcmodule schgr sctl stape
```

The following example shows output from kcmodule where the stape driver is not installed:

```
Module    State     Cause

schgr     static    explicit

sctl      static    depend

stape     unused
```

If one or more of the above drivers is in the unused state, they must be installed in the kernel. If they are all installed (static state), proceed to the next section, "Configuring the SAN."

3. Use kcmodule to install modules in the kernel, for example to install the stape module do the following:

   ```
   # /usr/sbin/kcmodule stape=static
   ```

   Enter yes to backup the current kernel configuration file and initiate the new kernel build.
4. Reboot the server to activate the new kernel.

   ```
   # /usr/sbin/shutdown -r now
   ```

Configuring the SAN

Set up the qualified tape library and router. Refer to the documentation provided with each Storage Area Network (SAN) component for additional component setup and configuration information.

Due to current issues with the fcparray driver within HP-UX, HP recommends that there be no SCC LUN set to 0 on the router.

Final host configurations

When the preliminary devices and the appropriate drivers listed earlier are installed and the SAN configuration is complete, the host should see the devices presented to it.

1. Run ioscan to verify that the host detects the tape devices.

   ```
   # ioscan
   ```
2. After verifying that all devices are detected, check for device files assigned to each device:

   ```
   # ioscan -fnkC tape
   # ioscan -fnkC autoch
   ```
3. If no device files have been installed, type the following command:

   ```
   # insf -C tape -e
   # insf -C autoch -e
   ```
4. Repeat step 2 to make sure device files are assigned.
5. Install and configure the backup software.

Installation checklist

With a complete SAN configuration, review the questions below to ensure that all components on the SAN are logged in and configured properly.

- Are all hardware components at the minimum supported firmware revision, including: Server, HBA, Fibre Channel Switch, Fibre Channel to SCSI Router, Interface Manager, Command View TL, tape drives, library robot?
- Are all recommended HP-UX patches, service packs, quality packs or hardware enablement bundles installed on the host?
- Is the minimum supported HBA driver loaded on the host?
- Are all tape and robotic devices mapped, configured and presented to the host from the Fibre Channel to SCSI Router, or Interface Manager?
- Is the tape library online?
- Is the Fibre Channel to SCSI router correctly logged into the Fibre Channel Switch?
- Is the host HBA correctly logged into the Fibre Channel Switch?
- If multiple Fibre Channel switches are cascaded or meshed, are all ISL ports correctly logged in?
- If using zoning on the Fibre Channel Switch, is the server HBA and Tape Library's Fibre Channel to SCSI Router in the same switch zone (either by WWN or by switch Port)?
- If using zoning on the Fibre Channel Switch, has the zone been added to the active switch configuration?

Windows NT 4.0, Windows 2000, Windows Server 2003, and Windows 2000/2003 SAK

This section provides instructions for configuring Windows NT 4.0, Windows 2000, Windows Server 2003, and Windows 2000/2003 SAK in an Enterprise Backup Solution (EBS) environment.

NOTE: Windows 2000 Advanced Server and Windows 2000 Datacenter are also supported with EBS.

Windows Server Appliance Kit is often the operating system used to build Network Attached Storage servers. While this is a modified build of Windows 2000 and Windows Server 2003, it operates in the same manner as other Windows servers do in EBS. Please note however that the storage servers will have limitations on how much they should be changed. Refer to the storage server installation and administration guides for more information:

http://www.hp.com/go/servers

The configuration process involves:

- Upgrading essential EBS hardware components to meet the minimum firmware and device driver requirements.
- Installing the minimum patch/service pack level support for:
  - Windows NT/2000/2003 on 32bit and 64bit platforms
  - Backup software

    Refer to the following web sites to obtain the necessary patches:

    — For HP: http://www.hp.com/support

    — For Microsoft: http://www.microsoft.com

NOTE: Refer to the EBS Compatibility Matrix for all current and required hardware, software, firmware, and device driver versions at http://www.hp.com/go/ebs.

See the "Installation Checklist" at the end of this section to ensure proper installation and configuration of the hardware and software in the SAN.

Configuring the SAN

This procedural overview provides the necessary steps to configure a Windows NT/2000/2003 host into an EBS. Refer to the documentation provided with each Storage Area Network (SAN) component for additional component setup and configuration information.

NOTE: To complete this installation, log in as a user with Administrator privileges.

Installing HBA device drivers (Windows NT only)

Ensure that the system meets these minimum requirements:

- Installed HBA
- Windows NT 4.0 with service pack 5 or higher

From the Windows NT desktop:

1. Click **Start**, select **Settings**, and then **Control Panel**.
2. Double-click the **SCSI Adapters** icon.
3. Select the **Drivers** tab.
4. Click **Add**.
5. Click **Have Disk**.
6. Type in the path to where the device driver for the HBA is located, and then click **OK**.
7. Select the appropriate driver for the HBA.
8. Click **Install** and continue to install the driver.
9. Restart Windows NT.

Verifying the device driver installation (Windows NT only)

Verify the driver installation from the Windows NT desktop.

1. Click **Start**, select **Settings**, and then **Control Panel**.
2. Double-click the **SCSI Adapters** icon.
3. Select the **Drivers** tab. Verify that the Emulex SCSI mini-port driver is present and started.
4. Select the **Default** tab. Verify that the HBA is present.

Storport considerations

EBS supports Storport configurations today with the Emulex Storport mini-port drivers and QLogic Storport mini-port drivers. Prior to installing the Storport mini-port HBA driver, the Storport storage driver (`storport.sys`) must be updated. Check the EBS Compatibility Matrix for the currently supported version.

NOTE: Failure to upgrade the Storport storage driver prior to installing the HBA mini-port driver may result in system instability.

Installing the HBA device driver (Windows 2000/2003)

Perform the following steps to install the Fibre Channel Host Bus Adapter device driver into an Intel-based computer running Windows 2000/2003:

NOTE: Windows 2000/2003 plug and play technology automatically installs a default driver for the host bus adapter.

The current drivers are available in the form of a Smart Component that will automatically check and see if the driver is required and if so verify that a newer version is not already installed on the system. This is the recommended installation method.

For manual installation, extract the files to a temporary location and do the following:

1. From the Windows 2000/2003 **Start** Menu, select **Settings**, then open **Control Panel**.
2. From **Administrative Tools**, select **Computer Management**, then open **Device Manager**.
3. From the Device Manger, select **SCSI and RAID controllers** to select the driver type. Select either the Emulex or QLogic adapter, depending on which HBA model is installed. Right-click the selection and select **Properties**. From the properties page, select the **Driver** tab.
4. From the Driver screen, click **Update Driver** to begin the Upgrade Device Driver Wizard.
5. From the second screen of the wizard, select **Display a List of the Known Drivers for this Device so that I Can Choose a Specific Driver**.
6. In the third screen of the wizard, click **Have Disk** to display the **Install From Disk** box. Select **Browse**.
7. Navigate to the location where the appropriate device driver for the HBA is located. Click **Open**.
8. Proceed through the remaining steps of the wizard to complete the driver installation.

9. Restart the computer.

Configuring the Emulex based FC HBA

NOTE: The default settings are now correct and the following is supplied for verification only.

The ResetTPRLO setting on the HBA must be set to 2. To verify the setting perform the following:

1. Click **Start** and select **Run**.
2. In the Run dialog box, enter `Lputilnt.exe` and click **OK**.
3. Select the appropriate HBA.
4. Click the drop-down box and select **Driver Parameters**.
5. Verify the **Parameters** radio button is selected.
6. Find the **ResetTPRLO** parameter and verify the value is 2.

NOTE: This setting forces the HBA driver to use Abort Sequence (ABTS) and Third Party Process Logout (TPRLO) instead of Target Reset for the command timeouts and similar error conditions.

7. Click **File**, and then select **Exit**.
8. Restart the computer.

Installation checklist

To ensure that all components on the SAN are logged in and configured properly, review the following questions:

- Are all hardware components at the minimum supported firmware revision, including: Server, HBA, Fibre Channel Switch, Fibre Channel to SCSI Router, Interface Manager, Command View TL, tape drives, library robot?
- Are all recommended Windows NT/2000/2003 patches and service packs installed on the host?
- Is the minimum supported HBA driver loaded on the Windows server?
- Are all tape and robotic devices mapped, configured and presented to the host from the Fibre Channel to SCSI Router, or Interface Manager?
- Is the tape library online?
- Is the Fibre Channel to SCSI router correctly logged into the Fibre Channel Switch?·Is the host HBA correctly logged into the Fibre Channel Switch?
- If multiple Fibre Channel switches are cascaded or meshed, are all ISL ports correctly logged in?
- If using zoning on the Fibre Channel Switch, is the server HBA and Tape Library's Fibre Channel to SCSI Router in the same switch zone (either by WWN or by switch Port)?
- If using zoning on the Fibre Channel Switch, has the zone been added to the active switch configuration?

Windows 2000/2003 known issues

Tape devices and libraries may change their LUNs in Windows 2000/2003. Windows 2000/2003 assigns device handles based upon the order in which targets are presented to the OS. This assignment occurs during the boot process. If targets are present for one boot cycle and not present for another boot cycle, then the LUNs will shift. Workarounds:

- Zoning should be used to isolate the server from any potential targets that are not required (such as UNIX systems, libraries, tape devices, and/or RAID controllers). Refer to the zoning section in this guide.
- Precautions must be taken when rebooting the server. Ideally, no targets will have changed from the previous boot, in which case there is no issue. If, however, the targets have changed, then the server may or may not shift the LUNs. This depends on where the target or targets that were removed were previously found during OS discovery. If they were at the end of the discovery, then nothing will shift. Otherwise, the backup software must be changed to reflect the new LUNs. Refer to the backup software documentation for instructions on assigning drives and libraries. See the section, "Target and LUN shifting" in chapter 2 for additional information.

NOTE: Some vendor applications use device serialization and are not affected by LUN shifting.

- Windows Server 2003 has a known compatibility issue with Plug and Play that causes the Windows server to send out a Test Unit Ready (TUR) command every second for each tape or library device with a loaded driver. In an environment where each server sees a large number of tape and robotic devices, such as a SAN, TURs generated by Plug and Play will have impacts on data throughput and performance because the devices are so busy responding to the TUR command as well as the traffic crossing the SAN. There are two workarounds that address this problem:
  - The TUR commands can be stopped by implementing a work-around listed in Microsoft Knowledge Base article number 842411. Refer to the Microsoft web site to view this article: http://support.microsoft.com/default.aspx?scid=kb;en-us;842411.
  - The latest releases of the HP Tape and Automation device drivers disable the auto-run feature, which in turn disables TUR polling. This functionality was implemented in the HP LTO driver version 1.0.3.0 introduced with the Ultrium 960 drive. This driver supports all generations of the HP LTO tape drive. This functionality was also added in the HP SDLT driver version 3.0.2.0. To implement this change in the HP SDLT driver:
    1. Open Device Manager.
    2. Double-click an SDLT tape drive.
    3. Click the DLT tab.
    4. Check the **Increase performance by disabling support for Microsoft Backup Utility** checkbox.
    5. Repeat steps 2 through 4 for each SDLT tape drive.

    Additionally, many ISV applications that supply their own tape device drivers (for example, Symantec NetBackup and Backup Exec) have also disabled TUR polling.

IMPORTANT: With the release of the 1.0.3.1 LTO tape driver, TUR is turned back on due to compatibility issues with native Windows backup. See the bullet above for instructions on turning TUR polling off if this driver is loaded.

- Windows Server 2003 configured with SCSIport mini-port HBA drivers will stop enumerating devices if there is no LUN 0 presented from any Fibre Channel target. This is a SCSIport driver issue and will affect both disk and tape. The current workaround is to ensure that a LUN 0 is presented from the target's device map for any devices to be seen on a specific target. This issue does not exist in Storport configurations.
- The "Max Scatter Gather List" parameter for the Emulex driver must be changed for hosts with a library that has a slot count greater than 2000. The recommended fix is to make the windows register parameter "MaximumSGList" a value of 0x40 (64) or greater which allows the transfer of larger blocks of data. This may already be a default parameter in newer driver revisions.

- At the end of March 2005, Microsoft released Service Pack 1 (SP1) for the Windows Server 2003 platform. With SP1, Microsoft changed the driver `tape.sys` to allow for NTBackup tapes written on 64-bit Windows 2003 Server to be read or cataloged on 32-bit Windows 2003 Server systems. The change in the `tape.sys` driver imposes a limit on the data transfers to a block size of no greater than 64KB. Performance issues will be more apparent on all high performance tape drives such as the HP Ultrium 960 and SDLT 600 using the `tape.sys` driver.

  As a result, backup applications utilizing HP tape drivers (`hplto.sys`, `hpdat.sys`, `hpdltw32.sys`, `hpdltx64.sys`, and `hpdltw64.sys`) and `tape.sys` driver may experience poor performance and/or failed backup jobs. If experiencing either of these symptoms, check the backup application, and/or with the software vendor, to see if the backup application is using the Microsoft tape driver, `tape.sys`. If this is the case, determine if the backup application can use an alternative driver to overcome this issue.

  Microsoft is developing a patch/update to remove this limitation; HP is working closely with Microsoft engineers and HP driver developers to get this resolved as soon as possible.
- Windows Server 2003 has a potential issue between backup applications and the Windows Removable Storage Manager service (RSM). If RSM is enabled and allowed to discover tape devices and then later disabled, the RSM database may conflict with the configuration settings for the backup software. Symptoms may include shifting of logical device handles (such as \\tape0), loss of device access, and failed jobs. Follow the steps below to remove the entries from the RSM database and completely disable the service:
  1. Disconnect the Windows node from the SAN (unplug all Fibre Channel cables).
  2. Delete all files and subfolders under the `..\system32\NtmsData` folder (location of the `system32` folder varies with different Windows versions).
  3. Enable and start the Removable Storage service in the Microsoft Computer Management applet.
  4. Access the Removable Storage (My Computer / Manage / Storage / Removable Storage) in the Microsoft Computer Management applet.
  5. Verify that there are no tape or library devices listed (other than the direct-attached devices such as the CD-ROM drive).
  6. Stop and disable the Removable Storage service in the Microsoft Computer Management applet.
  7. Reconnect the Windows node to the SAN (plug all Fibre Channel cables back in).
  8. Reboot.

NAS and ProLiant Storage Server devices using Microsoft Windows Storage Server 2003

Server storage differs from direct attached storage in several ways.

- Stored data can have multiple sets of file attributes due to heterogeneous access (NFS, SMB, Novel, Macintosh).
- The storage server is typically not supported by a console.
- Storage server vendors are often forced to use a common backup protocol, NDMP, because of lack of backup application support of the underlying or customized storage server OS.
- Storage servers using Data Protection Manager (DPM) provide administrative tools for protecting and recovering data on the file servers in the network.

HP StorageWorks NAS and HP ProLiant Storage Server devices are built on Windows Storage Server 2003 (Server Appliance Kit or SAK). Backup applications supported by Windows 2003 also run on WSS 2003 SAK, and the terminal services on the Microsoft based storage server supports backup application's GUI. The major backup vendors are actively testing their applications on the WSS framework.

All tape devices (both SCSI and FC connected) supported by the Windows systems are automatically available on Windows Storage Server 2003 storage server solutions. Since most storage servers are built with a specialized version of the OS, some of the device drivers may be outdated or unavailable. Updates to the storage server product from HP may have more current drivers. These updates are available for download from the HP server web site. Newer tape device drivers are made available from hardware and software vendors and should be used on these platforms. See the following HP web site for a backup device compatibility matrix and certified Windows device drivers:

http://www.hp.com/go/ebs

Known issues with NAS and ProLiant Storage Servers

Storage servers are highly dependent on networking resources to serve up data. Backup applications are also highly dependent on networking resources to establish communications with other backup servers to coordinate the usage of the tape libraries. At times this dependency on networking services can conflict and the backup application may lose contact with the other servers, causing backups to fail. Take note of any extended networking resources used for storage servers that may be shared with backup, such as NIC teaming, and make sure that communications are not broken.

Tru64 UNIX

The configuration process for Tru64 UNIX can be a somewhat seamless process. When firmware and driver revisions of the components are at minimum EBS acceptable levels the integration process is as simple as installation of hardware and configuring devices to the SAN fabric. This is possible because Tru64 UNIX maintains driver and configuration parameters in the OS kernel and device database table.

It is recommended, however, that if new console firmware is available that it is applied as outlined below to Tru64 UNIX servers in an EBS.

NOTE: Refer to the EBS Compatibility Matrix for all current and required hardware, software, firmware, and device driver versions at:
http://www.hp.com/go/ebs.

To ensure that you have correctly installed and configured the hardware, see "Installation checklist" on page 77.

Backup software patch

Refer to the vendor of your backup software to determine if any updates or patches are required.

Configuring the SAN

This procedural overview provides the necessary steps to configure a Tru64 UNIX host into an EBS. Refer to the documentation provided with each Storage Area Network (SAN) component for additional component setup and configuration information.

1. Prepare the required rack mounted hardware and cabling in accordance with the specifications listed in backup software user guide as well as the installation and support documentation for each component in the SAN.

NOTE: Loading Console firmware from the Console firmware CD may also update the host bus adapter (HBA) firmware. This HBA firmware may or may not be the minimum supported by EBS. Refer to the EBS Compatibility Matrix for minimum supported HBA firmware revisions.

2. Upgrade the AlphaServer to the latest released Console firmware revision.
   Refer to http://www.hp.com/support to obtain the latest Console firmware revision.
   a. Boot the server to the chevron prompt (>>>).
   b. Insert the Console firmware CD into CD-ROM drive.
   c. To see a list of all accessible devices, at the chevron prompt, type:

```
>>> show dev
```

   d. Obtain the CD-ROM device filename from the device list. Where DQA0 is an example CD-ROM device filename for the CD-ROM drive, at the chevron prompt type:

```
>>> Boot DQA0
```

   e. Complete all of the steps in the readme file, as noted in the message prompt.
   f. If the minimum supported HBA firmware revision was installed in this step, skip to step 3. If the minimum supported HBA firmware revision was not installed in this step, upgrade at this time. Refer to the release notes provided with the HBA firmware for installation instructions. To verify the latest supported revisions of HBA firmware and driver levels for the 32-bit KGPSA-BC, and 64-bit KGPSA-CA, FCA2354, FCA2384, FCA2684 and FCA2684DC, refer to the EBS Compatibility Matrix at:
   http://www.hp.com/go/ebs

NOTE: HBA firmware can be upgraded before or after installing Tru64 UNIX. The driver will be installed after Tru64 UNIX is installed. Contact Global Services to obtain the most current HBA firmware and drivers.

3. Install the Tru64 patch kit.
   a. Refer to the release notes and perform the steps necessary to install the most current Tru64 patch kit.
   b. The current patch kit installs the current Tru64 UNIX HBA driver. To verify that the installed HBA driver meets minimum support requirements, refer to the EBS Compatibility Matrix at:
      http://www.hp.com/go/ebs
4. Upgrade the HBA driver if the HBA does not contain the most current supported driver.
   a. Contact **Global Services** to obtain the latest HBA driver.
   b. Upgrading the HBA driver may require building a new kernel. Create a backup copy of the kernel file (/vmunix) before building a new kernel.
   c. If building a new kernel was necessary, reboot the server. If building a new kernel was not necessary, at a Tru64 UNIX terminal window type:

```
# hwmgr -scan scsi.
```

5. Verify that the Tru64 UNIX host is logged in to the Fibre Channel switch.

Make sure that the server logs in to the switch as an F-port.

Confirming mapped components

This section provides the commands needed to confirm that the components have been successfully installed in the SAN.

Installed and Configured Host Bus Adapters

To obtain a list of all Host Bus Adapters (HBAs) that are physically installed and configured in the server, enter the following command in a terminal window on the Tru64 host:

```
# emxmgr -d
```

For Tru64 5.1b the following command is recommended:

```
# hwmgr -show fibre
```

Visible target devices

- **WWN of the router**—To view a list of target devices that are visible to each installed HBA on the Tru64 UNIX host, enter the following command where emx0 is the name of the HBA.

  ```
  # emxmgr -t emx0
  ```

  For Tru64 5.1b the following command is recommended:

  ```
  # hwmgr -show fibre -adapter -topology
  ```

  Verify that the WWN of the router is included in the list.
- **Tape and Robot Devices**—To view a list of all of the tape and robotic devices that are visible and configured by Tru64 UNIX host, enter the following command:

  ```
  # hwmgr -view dev
  ```

Tru64 UNIX dynamically builds all device files. This process may take several minutes.

Configuring switch zoning

If zoning will be used, either by World Wide Name or by port, perform the setup after the HBA has logged into the fabric. Refer to the Fibre Channel switch documentation for complete switch zone setup information. Ensure that the World Wide Name (WWN) or port of the Fibre-Channel-to-SCSI bridge is in the same zone as the WWN or port of the HBA installed in the server.

Installation checklist

To ensure that all components on the SAN are logged in and configured properly, review the following questions:

- Are all hardware components at the minimum supported firmware revision, including: Server, HBA, Fibre Channel Switch, Fibre Channel to SCSI Router, Interface Manager, Command View TL, tape drives, library robot?
- Are the current Tru64 operating system patches installed, and is the server running the current console firmware?
- Is the minimum supported HBA driver loaded on the host?
- Are all tape and robotic devices mapped, configured and presented to the host from the Fibre Channel to SCSI Router, or Interface Manager?
- Is the tape library online?
- Is the Fibre Channel to SCSI router correctly logged into the Fibre Channel Switch?
- Is the host HBA correctly logged into the Fibre Channel Switch?
- If multiple Fibre Channel switches are cascaded or meshed, are all ISL ports correctly logged in?
- If using zoning on the Fibre Channel Switch, is the server HBA and Tape Library's Fibre Channel to SCSI Router in the same switch zone (either by WWN or by switch Port)?
- If using zoning on the Fibre Channel Switch, has the zone been added to the active switch configuration?

Red Hat and SuSE Linux

This section provides instructions for configuring supported versions of Linux in an Enterprise Backup Solution (EBS) environment.

NOTE: Refer to the EBS Compatibility Matrix for all supported current and required hardware, software, firmware and device driver versions at:
http://www.hp.com/go/ebs

The configuration process involves:

- Upgrading essential EBS hardware components to meet the minimum firmware and device driver requirements.
- Installing the supported version of the Linux Operating System onto the Intel based x86 HP Proliant server or Intel based Itanium ia64 HP Integrity server.
- Installing the OS with the kernel development option (source code) as a custom installation.
- Install the minimum supported patches/kernel errata as required.
- Install the latest HBA driver and HP Utils available from HP website.

Install Linux

NOTE: The Linux operating system and driver components change frequently and these installation and configuration notes reflect current technology, as of the version date of this guide. With new versions of drivers and errata, this guide may become outdated, however, it will provide good tips and methodologies that should help in most installations.

Drivers

Obtain the latest released Fibre Channel Host Bus Adapter driver, utilities, or Platform Kit from www.hp.com:

1. From an Internet web browser, connect to www.hp.com
2. Choose Support and Drivers.
3. Select "Download drivers and software"
4. To obtain HBA drivers, enter the HBA model number in the *for:* box (example: fca2214 or a6826a).
   To obtain the EVA Platform Kit enter the EVA model number in the *for:* box (example: EVA5000).
5. Select the Operating System version of the system where the HBA will be installed.

There are two options for setting up the HBA driver and utilities:

- Using the Linux Platform Kit (listed as Linux EVA x.xx Platform Kit)
- Manually installing the driver rpm and utilities rpm

EBS recommends using the Platform Kit to configure the server on the SAN.

Configuring the SAN

This procedural overview provides the necessary steps to configure an x86 Linux host into an Enterprise Backup Solution (EBS). Refer to the documentation provided with each Storage Area Network (SAN) component for additional component setup and configuration information.

Currently supported adapters for Linux servers included:

- 32-bit: FCA2214
- 64-bit: A6826A

Currently supported Linux in the EBS environment includes the 32-bit and 64bit version of the following OS (please see the EBS compatibility matrix for any updates to the following list):

- Red Hat Enterprise Linux 2.1 (AS/ES)

- Red Hat Enterprise Linux 3.0 (AS/ES/WS)
- Red Hat Enterprise Linux 4.0 (AS/ES/WS)
- SuSE Linux 8 (ES/SS)
- SuSE Linux 9 (ES)

NOTE: To complete this installation, log in as root.

Red Hat Enterprise Server

NOTE: Before installing the driver on an x86 Red Hat Enterprise Linux Server 2.1, increase the default size of the `initrd`. To do this, edit the file `/sbin/mkinitrd` and change the IMAGESIZE flag to 4000. Failure to do so may result in a server panic condition.

NOTE: Prior to installation of the HBA driver, unload any existing HBA driver installed. Type `lsmod|grep qla` to list the HBA driver loaded. If the driver is loaded, then type `rmmod qla2300` to unload the driver.

1. If the HBA drivers were installed from the platform kit, proceed to step 3. If performing a manual driver and utility installation, untar the `.gz` file to a temporary directory on the server:

   ```
   tar -xvzf hp_qla2x00src_<version number>.tar.gz
   ```

2. This will untar the files needed for installation. Type ./INSTALL to begin installation of the driver and fibre utilities. Once the driver is installed, reboot the server to load the new driver.
3. Type `lsmod` to check for driver installation. Note that the HBA driver loaded (qla2300):

   ```
   Module          Size        Used by     Not tainted
   Autofs          13796       0           (autoclean) (unused)
   eepro100        21968       1
   ext3            70944       2
   jbd             55444       2           [ext3]
   sg              35044       0           (unused)
   qla2300         701120      0
   qla2300_conf    301344      0
   cpqarray        26080       3
   sd_mod          13920       0           (unused)
   scsi_mod        126908      3           [sg qla2300 sd_mod]
   ```

4. After the driver is installed, if zoning is deployed, ensure that the HBA of the server and the tape library are in the same zone.
5. Type: `hp_rescan -a` to perform a hardware discovery on the SCSI bus. This command is part of the HBA SCSI utility or be sure that this rpm is installed. The result should show the successful scan of the bridge, library robotic, and the tape devices.

   ```
   scsi4   00 00 01 COMPAQ        HSV110        3010   Direct-Access
   scsi4   00 01 00 HP            MSL6000       0421   Medium
   scsi4   00 02 00 COMPAQ        HSV110        3010
   scsi4   00 01 01 HP            Ultrium       F43W   Sequential-Access
   scsi4   00 01 02 HP            Ultrium       F43W   Sequential-Access
   scsi4   00 01 03 HP            Ultrium       F43W   Sequential-Access
   scsi4   00 01 04 HP            Ultrium       F43W   Sequential-Access
   scsi4   00 01 05 HP            NS            5303
   scsi4   00 00 00 COMPAQ        HSV110        3010
   scsi5   00 01 00 COMPAQ        HSV110        3010
   scsi5   00 00 00 COMPAQ        HSV110        3010
   ```

6. vi /etc/rc.d/rc.local and add the following line:

   ```
   hp_rescan -a
   ```

   This will help to ensure that devices are discovered and configured across server reboots.
7. Reboot the server, once the server is back online, issue the command:

   ```
   cat /proc/scsi/scsi
   ```

   to verify that the previous step works and the server sees library.
8. To verify the correct version of the HBA driver is loaded, type `ls /proc/scsi/qla2300`, which will display a numeral value for each HBA. Then type `more /proc/scsi/qla2300/x`, where `x` is the numeral assigned to the HBA. Typically the first couple of lines in the output from this command will show the adapter vendor, type and firmware and driver versions. See below for sample output:

   ```
   QLogic PCI to Fibre Channel Host Adapter for HP A6826-60001 :
   Firmware version: 3.02.28, Driver version 7.00.03-fo
   Entry address = a00000000024ae00
   HBA: QLA2312 , Serial# S69043
   Request Queue = 0x4190000, Response Queue = 0x4180000
   Request Queue count= 512, Response Queue count= 512
   Total number of active commands = 0
   Total number of interrupts = 79687838
   Total number of IOCBs (used/max) = (0/600)
   Total number of queued commands = 0
   Device queue depth = 0x10
   Number of free request entries = 11
   Number of mailbox timeouts = 0
   Number of ISP aborts = 0
   Number of loop resyncs = 0
   Number of retries for empty slots = 0
   Number of reqs in pending_q= 0, retry_q= 0, done_q= 0, scsi_retry_q= 0
   Number of reqs in failover_q= 0
   Host adapter:loop state= <READY>, flags= 0x2860833
   Dpc flags = 0x40
   MBX flags = 0x0
   SRB Free Count = 4096
   Link down Timeout = 008
   Port down retry = 016
   Login retry count = 016
   Commands retried with dropped frame(s) = 0
   Configured characteristic impedance: 50 ohms
   Configured data rate: 1-2 Gb/sec auto-negotiate
   ```

SuSE Enterprise Server 8

NOTE: Prior to installation of the HBA driver, unload any existing HBA driver installed. Type `lsmod|grep qla` to list the HBA driver loaded. If the driver is loaded, then type `rmmod qla2300` to unload the driver.

1. If the HBA drivers were installed from the platform kit, proceed to step 3. If performing a manual driver and utility installation, untar the `.gz` file to a temporary directory on the server:

   ```
   tar -xvzf hp_qla2x00src_<version number>.tar.gz
   ```

2. This will untar the files needed for installation. Type ./INSTALL to begin installation of the driver and fibre utilities. Once the driver is installed, reboot the server to load the new driver.
3. Type `lsmod` to check for driver installation. Note the following:

   ```
   Module        Size      Used by      Not tainted
   Autofs        13796     0            (autoclean) (unused)
   eepro100      21968     1
   ext3          70944     2
   jbd           55444     2            [ext3]
   sg            35044     0            (unused)
   qla2300       701120    0
   qla2300_conf  301344    0
   cpqarray      26080     3
   sd_mod        13920     0            (unused)
   scsi_mod      126908    3            [sg qla2300 sd_mod]
   ```

4. After the driver is installed, if there is switch zoning on the fabric switch, be sure to add the FC HBA WWN to the switch and zone in the tape library to the server HBA.
5. Type: `hp_rescan -a` to perform a hardware discovery on the SCSI bus. This command is part of the HBA SCSI utility or be sure that this rpm is installed. The result should show the successful scan of the bridge, library robotic, and the tape devices.

   ```
   scsi4  00 01 00 HPMSL6000 0421Medium
   scsi4  00 01 01 HPUltrium F43WSequential-Access
   scsi4  00 01 02 HPUltrium F43WSequential-Access
   scsi4  00 01 03 HPUltrium F43WSequential-Access
   scsi4  00 01 04 HPUltrium F43WSequential-Access
   scsi4  00 01 05 HPNS      5303
   ```

6. Reboot the server, once the server is back online, issue the command:

   ```
   cat /proc/scsi/scsi
   ```

   to verify that the server sees library.

7. To verify the correct version of the HBA driver is loaded, type `ls /proc/scsi/qla2300`, which will display a numeral value for each HBA. Then type `more /proc/scsi/qla2300/x`, where `x` is the numeral assigned to the HBA. Typically the first couple of lines in the output from this command will show the adapter vendor, type and firmware and driver versions. See below for sample output:

```
QLogic PCI to Fibre Channel Host Adapter for HP A6826-60001 :
Firmware version: 3.02.28, Driver version 7.00.03-fo
Entry address = a00000000024ae00
HBA: QLA2312 , Serial# S69043
Request Queue = 0x4190000, Response Queue = 0x4180000
Request Queue count= 512, Response Queue count= 512
Total number of active commands = 0
Total number of interrupts = 79687838
Total number of IOCBs (used/max) = (0/600)
Total number of queued commands = 0
Device queue depth = 0x10
Number of free request entries = 11
Number of mailbox timeouts = 0
Number of ISP aborts = 0
Number of loop resyncs = 0
Number of retries for empty slots = 0
Number of reqs in pending_q= 0, retry_q= 0, done_q= 0, scsi_retry_q= 0
Number of reqs in failover_q= 0
Host adapter:loop state= <READY>, flags= 0x2860833
Dpc flags = 0x40
MBX flags = 0x0
SRB Free Count = 4096
Link down Timeout = 008
Port down retry = 016
Login retry count = 016
Commands retried with dropped frame(s) = 0
Configured characteristic impedance: 50 ohms
Configured data rate: 1-2 Gb/sec auto-negotiate
```

Additional tools

The fibre utilities added by the Linux Platform Kit can be found in the path /opt/hp/hp_fibreutils/. The tools are:

- **hp_rescan**—scan the SCSI bus for hardware addition and removal
- **scsi_info**—query the SCSI devices for information
- **adapter_info**—displayed the WWNs of the available HBAs
- **lssd**—list the available online disk devices
- **probe_luns**—same function as hp_rescan

Configuring switch zoning

If zoning will be used, either by World Wide Name or by port, perform the setup after the HBA has logged into the fabric. Refer to the Fibre Channel switch documentation for complete switch zone setup information. Ensure that the World Wide Name (WWN) or port of the Fibre-Channel-to-SCSI bridge is in the same zone as the WWN or port of the HBA installed in the server.

Installation checklist

To ensure that all components on the SAN are logged in and configured properly, review the following questions:

- Are all hardware components at the minimum supported firmware revision, including: Server, HBA, Fibre Channel Switch, Fibre Channel to SCSI Router, Interface Manager, Command View TL, tape drives, library robot?
- Is the Linux kernel errata at a minimum supported level?

- Are the minimum recommended Linux Operating System and driver patches installed on the host?
- Is the minimum supported HBA driver loaded on the host?
- Are all tape and robotic devices mapped, configured and presented to the host from the Fibre Channel to SCSI Router, or Interface Manager?
- Is the tape library online?
- Is the Fibre Channel to SCSI router correctly logged into the Fibre Channel Switch?
- Is the host HBA correctly logged into the Fibre Channel Switch?
- If multiple Fibre Channel switches are cascaded or meshed, are all ISL ports correctly logged in?
- If using zoning on the Fibre Channel Switch, is the server HBA and Tape Library's Fibre Channel to SCSI Router in the same switch zone (either by WWN or by switch Port)?
- If using zoning on the Fibre Channel Switch, has the zone been added to the active switch configuration?

Novell NetWare

NetWare environment considerations

Novell NetWare servers utilizing the Compaq Fibre Channel Host Bus Adapters must enable the FC Interface Controller's Force FCP Response Code setting. This setting is enabled/disabled on a per FC port basis and can be set via the FC Interface Controller's browser interface, FC Module Configuration Settings menu. Without the Force FCP Response Code bit enabled, the Compaq Fibre Channel Host Bus Adapter will not properly detect any devices behind the FC Interface Controller.

For details on enabling the Force FCP Response Code bit, refer to the Fibre Channel Module Configuration sections in the User Interface chapters of the *HP StorageWorks e2400-160 FC Interface Controller User Guide*.

NOTE: This setting only applies to the Compaq Fibre Channel Host Bus Adapter. The FCA-2214 Host Bus Adapter for NetWare does not require this setting and will not operate correctly if the Force FCP Response Code bit is enabled.

Heterogeneous Windows and NetWare environment limitations

Heterogeneous operating system environments that include Windows NT/2000/2003 and NetWare require that the NetWare servers utilize the FCA-2214 Host Bus Adapters for access to shared tape configurations. As discussed in the previous section, the Compaq Fibre Channel Host Bus Adapters require the Force FCP Response Code bit to be enabled in the FC Interface Controller. This setting is not compatible with any of the Host Bus Adapters supported in Windows servers.

If the NetWare configuration includes HSG80-based disk storage systems (MA8000,EMA12000, EMA16000 arrays) and the NetWare servers are utilizing the Compaq Fibre Channel Host Bus Adapters, then these HBAs should be used strictly for access to the shared disk array and FCA-2214 HBAs should be used for access to the shared tape libraries. This type of configuration should utilize separate Fibre Channel switch zones for disk and tape. If the Compaq Fibre Channel Host Bus Adapters are replaced with FCA-2214s, then it is permissible to configure disk and tape on the same host bus adapter. This configuration requires Fibre Channel driver QL2300.HAM v6.51 or later and Secure Path 3.0C SP2 or later.

NOTE: All third-party backup applications may not be supported on all hardware. Refer to the EBS Compatibility Matrix at http://www.hp.com/go/ebs.

FCA2214 configuration settings

NOTE: The FCA2214 was formerly the FCA2210.

When installing the FCA2214 Host Bus Adapter, the following load line and option settings should be included in the server's STARTUP.NCF file:

LOAD QL2300.HAM SLOT=x /LUNS /PORTNAMES /ALLPATHS [/MAXLUNS=x]

- Where SLOT specifies the PCI slot in which the adapter is installed.
- /LUNS directs NetWare to scan for all LUNs during the load of this driver instance. Without this parameter, NetWare will only scan for LUN 0 devices. The scanned LUN number range is 0 to (n - 1) where n is specified by the /MAXLUNS=n option. By default, this value is set to 32.
- /PORTNAMES causes NetWare to internally track devices by Fibre Channel port name rather than node name. This parameter is required when storage LUNs do not have a 1:1 correspondence across port names.
- /ALLPATHS disables native failover and reports all devices on all adapter paths back to the operating system.

- /MAXLUNS=x is an optional setting. If the configuration includes more than 32 LUNs behind a single adapter, this setting must be used to tell the operating system to scan for additional LUN values beyond LUN 31.

If the target configuration includes Secure Path multi-path software, the Secure Path installation will modify the startup options in the STARTUP.NCF file for the FCA2214 adapter. Specifically, the installation script will add the /PORTDOWN=2 parameter to the load line for the QL2300.HAM driver. This parameter sets the timeout period for adapter link down and storage port down; the expiration of this timer, set in seconds, triggers the failover logic in the Secure Path software.

For additional information, please refer to the Installation Guide that accompanies the FCA2214 adapter.

Configuring switch zoning

If zoning will be used, either by World Wide Name or by port, perform the setup after the HBA has logged into the fabric. Refer to the Fibre Channel switch documentation for complete switch zone setup information. Ensure that the World Wide Name (WWN) or port of the Fibre-Channel-to-SCSI bridge is in the same zone as the WWN or port of the HBA installed in the server.

Installation checklist

To ensure that all components on the SAN are logged in and configured properly, review the following questions:

- Are all hardware components at the minimum supported firmware revision, including: Server, HBA (QL2300.HAM), Fibre Channel Switch, Fibre Channel to SCSI Router, Interface Manager, Command View TL, tape drives, library robot?
- Are all recommended Netware support patches installed on the host?
- Is the minimum supported HBA driver loaded on the host?
- Are all tape and robotic devices mapped, configured and presented to the host from the Fibre Channel to SCSI Router, or Interface Manager?
- Is the tape library online?
- Is the Fibre Channel to SCSI router correctly logged into the Fibre Channel Switch?
- Is the host HBA correctly logged into the Fibre Channel Switch?
- If multiple Fibre Channel switches are cascaded or meshed, are all ISL ports correctly logged in?
- If using zoning on the Fibre Channel Switch, is the server HBA and Tape Library's Fibre Channel to SCSI Router in the same switch zone (either by WWN or by switch Port)?
- If using zoning on the Fibre Channel Switch, has the zone been added to the active switch configuration?

Sun Solaris

This section provides instructions for configuring Sun Solaris in an Enterprise Backup Solution (EBS) environment. The configuration process involves:

- Upgrading essential EBS hardware components to meet the minimum firmware and device driver requirements
- Installing the minimum patch/service pack level support for:
  - Sun Solaris
  - backup software

Refer to the following web sites to obtain the necessary patches:

- For HP: http://www.hp.com/support
- For Sun: http://www.sun.com

NOTE: Refer to the EBS Compatibility Matrix for all current and required hardware, software, firmware, and device driver versions at: http://www.hp.com/go/ebs.

See "Installation checklist" on page 103 to ensure that the hardware and software in the SAN is correctly installed and configured.

Configuring the SAN

This procedural overview provides the necessary steps to configure a Sun Solaris host into an EBS. Refer to the documentation provided with each Storage Area Network (SAN) component for additional component setup and configuration information.

Currently supported adapters for Sun Solaris include:

- **SWSA4-SB** uses the package CPQfca and configuration file fca.conf
- **SWSA4-SC** uses CPQfcaw and configuration file fcaw.conf
- **SWSA4-PC** uses CPQfcaPCI and configuration file fca-pci.conf
- **FCA2257P** uses the package QLA2300 and the configuration file qla2300.conf
- **JNI FCE6460**, **FCX-6562** and **FCX2-6562** use the package JNIC146x and the configuration file jnic146x.conf
- **Sun SG-XPCI1FC-QF2** (X6767A) and **SG-XPCI2FC-QF2** (X6768A) use the Sun SAN Foundation software packages and the `cfgadm` configuration utility
- **Sun SG-XPCI1FC-JF2** and **SG-XPCI2FC-JF2** use the package SUNWjfca and SUNWjfcax and the configuration file jfca.conf
- **Emulex LP9002L/LP10000/LP10000DC** use the package lpfc and the configuration file lpfc.conf

SWSA4 adapter configuration

IMPORTANT: This guide uses SWSA4-SC as the example for all SWSA4 adapters. Substitute your device name, driver package, and configuration file appropriately.

1. Prepare the required rack mounted hardware and cabling in accordance with the specifications listed in backup software user guide as well as the installation and support documentation for each component in the SAN.

NOTE: To complete this installation, log in as root.

2. After installing the HBA, install the device driver. The driver comes with the HBA or can be obtained from http://www.hp.com/support.

3. To ensure that no previous device driver was installed, at the prompt, type:

   ```
   #pkginfo | grep CPQfcaw
   ```

   If no driver is loaded, a prompt is returned. If there is a driver installed, verify that it is the correct revision. If not, enter the following to remove the driver:

   ```
   #pkgrm <package name>
   ```

4. Install the new driver. Navigate to the directory where the driver package is located and at the prompt, type:

   ```
   #pkgadd -d ./CPQfcaw
   ```

5. Make sure that the driver is installed. At the prompt, type:

   ```
   #pkginfo -l CPQfcaw
   ```

6. Look at the device configuration file to make sure the configuration is appropriate. There are two lines needed for this configuration. Check these lines with the following:

   ```
   #egrep "fca_nport =|def_wwpn_binding " /kernel/drv/fcaw.conf
   ```

   The output should be:

   ```
   fca_nport = 1;
   def_wwpn_binding = "$0000000000000000"
   ```

NOTE: The numbers that def_wwpn_binding = are not important. As long as there is a '$' followed by any 16 digits the device is configured properly. If these are not set properly, edit them as needed.

FCA2257P adapter configuration

Substitute for your device name appropriately.

1. Prepare the required rack mounted hardware and cabling in accordance with the specifications listed in backup software user guide as well as the installation and support documentation for each component in the SAN.
2. After installing the HBA, verify proper hardware installation. At the OpenBoot PROM ok prompt, type:

   ```
   show-devs
   ```

   If the HBA is installed correctly, an entry similar to the following is displayed (the path will very slightly depending on your configuration):

   ```
   /pci@1f,4000/QLGC,qla@5
   ```

   Verify the HBA hardware installation in Solaris at the shell prompt by typing:

   ```
   prtconf -v | grep QLGC
   ```

   If the HBA is installed correctly and the driver has not yet been installed you will see a device similar to the following:

   ```
   QLGC,qla (driver not attached)
   ```

NOTE: To complete this installation, log in as root.

3. After installing the HBA, install the device driver. The driver comes with the HBA or can be obtained from http://www.qlogic.com/support/drivers_software.asp. Refer to the section, "OEM and ISV approved/recommended drivers and firmware."
4. To ensure that no previous device driver was installed, at the prompt, type:

   ```
   #pkginfo | grep QLA2300
   ```

   This will list the specific driver package installed, such as QLA2300-3, if any. If no driver is installed, a prompt is returned. If there is a driver installed, verify that it is the correct revision by entering:

   ```
   #pkginfo -l QLA2300-3
   ```

   If you need to remove the driver, enter:

   ```
   #pkgrm <package name>
   ```

5. Install the new driver. Navigate to the directory where the driver package is located and at the prompt, type:

   ```
   #pkgadd -d ./qla2300
   ```

6. Make sure that the driver is installed. At the prompt, type:

```
#pkginfo -l QLA2300-3
```

7. Look at the device configuration file to make sure the configuration is appropriate.

Fibre Channel tape support should be enabled. An example follows:

```
hba0-fc-tape=1;
```

Persistent binding can be configured by binding SCSI target IDs to the Fibre Channel world wide port name of the router. To setup persistent binding the persistent binding only option should be enabled. An example follows.

```
hba0-persistent-binding-configuration=1;
```

After enabling persistent binding only, router world wide port names (wwpn) should be bound to SCSI target IDs. For example, if a router has a wwpn of 1111222233334444 and is visible to hba0, bind it to SCSI target ID 64 as follows:

```
hba0-SCSI-target-id-64-fibre-channel-port-name = "1111222233334444";
```

NOTE: Persistent binding for the FCA2257P HBA used to be defined in the st.conf configuration file. It is now defined in the qla2300.conf configuration file as shown above.

JNI FCE6460, FCX-6562 and FCX2-6562 adapter configuration

Substitute for your device name appropriately.

1. Prepare the required rack mounted hardware and cabling in accordance with the specifications listed in backup software user guide as well as the installation and support documentation for each component in the SAN.

NOTE: To complete this installation, you must log in as root.

2. After installing the HBA, verify proper hardware installation. At the OpenBoot PROM ok prompt, type:

```
show-devs
```

If the HBA is installed correctly you will see a device similar to the following (the path will vary slightly depending on your configuration):

```
/pci@18,700000/JNI,FCR@1
```

Verify the HBA hardware installation in Solaris at the shell prompt by typing:

```
prtconf -v | grep JNI
```

If the HBA is installed correctly and the driver has not yet been installed you will see a device similar to the following:

```
JNI, FCR (driver not attached)
```

3. Install the HBA device driver. The driver for the HBA can be obtained from http://www.jni.com/OEM. Be sure to download the Solaris driver for HP.
4. To ensure that no previous device driver was installed, at the prompt, type:

```
#pkginfo -l JNIC146x
```

If no driver is loaded, a prompt is returned. If there is a driver installed, verify that it is the correct revision. If you need to remove the driver, enter:

```
#pkgrm <package name>
```

5. Install the new driver. Navigate to the directory where the driver package is located and at the prompt, type:

```
#pkgadd -d ./JNIC146x.pkg
```

Select the JNIC146x package.

6. Make sure that the driver is installed. At the prompt, type:

```
#pkginfo -l JNIC146x
```

7. Verify the HBA driver attached by typing:

```
prtconf -v | grep JNI
```

If the driver is attached you will see a device similar to the following:

```
JNI, FCR, instance #0
```

NOTE: In the following examples, the information is provided for HBA instance 1. Your HBA may be of a different instance.

8. Look at the device configuration file to make sure the configuration is appropriate. To set the HBA in fabric mode make sure the following entries are in the file:

```
jnic146x1-FcLoopEnabled = 0;
jnic146x1-FcFabricEnabled = 1;
```

9. Static (persistent) binding can be configured in the device configuration file by binding SCSI target IDs and LUNs to the Fibre Channel world wide port name (wwpn) of the router. An example follows:

```
jnic146x1-automap = 0;
```

NOTE: "automap = 0" means no target/LUN instance will be initialized by any jnic146x instance unless the targetX_hba or targetX_lunY_hba binding parameters are explicitly defined.

You also need to add the following in the "Configuration parameters for target to FC device mapping section":

```
jnic146x1-target64_lun0_hba="jnic146x1";
jnic146x1-target64_lun1_hba="jnic146x1";
jnic146x1-target64_lun2_hba="jnic146x1";
jnic146x1-target64_lun3_hba="jnic146x1";
jnic146x1-target64_wwpn="100000e0022286bf";
```

where "100000e0022286bf" is the wwpn of the router Fibre Channel port. In addition, JNI recommends the following settings:

NOTE: In the following examples, the information is provided for HBA instance 1. Your HBA may be of a different instance.

Some parameters may not currently exist in the jnic146x.conf configuration file and may need to be added.

Recommended settings for tape

- "FCP Command Task Attribute" to a value of "Untagged." Example:

```
jnic146x1-CmdTaskAttr=1;
```

- "LUN Discovery Method" to a value of "Report LUNs." Example:

```
jnic146x1-LunDiscoveryMethod=1;
```

- "Lun Throttle" to a value of "1" (if disk is configured on the same HBA the value should be "64"). Example:

```
jnic146x1-LunThrottle=1;
```

- "Target Failed Reporting Delay" to a value of "0" (unless attempting failover with tape or disk targets in which case the value should be "300"). Example:

```
jnic146x1-FailoverDelay=0;
```

Recommendations in a multi-switch fabric environment

- I/O Recovery Interval
- Default:50
- Large Fabrics: 2000

This allows time to recover LUN Masking software after a cable pull. Example:

```
jnic146x1-LunRecoveryInterval=2000;
```

- Plogi Retry Attempts
- Default: 5
- Large Fabrics: 100

This is changed because HP XP 512 LUN Masking software prevents us from logging into it for a few seconds. Example:

```
jnic146x1-PlogiRetryCount=100;
```

- Switch GID_PT Sync
- Default: Disabled
- Large Fabrics: Enabled

This is enabled for fabrics with multiple switches to allow time for it to update its SNS database across all directors. Example:

```
jnic146x1-SwitchGidPtSyncEnable=1;
```

Refer to the readme file that comes with the driver for additional information, or go to the JNI website at http://www.jni.com.

SG-XPCI1FC-QF2 (X6767A), SG-XPCI2FC-QF2 (X6768A), SG-XPCI1FC-JF2 or SG-XPCI2FC-JF2 adapter configuration

1. Prepare the required rack mounted hardware and cabling in accordance with the specifications listed in backup software user guide as well as the installation and support documentation for each component in the SAN.

   NOTE: To complete this installation, you must log in as root.

2. Download the current Sun StorEdge SAN Foundation Software (SFS) from http://www.sun.com/storage/san. As of this EBS Design Guide publication date, the latest version of Sun StorEdge SAN is 4.4.x. Select the following files for download:
   - Install_it Script SAN 4.4.x (SAN_4.4.x_install_it.tar.Z)
   - Install_it Script SAN 4.4.x Readme (README_install_it.txt)

   The README document explains how to uncompress the downloaded file and execute the Install_it Script.

   NOTE: From Sun's site, the Install_it Script is considered an optional download, but does include all required SFS packages and patches for both Solaris 8 and Solaris 9. The Install_it Script will identify the type of HBA and version of Solaris before installing the appropriate SFS packages and patches.

3. For SG-XPCI1FC-QF2 (X6767A) or SG-XPCI2FC-QF2 (X6768A) update the HBA Fcode if needed using the flash-upgrade utility. Current Fcode release is 1.14.11 as of November 2005. Fcode 1.14.11 and flash-upgrade utility are included in the following patches:
   - SG-XPCI1FC-QF2 (X6767A)Patch 114873-03
   - SG-XPCI2FC-QF2 (X6768A)Patch 114874-03
4. Reboot the server with -r option:

   ```
   #reboot -- -r
   ```
5. Use the cfgadm utility to show the HBA devices:

   ```
   #cfgadm -al
   ```
6. Reboot the server with -r option:

   ```
   #reboot -- -r
   ```
7. Use the cfgadm utility to configure the HBA devices. “c2” is the HBA device in this example.

   ```
   #cfgadm -o force_update -c configure c2
   ```

8. Use devfsadm utility to create device files:

```
#devfsadm
```

Troubleshooting with the cfgadm Utility for the Sun StorEdge SG-XPCI1FC-QF2, SG-XPCI2FC-QF2, SG-XPCI1FC-JF2 and SG-XPCI2FC-JF2 HBAs

- Getting the status of FC devices using cfgadm:

  ```
  # cfgadm -al
  ```

  Example output for above command:

  ```
  Ap_Id                  Type            Receptacle   Occupant     Condition
  c3                     fc-fabric       connected    configured   unknown
  c3::100000e002229fa9   med-changer     connected    configured   unknown
  c3::100000e002429fa9   tape            connected    configured   unknown
  c3::50060e80034fc200   disk            connected    configured   unknown
  c4                     fc-fabric       connected    configured   unknown
  c4::100000e0022286ec   tape            connected    configured   unknown
  c4::100000e0024286ec   tape            connected    configured   unknown
  c4::50060e80034fc210   disk            connected    configured   unknown
  ```

  This output shows a media changer at lun 0 for the 100000e0022229f9 world wide name, and tape and disk devices at lun 0 for other world wide names. The devices are connected and have been configured and are ready for use. "`cfgadm -al -o show_FCP_dev`" can be used to show the devices for all luns of each Ap_Id.

- Fixing a device with an "unusable" condition:

  If the condition field of a device in the cfgadm output is "unusable" then the device is in a state such that the server cannot use the device. This may have been caused by a hardware issue. In this case, do the following to resolve the issue:

  1. Resolve the hardware issue so the device is available to the server.
  2. After the hardware issue has been resolved, use the cfgadm utility to verify device status and to mend the status if necessary:
     - Use cfgadm to get device status:

       ```
       # cfgadm -al
       ```

     - For a device that is "unusable", use cfgadm to unconfigure the device and then re-configure the device. For example (this is an example only, your device world wide name will be different):

       ```
       # cfgadm -c unconfigure c4::100000e0022286ec
       # cfgadm -o force_update -c configure c4::100000e0022286ec
       ```

     - Use cfgadm again to verify that the condition of the device is no longer "unusable":

       ```
       # cfgadm -al
       ```

Emulex LP9002L / LP10000 / LP10000DC adapter configuration

Substitute for your device name appropriately. The example shown is for a dual FC port adapter connected to the fabric.

1. Prepare the required rack mounted hardware and cabling in accordance with the specifications listed in backup software user guide as well as the installation and support documentation for each component in the SAN.

   NOTE: To complete this installation, you must log in as root.

2. After installing the HBA, verify proper hardware installation. At the OpenBoot PROM ok prompt, type:

   ```
   show-devs
   ```

   If the HBA installed correctly, you will see devices similar to the following (the path will vary slightly depending on your configuration).

   ```
   /pci@8,700000/fibre-channel@1,1
   /pci@8,700000/fibre-channel@1
   ```

Verify the HBA hardware installation in Solaris at the shell prompt by typing:

```
prtconf -v | grep fibre-channel
```

If the HBA is installed correctly, you will see devices similar to the following:

```
fibre-channel (driver not attached)
fibre-channel (driver not attached)
```

3. Install the HBA device driver. The driver for the HBA can be obtained from http://www.emulex.com/ts/docfc/solframe.htm.
4. To ensure that no previous device driver was installed, at the prompt, type:

   ```
   #pkginfo -l lpfc
   ```

   If no driver is loaded, a prompt is returned. If there is a driver installed, verify that it is the correct revision. If you need to remove the driver, enter:

   ```
   #pkgrm <package name>
   ```

5. Install the new driver. Instructions for installing the driver kit can also be obtained from http://www.emulex.com/ts/docfc/solframe.htm. Navigate to one directory level above where the driver package directory is located and at the prompt, type:

   ```
   #pkgadd -d .
   ```

   Select the lpfc.1 package.
6. Make sure that the driver is installed. At the prompt, type:

   ```
   #pkginfo -l lpfc
   ```

7. Verify the HBA driver attached by typing:

   ```
   #prtconf -v | grep fibre-channel
   ```

   If the driver attached, you will see devices similar to the following:

   ```
   fibre-channel, instance #0
   fibre-channel, instance #1
   ```

8. Look at the device configuration file lpfc.conf to make sure the configuration is appropriate.

   For WorldWide PortName binding, add the following line:

   ```
   fcp-bind-method=2;
   ```

   For FCP persistent binding, the setting fcp-bind-WWPN binds a specific WorldWide PortName to a target id. The following example shows two NSR FC ports zoned in to the second interface on the HBA:

   ```
                    WWPN              SCSI ID
   fcp-bind-WWPN="100000e0022286dd:lpfc1t62",
                 "100000e002225053:lpfc1t63";
   ```

NOTE: The interface definitions appear in /var/adm/messages. The interfaces lpfc0 and lpfc1 map to the following devices:

```
lpfc1 is /pci@8,700000/fibre-channel@1,1
lpfc0 is /pci@8,700000/fibre-channel@1
```

NOTE: Refer to comments within the lpfc.conf for more details on syntax when setting fcp-bind-WWPN. Add the following to item 3 within section “Configuring Sun Servers for tape devices on SAN”:

For LP10000 adapter:

```
name="st" class="scsi" target=62 lun=0;
name="st" class="scsi" target=62 lun=1;
name="st" class="scsi" target=62 lun=2;
name="st" class="scsi" target=62 lun=3;
```

NOTE: The information in the following examples, such as target IDs, paths, and LUNs, are examples only. The specific data for your configuration may vary.

1. Edit the *st.conf* file for the type of devices to be used and also for binding. The st.conf file should already reside in the */kernel/drv* directory. Many of the lines in the *st.conf* file are commented out. To turn on the proper tape devices, uncomment or insert the appropriate lines in the file.

   tape-config-list=

```
"COMPAQ  DLT7000","Compaq DLT7000","DLT7k-data",
"COMPAQ  DLT8000", "Compaq DLT8000","DLT8k-data",
"COMPAQ  SuperDLT1","Compaq SuperDLT","SDLT-data",
"COMPAQ  SDLT320", "Compaq SuperDLT 2", "SDLT320-data",
"HP      SDLT600","HP SDLT600","SDLT600",
"HP      Ultrium 3","HP Ultrium LTO 3","LTO3-data",
"HP      Ultrium 2-SCSI","HP Ultrium LTO 2","LTO-data",
"HP      Ultrium 1-SCSI","HP Ultrium LTO 1","ULTRIUM",
"DEC     TZ89","DEC DLT TZ89","DLT7k-data";
```

NOTE: The syntax in this file is very important. There must be eight characters for the vendor ID (COMPAQ, HP, DEC, for example) before the Product ID (DLT7000, Ultrium, and so on). In the above line, there are exactly two spaces between "COMPAQ" and "DLT7000" and there are exactly six spaces between "HP" and "Ultrium." The order of the list above is also important for Ultrium tape drives, for discovery.

   Below the tape config list is a list used to configure specific settings for each device type.

```
DLT8k-data = 1,0x38,0,0x39639,4,0x1a,0x1b,0x41,0x41,3;
SDLT-data = 1,0x38,0,0x39639,4,0x90,0x91,0x90,0x91,3;
SDLT320-data = 1,0x36,0,0x39639,4,0x92,0x93,0x92,0x93,3;
SDLT600 = 2,0x38,0,0x18619,4,0x4a,0x4a,0x4a,0x4a,3,0,3600,240,21600,960,960,21600;
ULTRIUM = 1,0x36,0,0x29639,4,0x00,0x00,0x00,0x40,3;
LTO-data = 1,0x3b,0,0x29639,4,0x00,0x00,0x00,0x42,3;
LTO3-data = 2,0x3b,0,0x18659,4,0x44,0x44,0x44,0x44,3,60,1200,600,1200,600,600,18000;
```

   Some data protection applications require SCSI reservation of the tape drives to be turned off. In the example above, this is done by changing a 1 to a 3 in the string above (ex 0x39639). Please review the st man page for more detailed information on this.

2. Define and statically bind the tape devices for SWSA4 adapters by adding lines similar to the following to the SCSI target definition section of the *st.conf* file.

```
name="st" parent="/pci@1f,4000/fca@2,0" target=64 lun=0
wwpn="1000-00e0-0202-148a";
name="st" parent="/pci@1f,4000/fca@2,0" target=64 lun=1
wwpn="1000-00e0-0202-148a";
```

3. Define tape devices for other adapters by adding lines similar to the following to the SCSI target definition section of the st.conf file.

   For FCA2257P adapters:

```
name="st" class="scsi" parent="/pci@1f,4000/QLGC,qla@1"
target=64 lun=0;
name="st" class="scsi" parent="/pci@1f,4000/QLGC,qla@1"
target=64 lun=1;
```

NOTE: The parent is the location of the HBA in the /devices directory.

For JNI FCE6460, FCX-6562 and FCX2-6562 adapters:

```
name="st" parent="fp" target=64;
name="st" class="scsi" target=64 lun=0;
name="st" class="scsi" target=64 lun=1;
name="st" class="scsi" target=64 lun=2;
name="st" class="scsi" target=64 lun=3;
```

NOTE: The target can be chosen, however it must not conflict with other target bindings in the st.conf and sd.conf files.

4. Perform a reconfiguration reboot (`reboot -- -r`) on the server and verify that the new tape devices are seen in */dev/rmt*.

Configuring switch zoning

If zoning will be used, either by World Wide Name or by port, perform the setup after the HBA has logged into the fabric. Refer to the Fibre Channel switch documentation for complete switch zone setup information. Ensure that the World Wide Name (WWN) or port of the Fibre-Channel-to-SCSI bridge is in the same zone as the WWN or port of the HBA installed in the server.

Installation checklist

To ensure that all components on the SAN are logged in and configured properly, review the following questions:

- Are all hardware components at the minimum supported firmware revision, including: Server, HBA, Fibre Channel Switch, Fibre Channel to SCSI Router, Interface Manager, Command View TL, tape drives, library robot?
- Are all recommended Solaris patches installed on the host?
- Is the minimum supported HBA driver loaded on the host?
- Are all tape and robotic devices mapped, configured and presented to the host from the Fibre Channel to SCSI Router, or Interface Manager?
- Is the tape library online?
- Is the Fibre Channel to SCSI router correctly logged into the Fibre Channel Switch?
- Is the host HBA correctly logged into the Fibre Channel Switch?
- If multiple Fibre Channel switches are cascaded or meshed, are all ISL ports correctly logged in?
- If using zoning on the Fibre Channel Switch, is the server HBA and Tape Library's Fibre Channel to SCSI Router in the same switch zone (either by WWN or by switch Port)?
- If using zoning on the Fibre Channel Switch, has the zone been added to the active switch configuration?

Troubleshooting for Sun StoreEdge FC host bus adapters

PROBLEM: An ESL 712e library power cycle can cause the ESL tape devices to become unusable on Solaris 8 servers using the X6757A or X6768A Sun StorEdge FC host bus adapters.

With the ESL 712e library and E2400-160 interface controller, tape drives are not available at initial library interface controller SCSI bus discovery after a library power-up. Therefore, the tape devices are not activated in the device map that was downloaded from the library interface manager. When the Solaris 8 server HBA executes a `report luns` command to the interface controller, zero LUNs are returned. The Sun StorEdge HBAs (X6757A and X6768A) place the tape devices in an *unusable* condition upon initial discovery shortly after the FC link is established. Subsequent discoveries do not change the condition even though the `report luns` command returns the correct information.

On the Solaris 8 server the following command can be run to check the condition of the ESL 712e tape devices that have been presented to the server:

```
# /usr/sbin/cfgadm -al
```

The status of the condition field returned by cfgadm for tape devices associated with each E2400-160 world wide name should be *unknown*. If the server has experienced the unexpected condition caused by a library power cycle, the status of the condition field will be *unusable*.

Solaris 8 is the only known version of the Solaris operating system that is affected by this issue, however the problem may not be limited to just this version.

The X6757A and X6768A host bus adapters are the only known adapters affected by this issue, however any HBA and driver that execute a `report luns` command within the 30 second SCSI bus delay timer on the E2400-160 are susceptible to this problem.

RESOLUTION: An increase of the E2400-160 SCSI bus discovery delay from the default of 30 seconds to 300 seconds is necessary to allow the tape devices to power on prior to the library interface controller SCSI bus discovery.

Connect to each E2400-160 interface controller serial port, login to the interface controller, and execute the following steps to increase the SCSI bus discovery delay value:

1. At the main menu, enter `1` to perform configuration.
2. At the configuration menu, enter `4` to perform parallel SCSI configuration.
3. For each SCSI bus, select `4` to set the discovery delay time to 300 (Pressing **Enter** at the parallel SCSI configuration menu prompt will take you to the next SCSI bus).
4. After the discovery delay time has been set to 300 for each SCSI bus, enter `X` to return to the configuration menu.
5. At the configuration menu, enter `A` to save the configuration.
6. After the configuration has been saved, enter `X` to return to the main menu.
7. At the main menu, enter `4` to reboot the interface controller.

IMPORTANT: This 300 second wait period occurs every time a reboot of a library or library interface controller occurs. There is no indication in CommandView TL of the status of the timer and it may appear that the library is hung during this time. Be patient and allow the interface controller(s) to finish their boot cycle.

IBM AIX

The configuration process for IBM AIX in an EBS environment involves:

- Upgrading essential EBS hardware components to meet the minimum firmware and device driver requirements
- Installing the minimum patch level support for:
  - IBM AIX
  - Backup software

    Refer to the following web sites to obtain the necessary patches:

    — For HP: http://www.hp.com/support

    — For IBM: http://www.ibm.com

NOTE: Refer to the EBS Compatibility Matrix for all current and required hardware, software, firmware, and device driver versions at http://www.hp.com/go/ebs.

Refer to the Quick Checklist at the end of this section to ensure you have correctly installed and configured all of the hardware and software in the SAN.

Configuring the SAN

This procedural overview provides the necessary steps to configure an AIX host into an EBS. Refer to the documentation provided with each Storage Area Network (SAN) component for additional component setup and configuration information.

NOTE: To complete this installation, log in as root.

Prepare the required hardware and cabling in accordance with the specifications listed in chapter 2 of this guide as well as the installation and support documentation for each component in the SAN.

Cambex PC1000/2000F HBA

1. After installing the Cambex PC1000F HBA, install the device driver. The driver comes with the HBA or can be obtained from www.hp.com/support.

NOTE: The driver package for the PC2000 still reads as "PC1000.driver.obj."

2. To ensure that no previous device driver was installed, at the prompt, type:

   ```
   #lslpp -l PC1000.driver.obj
   ```
3. Verify that the driver provided is the latest version available. At the prompt, type:

   ```
   #installp -ld <path to driver>
   ```
   where path to driver is the complete path to where the driver is located.
4. Install the new driver. At the prompt, type:

   ```
   #installp -acd <path to driver> all
   ```
5. Make sure that the driver is installed and committed. At the prompt, type:

   ```
   #lslpp -l PC1000.driver.obj
   ```
6. Configure the adapter. At the prompt, type:

   ```
   #cfgmgr
   ```
7. Make sure that the adapter is seen and available. At the prompt, type:

   ```
   #lsdev -Cc adapter| grep Cambex
   ```
   Output should be similar to:

   ```
   'scsi2 Available 20-58 Cambex Fibre Channel I/O Controller'
   ```

Confirming mapped components and configuring devices with the Cambex HBA

This section provides the commands needed to confirm that the components have been successfully installed in the SAN.

1. To have the HBA discover all WWNs on your fabric, at the prompt, type:

   ```
   #/usr/lpp/cbxfc/mbtest <devicename> DISCOVER
   ```

NOTE: AIX scans the fabric and binds to WWNs in port order. To reduce the risk of problems, connect the routers to the switches in the order that they control the drives.

   If you are unsure of the device name, at the prompt, type the following command to retrieve it.

   ```
   #lsdev -HCc adapter | egrep "name|Cambex"
   ```

2. Make sure you have the correct WWN ports in your fabric database. To list each target that is bound, at the prompt, type:

   ```
   #/usr/lpp/cbxfc/mbtest <devicename> FABRIC
   ```

3. Configure your HBA and devices within the fabric. At the prompt, (where the device name is SCSI2, SCSI3, and so on) type:

   ```
   #cfgmgr -l <devicename> -v
   ```

NOTE: "-v" is an optional argument that allows you to see each device as it is configured.

4. To ensure all device files are available, at the prompt, type:

   ```
   #lsdev -HCc tape
   ```

5. By default, AIX creates tape devices with a fixed block length. To change the devices to have variable block lengths, at the prompt, type:

   ```
   #chdev -l <tapedevice> -a block_size=0
   ```

   To verify the block length has been set to variable execute the following command:

   ```
   #lsattr -l <tapedevice> -E
   ```

Configuration of your tape devices (where tape devices are rmt0, rmt1, rmt2, and so on) is complete.

IBM 6228, 6239, or 5716 HBA configuration

NOTE: The 6239 is only supported on AIX 5.1 and above, with the latest maintenance patches installed. The 5716 is only supported on AIX 5.2 and above with the latest maintenance patches installed.

1. Install the latest maintenance packages for your version of AIX. This ensures that the latest drivers for the 6228/6239/5716 HBA are installed on your system. For AIX 4.3.3, the latest packages must be installed because the base OS does not contain drivers for the newer HBAs.
2. Install the IBM 6228/6239/5716 HBA and restart the server.
3. Ensure that the card is recognized. At the prompt, type:

   ```
   #lsdev -Cc adapter
   ```

   There should be a line in the output similar to the following:

   ```
   fcs0 Available 1D-08 FC Adapter
   ```

   If the adapter is not recognized, check that the correct HBA driver is installed:

   6228: `#lslpp -L|grep devices.pci.df1000f7`
   6239: `#lslpp -L|grep devices.pci.df1080f9`
   5716: `#lslpp -L|grep devices.pci.df1000fa`

   There should be lines in the output for lslpp similar to the following for a 6239 HBA:

   ```
   devices.pci.df1080f9.diag  5.1.0.1    C     F    PCI-X FC Adapter Device
   devices.pci.df1080f9.rte   5.1.0.1    C     F    PCI-X FC Adapter Device
   ```

For AIX 5.1, the device drivers may need to be installed separately from the Maintenance pack. See the IBM installation guide for the 6239.

4. For information about the HBA, such as the WWN, execute the following command:

```
#lscfg -vl fcs0
```

The output will look similar to the following:

```
DEVICE            LOCATION          DESCRIPTION

  fcs0              1H-08             FC Adapter

        Part Number.................00P4295
        EC Level....................A
        Serial Number...............1E3180B22A
        Manufacturer................001E
        FRU Number..................     00P4297
        Device Specific.(ZM)........3
        Network Address.............10000000C9345CF9
        ROS Level and ID............02E01871
        Device Specific.(Z0)........2003806D
        Device Specific.(Z1)........00000000
        Device Specific.(Z2)........00000000
        Device Specific.(Z3)........03000909
        Device Specific.(Z4)........FF601231
        Device Specific.(Z5)........02E01871
        Device Specific.(Z6)........06631871
        Device Specific.(Z7)........07631871
        Device Specific.(Z8)........20000000C9345CF9
        Device Specific.(Z9)........HS1.81X1
        Device Specific.(ZA)........H1D1.81X1
        Device Specific.(ZB)........H2D1.81X1
        Device Specific.(YL)........U0.1-P2-I2/Q1
```

5. After the HBA has successfully logged into the SAN fabric and the necessary zoning is configured, configure your HBA and devices within the fabric. At the prompt, type:

```
#cfgmgr -l <devicename> -v
```

Within the command, `<devicename>` is the name from the output of the `lsdev` command in step 3, such as `fcs0`.

6. To ensure all tape device files are available, at the prompt, type:

```
#lsdev -HCc tape
```

7. By default, AIX creates tape devices with a fixed block length. To change the devices to have variable block lengths, at the prompt, type:

```
#chdev -l <tapedevice> -a block_size=0
```

Configuration of your tape devices (where tape devices are `rmt0`, `rmt1`, and so on) is complete.

NOTE: HP tape drives (SDLT and LTO) use the IBM `ost` tape driver. When properly configured, a device listing will show the tape device as follows:

For IBM native HBAs: `Other FC SCSI Tape Drive`
For non-IBM native HBAs: `Other SCSI Tape Drive`

Configuring switch zoning

If zoning will be used, either by World Wide Name or by port, perform the setup after the HBA has logged into the fabric. Refer to the Fibre Channel switch documentation for complete switch zone setup information. Ensure that the World Wide Name (WWN) or port of the Fibre-Channel-to-SCSI bridge is in the same zone as the WWN or port of the HBA installed in the server.

Installation checklist

To ensure that all components on the SAN are logged in and configured properly, review the following questions:

- Are all hardware components at the minimum supported firmware revision, including: Server, HBA, Fibre Channel Switch, Fibre Channel to SCSI Router, Interface Manager, Command View TL, tape drives, library robot?
- Are all recommended AIX maintenance packages installed on the host?
- Is the minimum supported HBA driver loaded on the host?
- Are all tape and robotic devices mapped, configured and presented to the host from the Fibre Channel to SCSI Router, or Interface Manager?
- Is the tape library online?
- Is the Fibre Channel to SCSI router correctly logged into the Fibre Channel Switch?
- Is the host HBA correctly logged into the Fibre Channel Switch?
- If multiple Fibre Channel switches are cascaded or meshed, are all ISL ports correctly logged in?
- If using zoning on the Fibre Channel Switch, is the server HBA and Tape Library's Fibre Channel to SCSI Router in the same switch zone (either by WWN or by switch Port)?
- If using zoning on the Fibre Channel Switch, has the zone been added to the active switch configuration?

Installing backup software and patches

After all components on the SAN are logged in and configured, the system is ready for the installation of any supported backup software. Refer to the installation guide for your particular software package, or contact the vendor for detailed installation procedures and requirements.

After installing the backup software, check with the software vendor for the latest updates and patches. If any updates or patches exist for your backup software, install them now.

5 Management Tools

HP has developed several important tools to assist with managing different devices within the EBS.

HP OpenView Storage Area Manager

HP OpenView Storage Area Manager simplifies and automates management of your storage resources and infrastructure. It manages both tape and disk, direct- and network-attached storage, including heterogeneous devices across multivendor products distributed worldwide. Its central management allows you to effectively monitor and manage storage and storage service availability, performance, usage, cost, and growth, helping you to gain control of your enterprise storage and optimize your resources.

HP OpenView Storage Area Manager is available for purchase from the HP website at:

http://www.hp.com/products1/storage/products/storagesoftware/openview/index.html

Library and Tape Tools

HP StorageWorks Library and Tape Tools (L&TT) is a premiere tape and magneto-optical storage device and diagnostic tool.

To provide continued service to our customers, HP provides the L&TT software application. L&TT is a diagnostic tool that is designed to aid in the installation and maintenance of HP tape and magneto-optical storage products. L&TT includes several features designed for use by both HP storage customers and trained service personnel. The key features include:

- Diagnostic tools for tape and magneto-optical devices designed for simple troubleshooting
- Multiple options for retrieving and updating both the latest firmware and the most current version of L&TT

Frequent firmware image updates are released on the Internet. For optimal performance, HP recommends that you update your system periodically with the latest device firmware.

L&TT is available for download at no cost from the HP website at:

http://www.hp.com/support/tapetools

If you encounter any issues transitioning to L&TT, please contact the L&TT team at: LTT_team@hp.com.

NOTE: Do not use any diagnostic tape tools, such as L&TT, during active backup jobs. These applications can interfere with the backup jobs and cause them to fail.

HP Systems Insight Manager (HP SIM)

HP SIM is the foundation for HP's unified infrastructure management strategy. It provides hardware level management for HP ProLiant, Integrity, and HP 9000 servers; HP BladeSystems; and HP StorageWorks MSA, EVA, and XP storage arrays. HP SIM also provides management of non-HP gear through industry standards.

HP SIM alone is an effective unified infrastructure management tool. When used in conjunction with Essentials plug-ins, it becomes a comprehensive, easy-to-use platform that enables organizations to holistically control their Windows, HP-UX, and Linux environments.

Features:

- Delivers fault monitoring, inventory reporting, and configuration management for ProLiant, Integrity, and HP 9000 systems as well as HP StorageWorks MSA, EVA, XP arrays and various third-party arrays via a web-based GUI or command line.
- Provides base-level management of HP clients and printers. Can be extended with HP Client Management Software and HP Web JetAdmin for more advanced management capabilities.

- Delivers notification of and automates response to pre-failure or failure conditions automatically through automated event handling.
- Facilitates secure, scheduled execution of OS commands, batch files, and custom or off-the-shelf applications across groups of Windows, Linux, or HP-UX systems.
- Enables centralized updates of BIOS, drivers, and agents across multiple ProLiant servers with system software version control.
- Enables secure management through support for SSL, SSH, OS authentication, and role-based security.
- Installs on Windows, HP-UX, and Linux.

Key benefits:

HP Systems Insight Manager, HP's unified server-storage management tool, helps maximize IT staff efficiency and hardware platform availability for small and large server deployments alike. It is designed for end-user setup, and its modular architecture enables systems administrators to plug in additional functionality as needed.

- Unified server and storage management
- Improves efficiency of the IT staff
- Extensibility through plug-in applications
- Integrate new technologies in response to changing conditions

Management agents

Many management agents are able to keep track of nearline storage devices through the use of in-band polling. In-band polling is done by requesting data from the storage device in-band, or in the same path as data travel. Typical SCSI commands that are used to gather this data are Inquiry and Log Sense commands.

Known issues

Inquiry commands report information such as make, model and serial number, while Log Sense reports other health statistics. Due to the multi-hosted nature of backups on SANs, these polling agents can cause the tape controller or tape and robotic devices to become unstable due to the flooding of these commands coming from all of the hosts that can see the devices. HP Fibre Channel interface controllers have an inquiry caching feature that minimizes the impact of inquiry commands in a backup environment.

Log Sense commands can still cause issues on SAN backups as is the case with HP Systems Insight Manager versions 6.4 and 7.0 and 7.1. Insight Manager uses a timeout for Log Sense commands that can sometimes be exceeded in a normal backup environment. Side affects from this behavior may include a robotic device to become unresponsive, poor performance, or a tape controller reboot.

Version 7.2 of the Insight Management agents will begin to use Inquiry commands for polling as opposed to Log Sense commands. Utilities have also been made available for versions 7.0 and 7.1. The HP Utility for Disabling Fibre Agent Tape Support can be used to allow these backup jobs to complete without being overrun with Log Sense commands. This utility disables the Fibre Agent Tape support, which disables the monitoring of the Fibre Attached Tape Library. Deploying this utility will disable only Fibre Attached Tape Library monitoring, leaving the monitoring of all other devices and peripherals by the Storage Agents unaffected. The HP Utility for Disabling Fibre Agent Tape Support is available in SoftPaq SP25792 at the following URL:

ftp://ftp.compaq.com/pub/softpaq/sp25501-26000/SP25792.EXE

Recommendations

Be aware of the management applications that run in backup environments as they may issue commands to the tape and robotic devices for polling or monitoring purposes, and adversely impact backup jobs in progress. Sometimes these applications or agents can be running on the server as part of the installed operating system. If these agents are running in the backup environment, and they are not needed, then disable them. If they must be run, then limit the agent to 1 or 2 servers that see the nearline storage device. Sometimes it is not necessary for the agents to poll nearline devices, as they are already monitored by the backup application. In most cases the backup application will remotely monitor the backup environment.

Refer to your management agent software updates for more information on how to manage nearline device polling.

6 High Availability

Typical high availability and cluster configurations for online storage include multiple paths to the disk array. This provides redundant I/O paths and maintains system uptime if a path fails. There is currently no capability like this for tape configurations. Currently, only a single path can be used between any host and tape device or tape library controller. See Figure 29.

Multi-path disk array configurations typically utilize a special driver on the host. This driver recognizes two views of the same disk array, presents only one device image to the host, and provides a fail-over capability between them. This type of functionality would need to be developed for tape devices either in a device driver or within the backup application for a redundant-path capability to be present.

Error recovery provides an additional hurdle for this type of configuration. When a disk I/O such as a read or write to a logical block fails, the host can simply retry the I/O. In this case, the device driver switches over to a different path when it sees the first attempt fail and the whole process is transparent to the application writing or reading the data.

For tape backup it is not as simple. Because the tape drive is a very state-full device, additional information is needed on how the I/O failed in order to recover properly. For example if a write command sent to a tape drive fails, one possible condition might be that the tape device did not receive the command. If that were the case, the host would simply resend the command. Another possibility might be that the tape device received the command, executed it, but then failed to send status back to the host. In this case, the tape would need to be rewound to a specific point that is prior to the failure, and the sequence of writes restarted from there. Similar issues exist when sending positioning commands to a tape drive such as forward or rewind.

FC-TAPE adds error recovery protocols to the Fibre Channel standard (FCP-2) to address these issues, but they are limited to work for a single HBA in a host. In order to have a backup automatically fail-over between two HBAs on the same host, further development needs to occur within the tape driver and backup application.

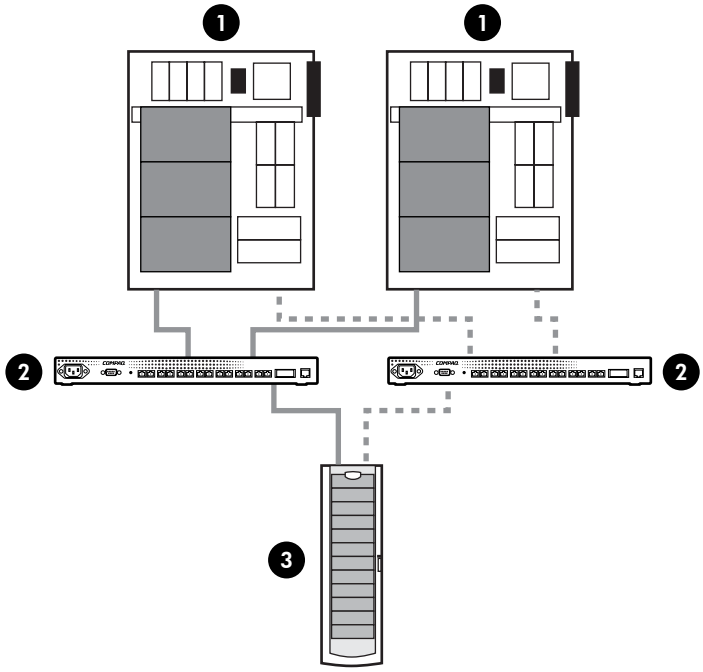


Figure 28 Typical multi-path configuration for disk

1 Server
2 SAN switch
3 Disk array

Servers can be configured to have no single point of failure between themselves and their online data. This is done by enabling multiple paths to the Fibre Channel disk array. Typically software on the host and the array will manage the logical units and their paths.

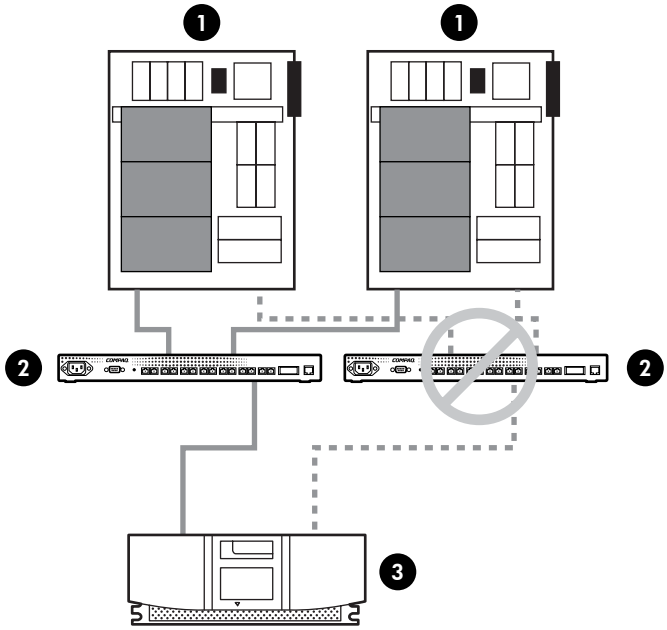


Figure 29 No multi-path fail-over capability for tape

1 Server
2 SAN switches
3 HP StorageWorks tape library with embedded router

Multiple paths are not supported to a tape or robotic device. This can cause device ghosting, which may result in configuration problems when deploying a backup application to manage the tape library.

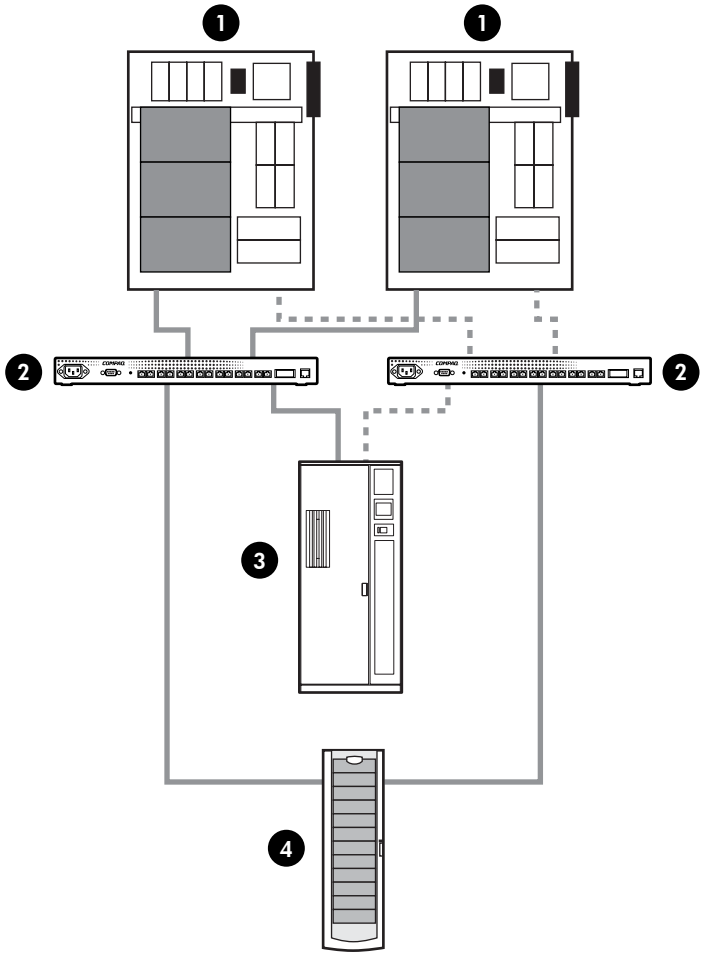


Figure 30 Balancing tape

1 Server
2 SAN switch
3 HP StorageWorks tape library with embedded Fibre Channel interface controller
4 Disk array

It is possible to balance I/O across multiple paths or SANS to your tape library provided there is only one path to any single device.

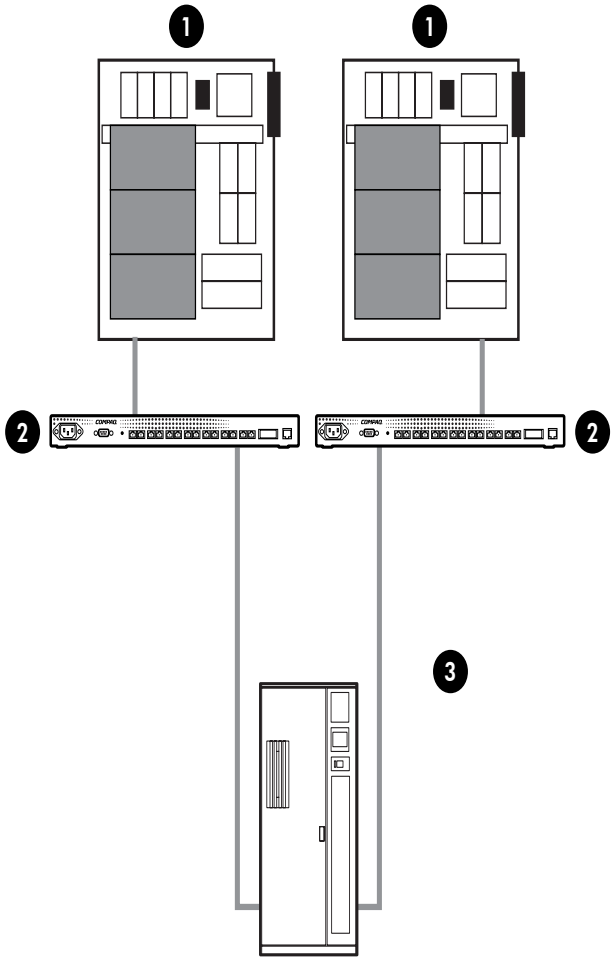


Figure 31 Connecting one library across multiple SANs

1 Server
2 SAN switch
3 HP StorageWorks tape library with embedded Fibre Channel interface controller

NOTE: When connecting one tape library to multiple SANs, you must use controllers with multiple Fibre Channel host ports, such as the NSR M2402 or the e2400-160. Connecting a tape drive or robotic device to more than one controller is not supported.

Multi-path failover software for disk arrays (MPIO)

HP supports high availability multi-pathing capabilities within various operating systems and through third-party vendors, providing continuous data access from HP's RAID arrays to host servers. MPIO options are available for servers running the Windows, Linux, Sun Solaris, Novell NetWare, IBM AIX, and HP-UX operating systems.

Redundant hardware, advanced RAID technology, and failover capability are used to enhance fault tolerance and availability. Path failover capability effectively eliminates controllers, disk drives, interconnect hardware and host bus adapters as single points of failure in the storage subsystem.

EBS-specific requirements

No special configuration is required for MPIO to function properly with this solution. The tape library can only be attached to one of the MPIO fabrics. Cascading the fabrics causes ghosting of the tape devices. In

some cases, it is recommended to use a separate HBA for EBS to improve performance and reduce host configuration complexity.

HP StorageWorks Secure Path

HP StorageWorks Secure Path is a high availability software product that provides continuous data access for online storage products such as the HP StorageWorks Enterprise Virtual Array (EVA), Modular SAN Array 1000, and others configured on Microsoft Windows NT, Microsoft Windows 2000/2003, IBM AIX, Linux, Novell NetWare, and Sun Solaris platforms. Redundant hardware, advanced RAID technology, and automated failover capability enhance fault tolerance and availability. Secure Path effectively eliminates controllers, interconnect hardware, and host bus adapters (HBAs) as single points of failure in the storage system. Secure Path enables the dual controllers in the storage subsystems to operate in the active/active Multiple-Bus failover mode. This failover mode allows each controller to be configured on its own bus and to process I/O independently under normal operation.

Secure Path software

The Secure Path software detects the failure of I/O operations to complete on a failed path and automatically reroutes all traffic to the second path. Controller and path failover are completed without disruption or data loss. The Secure Path management utility provides continuous monitoring capability and identifies failed paths and failed-over storage units. To facilitate static load balancing, storage units can be moved between paths using simple drag-and-drop operations.

EBS-specific requirements

No special configuration is required for Secure Path to function properly with this solution. The tape library can only be attached to one of the Secure Path fabrics. Cascading the fabrics causes ghosting of the tape devices. In some cases, it is recommended to use a separate HBA for EBS to improve performance and reduce host configuration complexity.

HP StorageWorks AutoPath XP

HP StorageWorks AutoPath XP provides I/O path failover and load balancing for XP and VA disk arrays. This server-based software helps provide a fault-tolerant infrastructure for redundant I/O paths from the servers to the disk arrays with automated protection against failures. Auto Path XP ensures that a failure in one of the paths does not cause data stoppages or catastrophic halts. Dynamic load balancing improves your overall performance.

Features

- Efficient: simplifies training, reduces time and costs, no operator involvement
- Manageable: offers consistent management with an easy-to-use graphical interface
- Available: provides automatic error detection, contributing to high-availability infrastructure
- Redundant: offers automatic failover to ensure that I/Os are routed to an alternate path
- Adaptable: provides a choice of load-balancing policies

EBS-specific requirements

No special configuration is required for AutoPath to function properly with this solution. The tape library can only be attached to one of the AutoPath fabrics. Cascading the fabrics causes ghosting of the tape devices. In some cases, it is recommended to use a separate HBA for EBS to improve performance and reduce host configuration complexity.

AutoPath VA

HP StorageWorks Auto Path Virtual Array is host-based software that provides data availability, performance, and ease-of-use that will keep your company up and running 24x7. It provides a simple yet powerful graphical user interface (GUI) to manage I/O multi-path fail-over for single or clustered server configurations, automatically recognizing and configuring HP virtual arrays and supported host bus adapters and providing dynamic load balancing of all I/O data paths.

Features

- Automatic error detection and fail-over helps eliminate planned and unplanned downtime
- Dynamic load balancing over multiple paths gives the best performance available for your business
- Works with your existing Windows 2000 Microsoft Cluster Server infrastructure
- Supports HP virtual arrays, providing maximum protection, performance, and scalability
- Automated configuration for simple no-work installation and configuration
- Graphical user interface provides a consistent, easy-to-use management console
- A cost-effective solution that complements HP virtual array storage solutions

Clustering

A Fibre Channel cluster in the EBS with data protection software consists of two servers and storage that can be distributed between two or more distant computer rooms interconnected by Fibre Channel links. A Fibre Channel cluster topology can be considered as an extension of a local SCSI Cluster where all the parallel SCSI shared buses are replaced by extended serial SCSI shared buses using Fibre Channel switches.

Highlights

- Communications between computers and storage units use the new high-speed Fibre Channel standard to carry SCSI commands and data over fiber optic links.
- Storage cabinets contain Fibre Channel disks and Fibre Channel components to connect to the SAN.

Benefits

- Computers and storage can be located in different rooms, distance can expand up to 10 kms.
- High-availability - Full hardware redundancy to ensure there is no single point of failure.
- Electrical insulation - The cluster can be split between two electrically independent areas.

Backup for cluster configurations may be deployed utilizing either separate switches and HBAs or common switches and HBAs. However, these configurations do not provide a fail-over path for tape or tape libraries.

To use separate switches, the configuration requires installing an additional HBA in each server, and a separate switch, as shown in the following diagram. Again, this option provides better performance for applications with large storage and/or short backup window requirements.

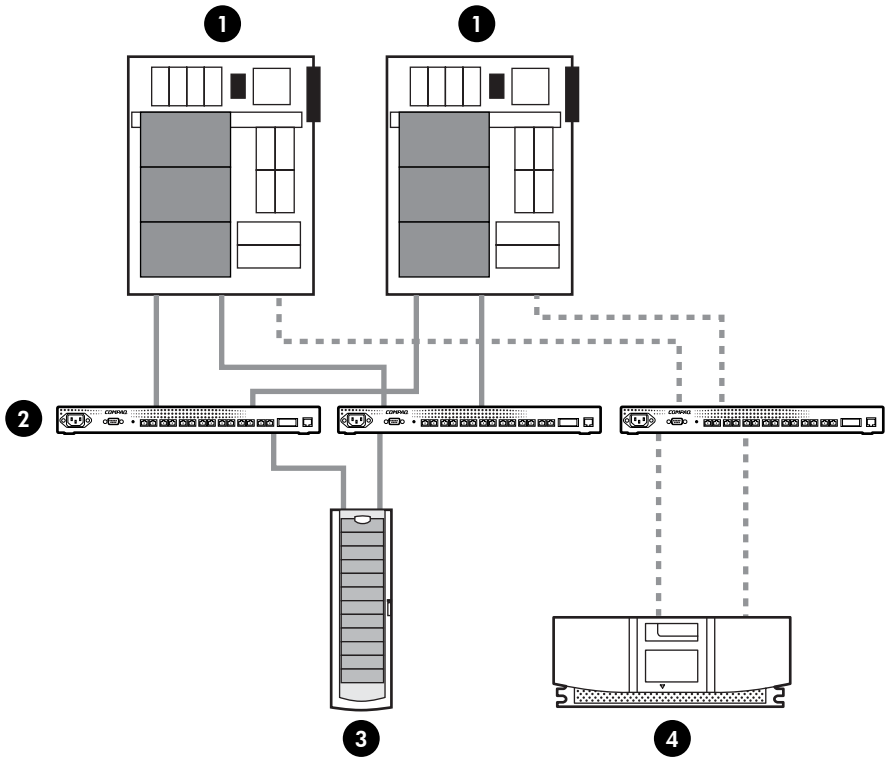


Figure 32 Cluster configuration with separate switches for disk and tape

1 Server
2 SAN switches
3 Disk array
4 HP StorageWorks tape library with embedded router

In addition, configurations may be deployed using a common HBA for disk and tape. In these configurations, multiple HBAs and switches are used to provide fail-over and redundancy for the disk subsystem. One of the HBAs and switches are shared for tape access. The following diagram provides an example.

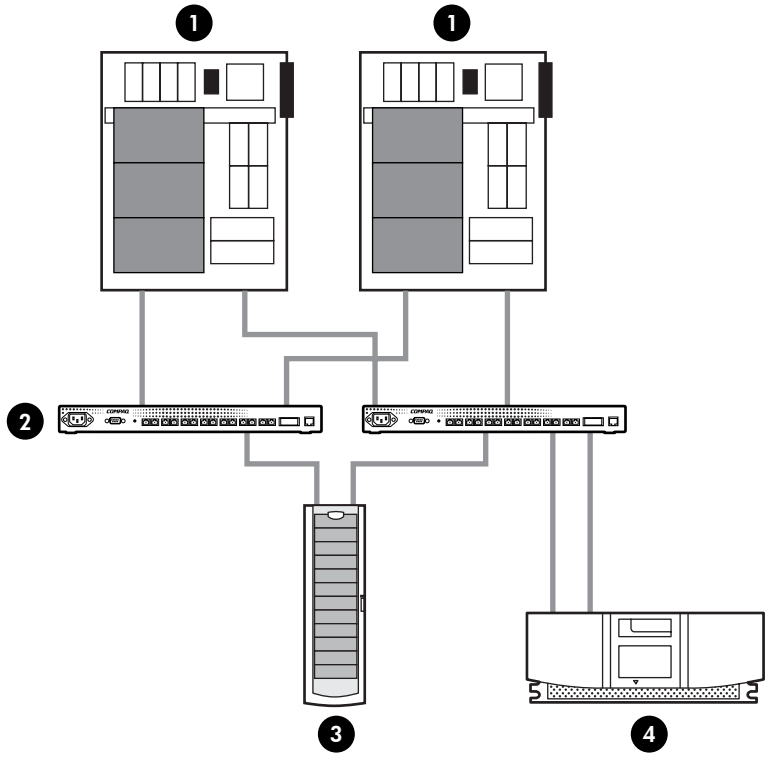


Figure 33 Cluster configuration with a common HBA for disk and tape

1 Server
2 SAN switches
3 Disk array
4 HP StorageWorks tape library with embedded router

NOTE: For Microsoft Windows 2000 and Windows 2003 using the SCSIport driver, Microsoft does not recommend the sharing of disk and tape devices on the same Fibre Channel host bus adapter, however, HP has tested and certified the sharing of disk and tape, in a Microsoft Cluster Server, with their supported HBAs. Please see the EBS compatibility Matrix for a listing of Supported HBAs with Windows 2000/2003. For Windows 2003 servers using the StorPort driver, the sharing of disk and tape is supported by Microsoft and HP.

EBS Support of failover versus non-failover applications

EBS can be setup to support clustering with application failover, or no application failover. Failover of the EBS data protection application can be supported when the application is cluster aware and has been configured properly to use nearline devices. In the case of application failover a backup job can be restarted or will resume using checkpoint restart after the failover occurs. In the case of non-application failover, the job will fail, and the backup job will occur on the next scheduled backup policy, or through manual intervention.

EBS clustering with failover

Currently there are a limited number of applications that support application clustering with failover. In this case the cluster alias is used as the backup server, and has some recovery hooks built into the backup process. These applications include but are not limited to:

- EBS with Symantec NetBackup on HP Tru64 5.1a Clusters
- EBS with Symantec NetBackup on Microsoft Cluster Server
- EBS with Symantec Backup Exec Windows Server on Microsoft Cluster Server
- EBS with Legato NetWorker on HP Tru64 5.1a Clusters

EBS clustering with no failover support

EBS in non-failover environments is setup to exist as an independent backup server on each node of the cluster, and the cluster alias is not used in the backup application.

Please refer to the EBS Compatibility matrix for a list of supported cluster environments. More detail will be provided in future EBS implementation guides.

Please refer to the application notes for cluster where available from each of the backup application and backup software vendors.

HP-UX MC/ServiceGuard

Backup for MC/ServiceGuard configurations may be deployed using standard backup software, such as HP Data Protector or Symantec NetBackup without installing and configuring Advanced Tape Services (ATS). In this case, the backup software instead of ATS provides all backup functionality including sharing and fail-over. This is the only option for MC/SG configurations participating in a multi-cluster or heterogeneous SAN environment.

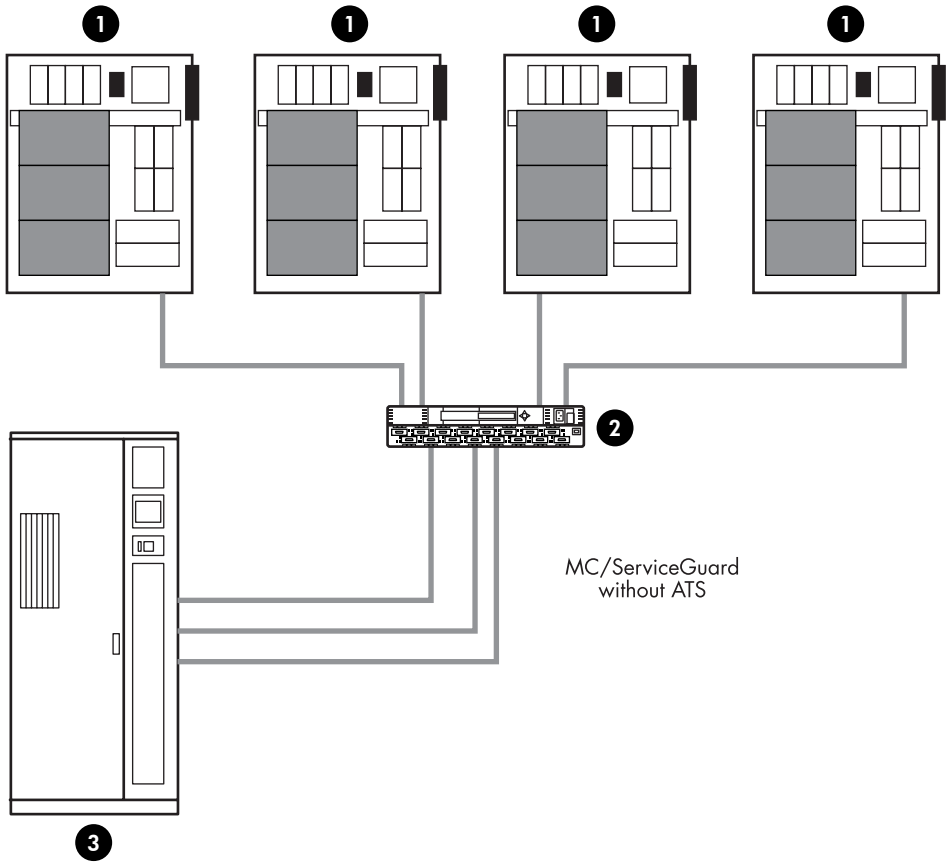


Figure 34 Backup for a 4-node HP-UX MC/ServiceGuard cluster

1 HP-UX host
2 SAN switch
3 HP StorageWorks tape library with embedded FC interface controllers

7 Extended Copy

SCSI Extended Copy is known under many different names: XCopy, Third Party Copy (3PC), serverless, E-copy, ServerFree, and Direct Backup. Extended Copy provides the means to copy data from one device to another, bypassing the server. This function offloads precious processing resources and relieves backup server downtime requirements.

Extended Copy solutions are unique in that they tie many software and hardware products together. Choosing a solution based on HP technology provides supportability and known compatibilities.

HP support of XCopy

Solutions using Extended Copy consist of data movers, hosts, disk arrays and backup applications. HP supports XCopy in the Direct Backup Solution through a number of its storage products. This support is made up of SAN interconnects such as Fibre Channel switches, Host Bus Adapters, disk array controllers, and tape controllers. There are a number of devices on the market today with Extended Copy capabilities, most notably Fibre Channel tape drives, servers or workstations and Fibre Channel disk or tape controllers. Because of their flexible platform, technical investment, and cost, tape controllers act as the most approved devices for this technology. HP network storage routers and interface controllers serve as the data mover or copy manager in the EBS Direct-Backup based solutions.

Standard extended copy topology

The standard topology for extended copy is one in which a data movement command (extended copy) is sent to a data router through Fibre Channel **(1)**. The information, sent through buffers from the host explains the Fibre Channel disk volume location and the location of the tape device behind the controller. The tape controller takes the information and moves the data from the Fibre Channel LUN **(2)** to the tape LUN **(3)** hosted on its own SCSI bus. See Figure 35 for an illustration of this topology.

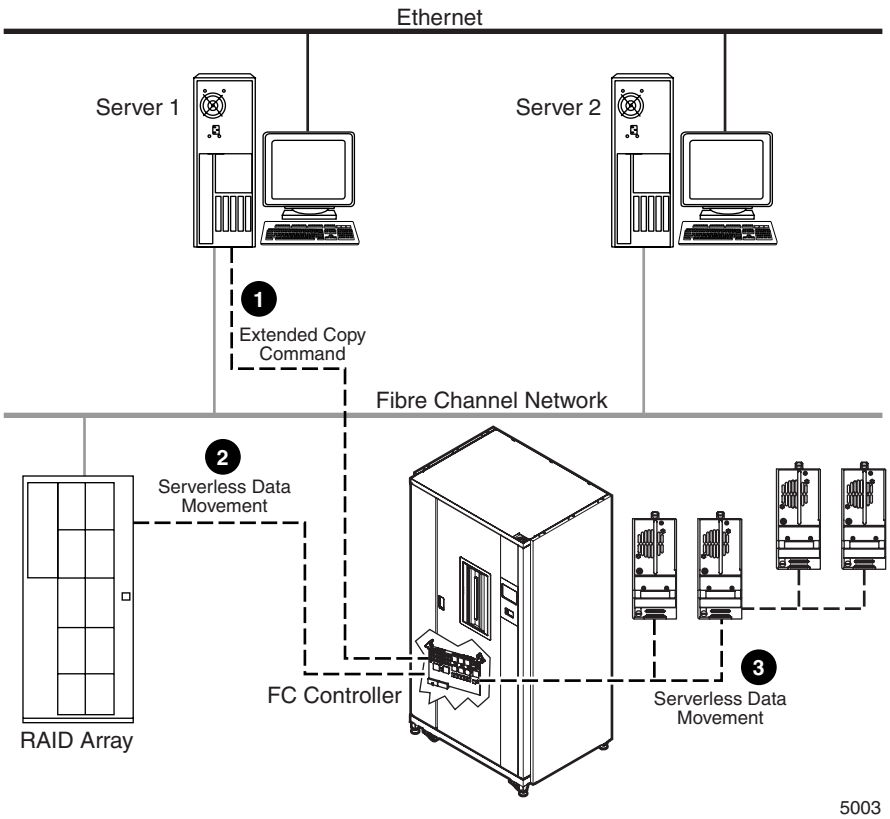


Figure 35 Standard XCopy topology

Planning an XCopy solution

There are several factors to consider when designing an XCopy solution: application server impact, cost, backup and restore performance, array integration, and ease of configuration and use. While all these factors are important, some may not be available in solutions as they are offered today. Because of the complexity of these solutions, they may be easy to use but can be difficult to setup.

While the cost of the solution is always a factor, application server impact and backup performance take center stage in Xcopy solutions. It is easy to see how the application server is removed from the heavy demands of backups in these solutions, whether the demand is handled by the extended copy engine or by an off-host server (as in Zero-Downtime Backup, Business Copy or Enterprise Volume Manager). Backup performance is the most noted benefit of the Extended Copy architecture. Good performance is not achieved using Xcopy to move single-stream backups, however, when used as a tool that can allow one server to initiate multiple streams, performance gains are realized. Taking care to setup an Xcopy backup so that it can be set up to move data in multiple streams requires knowledge in advance when setting up volumes on your Fibre Channel RAID arrays and servers.

Restores are obviously a very important part of the solution's equation but are often overlooked due to the benefits of the backups. While backups can be done very quickly and with little overhead to the application server, restores may be much more intensive and could take longer due to the fact that most applications do not support Xcopy restores.

Finally, array integration can make a substantial difference in how the Xcopy solution behaves. You must consider whether or not to use snapshots vs. clones, or hardware vs. software copies. Typically, a hardware clone (BCV, for example) will work best for 3PC solutions because of immediate availability and it is completely generated by the array. Because of the integration efforts required to control hardware snapshots and clones, most backup applications use a software snapshot engine that is built-in. These built-in options work well for some smaller environments without a lot of change of the primary data during the snapshots active period.

XCopy best practices

Special attention must be focused on presenting the correct targets to the appropriate initiators when using zoning on your SAN. Both the Fibre Channel ports of the disk array and the application server must see and be seen by the tape controllers. For XCopy backups to function properly, the data to be backed up must be located on a SAN device. This ensures that the data mover can communicate with the server, take data to/from the disk array and move it to/from the tape library.

There are three high level steps that must be followed for XCopy backups/restores to take place. They are:

1. Tape media must be mounted and ready for data transfer. Headers are usually written to the tape via local writes from the server as part of the mounting process.
2. The online data must be frozen so that there are no changes to the data structure on the disk and the extent maps for that data while it is being backed up.
3. Data can then be moved from source to target. The backup application issues the XCopy command, which initiates the data movement. The backup server builds the extended copy command with information including what source and targets to use, and what range of blocks is to be moved from source to target.

One of the most important steps in the XCopy backup is to have a frozen image of the data. There are many frozen image providers; they come in both hardware and software forms. The most popular type of frozen image for XCopy solutions is the software snapshot, due to the control needed by the backup application. This functionality is provided through options to the backup software known as image options or open file options. The software snapshot typically comes with the backup application, or sometimes volume managers interact with the backup application to coordinate the production of the frozen image. Creating software snapshots generally requires more CPU and memory overhead from the application server. Hardware snapshots or clones (broken mirrors) require much less effort from the application server, but require a high level of integration between the backup application and the disk array. Hardware snapshots or clones seem to be a good match for most XCopy solutions as all copy operations are performed by the disk array, with little or no impact to the application or backup server.

Some things to note regarding snapshots versus broken mirrors or Business Continuance Volumes (BCVs) are as follows:

- Snapshots are a quick and more affordable method to copy data.
- Snapshots work well in environments where data is not rapidly changing on the entire disk volume.
- As data changes, the snapshot engine must copy over the "frozen" data to its disk, while the primary disk is updated. This could cause backups to be much slower and more complicated.
- Using broken mirrors or BCVs are much more costly; however, they are completely frozen duplicates of data from a point in time.

Restores take on different forms in XCopy solutions. Restores are generally performed using the conventional (traditional) data transfer method. In the traditional method, the application or backup server mounts the tape and pulls data through its buses. From the buses, the data is then moved to the online storage array.

Known Issues

Due to the fact that XCopy is a fairly new technology, it has not been widely adopted in the industry as an enabler for backup and restore solutions. There are still some issues with XCopy that need attention before it will really have a chance to take off. Some of these issues are due to the fact that backup applications do not have a tight integration or Application Program Interface (API) with many of the online disk arrays they support. Because of this fact, putting together the solution can be cumbersome. There are also other issues with the ability to match the LUN ID between the host and the data mover at the disk array. When the host cannot have the same LUN as the data mover, then the backup of the wrong data may occur. Another issue relating to disk multipath environments cause XCopy backups to fail, because the data mover is not using an active port on the fibre channel disk array.

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