

StorageWorks by Compaq

SAN Director 64 Planning Guide

Part Number: AA-RPLAB-TE

Second Edition (February 2002)

This guide introduces storage area networks (SANs) and Fibre Channel technologies. It provides a hardware description of the StorageWorks SAN Director 64 (SD-64) and SANworks Director Connectivity Manager (SDCM). It also describes the firmware, backup and restore features, and graphic user interface delivered with the SD-64 and SDCM. Finally, it includes planning considerations and planning tasks to help ensure taking advantage of the SD-64 features.

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Printed in the U.S.A.

SAN Director 64 Planning Guide
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About This Guide

Use this guide if you are planning to acquire and install one or more SD-64 Directors. The publication describes Director features, hardware, software, planning considerations, and planning tasks. The information provided is intended for use by configuration and installation planners, however information is also provided for system administrators, customer engineers, and project managers.

Text Conventions

This document uses the following conventions to distinguish elements of text:

Keys	Keys appear in boldface. A plus sign (+) between two keys indicates they should be pressed simultaneously.
USER INPUT	User input appears in a different typeface and in uppercase.
<i>FILENAMES</i>	File names appear in uppercase italics.
Menu Options, Command Names, Dialog Box Names	These elements appear in initial capital letters.
COMMANDS, DIRECTORY NAMES, and DRIVE NAMES	These elements appear in upper case. NOTE: UNIX commands are case sensitive and will not appear in uppercase.

Type	When you are instructed to <i>type</i> information, type the information without pressing the Enter key.
Enter	When you are instructed to enter information, type the information and then press the Enter key.

Symbols in Text

These symbols may be found in the text of this guide. They have the following meanings.



WARNING: Text set off in this manner indicates that failure to follow directions in the warning could result in bodily harm or loss of life.



CAUTION: Text set off in this manner indicates that failure to follow directions could result in damage to equipment or loss of information.

IMPORTANT: Text set off in this manner presents clarifying information or specific instructions.

NOTE: Text set off in this manner presents commentary, sidelights, or interesting points of information.

Symbols on Equipment

These icons may be located on equipment in areas where hazardous conditions may exist.



Any surface or area of the equipment marked with these symbols indicates the presence of electrical shock hazards. Enclosed area contains no operator serviceable parts.

WARNING: To reduce the risk of injury from electrical shock hazards, do not open this enclosure.



Any RJ-45 receptacle marked with these symbols indicates a Network Interface Connection.

WARNING: To reduce the risk of electrical shock, fire, or damage to the equipment, do not plug telephone or telecommunications connectors into this receptacle.



Any surface or area of the equipment marked with these symbols indicates the presence of a hot surface or hot component. If this surface is contacted, the potential for injury exists.

WARNING: To reduce the risk of injury from a hot component, allow the surface to cool before touching.



Power Supplies or Systems marked with these symbols indicate the equipment is supplied by multiple sources of power.

WARNING: To reduce the risk of injury from electrical shock, remove all power cords to completely disconnect power from the system.



Any product or assembly marked with these symbols indicates that the component exceeds the recommended weight for one individual to handle safely.

WARNING: To reduce the risk of personal injury or damage to the equipment, observe local occupational health and safety requirements and guidelines for manual material handling.

Rack Stability



WARNING: To reduce the risk of personal injury or damage to the equipment, be sure that:

- The leveling jacks are extended to the floor.
 - The full weight of the rack rests on the leveling jacks.
 - The stabilizing feet are attached to the rack if it is a single rack installations.
 - The racks are coupled together in multiple rack installations.
 - A rack may become unstable if more than one component is extended for any reason. Extend only one component at a time.
-

Getting Help

If you have a problem and have exhausted the information in this guide, you can get further information and other help in the following locations.

Compaq Technical Support

In North America, call the Compaq Technical Phone Support Center at 1-800-OK-COMPAQ. This service is available 24 hours a day, 7 days a week.

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

Outside North America, call the nearest Compaq Technical Support Phone Center. Telephone numbers for world wide Technical Support Centers are listed on the Compaq website. Access the Compaq website by logging on to the Internet at <http://www.compaq.com>.

Be sure to have the following information available before you call Compaq:

- Technical support registration number (if applicable)
- Product serial numbers
- Product model names and numbers
- Applicable error messages
- Add-on boards or hardware

- Third-party hardware or software
- Operating system type and revision level
- Detailed, specific questions

Compaq Website

The Compaq website has latest information on this product as well as the latest drivers. You can access the Compaq website by logging on to the Internet at <http://www.compaq.com/storage>.

Compaq Authorized Reseller

For the name of your nearest Compaq Authorized Reseller:

- In the United States, call 1-800-345-1518.
- In Canada, call 1-800-263-5868.
- Elsewhere, see the Compaq website for locations and telephone numbers.

Chapter 1

Introduction

This chapter introduces storage area network (SAN) and Fibre Channel technologies, provides an overview of the Compaq StorageWorks SAN Director 64 (SD-64 Director or Director), and describes the Director's capabilities and features. The Director is a second-generation, 32-port product (expandable to 64 ports) that provides dynamic switched connections between Fibre Channel servers and devices in a SAN environment. Directors (from one to four) can be configured to order in a Compaq-supplied 19-inch equipment rack. The Series 9000 and M Series racks are supported.

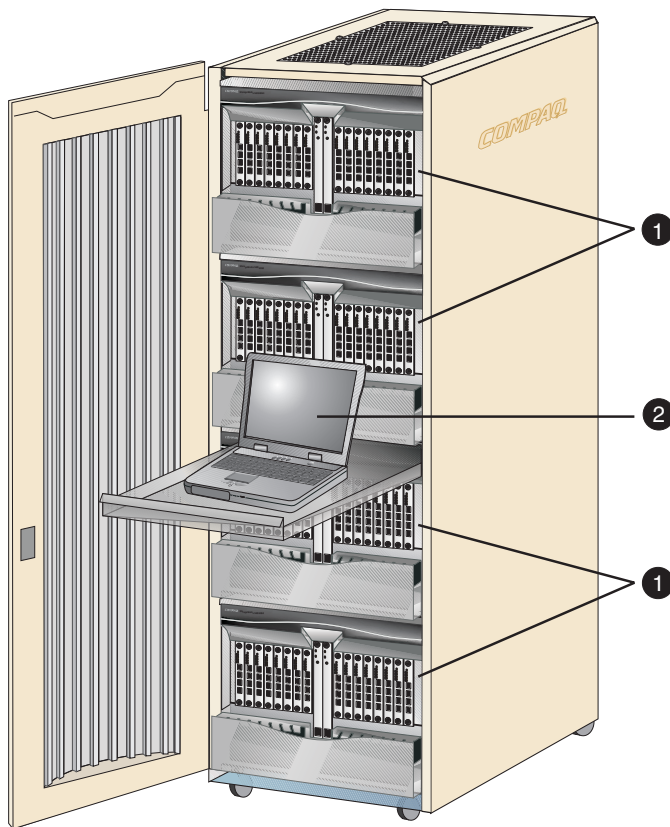
Directors are managed and controlled through a Compaq-supplied SANworks Director Connectivity Manager (SDCM) server with the SDCM, SD-64 Product Manager, and Fabric Manager applications installed. The SDCM server is a notebook personal computer (PC) that provides a central point of control for up to 48 Directors. Multiple Directors and the SDCM server communicate through the customer's local area network (LAN).

Figure 1-1 on page 1-2 illustrates an equipment rack with:

- ❶ Four SD-64 Directors.
- ❷ The shelf-mount SDCM server.

The Director implements Fibre Channel technology that provides high-performance scalable bandwidth (one gigabit per second), highly-available operation, redundant switched data paths, long transmission distances (up to 20 kilometers), and high device population. The Director supports mainframe and open-systems interconnection (OSI) computing environments, and provides data transmission and flow control between device node ports (N_Ports) as dictated by the Fibre Channel Physical and Signaling Interface (FC-PH 4.3).

The Director provides dynamic switched connections for servers and devices manufactured by multiple original equipment manufacturers (OEMs). To determine if an OEM product can communicate through connections provided by the Director, or if communication restrictions apply, refer to the supporting publications for the product or contact your Compaq marketing representative.



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Figure 1-1: Cabinet-Mount SD-64 Directors and SDCM Server

Director Overview

The Director provides high-performance port connections to end devices such as servers, mass storage devices, and other peripherals in a Fibre Channel SAN. Up to 32 Fibre Channel connections (expandable to 64 connections) are provided through generic ports (G_Ports). Director software configures and supports any-to-any port connectivity.

When connected to a device, a G_Port behaves as a fabric port (F_Port). When connected to another Director (or other managed Compaq switch product) in a multi-switch fabric, a G_Port behaves as an expansion port (E_Port).

Each fiber port module (FPM) card provides four Fibre Channel connections through duplex small form factor (SFF) pluggable fiber-optic transceivers. The Director is configured with eight FPM cards (32 ports), but can be upgraded through an expansion kit to 16 FPM cards (64 ports). Three types of FPM cards are available:

- An FPM card with four shortwave laser transceivers for transferring data over multi-mode fiber-optic cable.
- An FPM card with four longwave laser transceivers for transferring data over single-mode fiber-optic cable.
- A combination FPM card with three shortwave laser transceivers and one longwave laser transceiver.

Director Performance

In addition to Fibre Channel port connectivity described above, the Director provides the following performance features:

- **High bandwidth** - Each port provides full-duplex serial data transfer at a rate of 1.0625 gigabits per second (Gbps).
- **High-availability** - The Director design provides a redundant configuration of critical hardware components with automatic failure detection and notification.
- **Low latency** - The latency is less than two microseconds between transmission of a frame at a source port to receipt of the frame at the corresponding destination port (with no port contention).
- **Local control** - Actions taking place at a device N_Port seldom affect operation of other ports, therefore servers need to maintain little or no information about other connected devices in a SAN.
- **Low communication overhead** - Fibre Channel protocol provides efficient use of transmission bandwidth, reduces interlocked handshakes across the communication interface, and efficiently implements low-level error recovery mechanisms. This results in little communication overhead in the protocol and a Director bit error rate (BER) not exceeding one bit error per trillion (10^{12}) bits.
- **Multiple topology support** - The Director supports both point-to-point and multi-switch fabric topologies.

- ❑ Point-to-point topology provides a single direct connection between two device N_Ports. This topology supports bidirectional transmission between source and destination ports. Through dynamic switching, the Director configures different point-to-point transmission paths. In all cases, connected N_Ports use 100% of the available bandwidth.
- ❑ A multi-switch fabric topology provides the ability to connect Directors (and other Compaq switch elements) through E_Ports and ISLs to form a Fibre Channel fabric. Directors receive data from a device. Based on the destination N_Port address, Directors then route the data through the fabric (and possible through multiple switch elements) to the destination device.
- **Multiple service class support** - The Fibre Channel signaling protocol provides several classes of transmission service that support framing protocol and flow control between ports. The Director supports Class 2, Class 3, and Class F services.
 - ❑ Class 2 transmission service provides connectionless multiplexed frame delivery service with acknowledgment. This service duplicates the functions of a packet-switching network, and allows multiple nodes to share links by multiplexing the transmitted data. Multiplexing is supported from a source to multiple destinations, or from a destination to multiple sources. Data is adaptively transferred frame-by-frame between pairs of N_Ports through an undedicated path. In the absence of link errors, frame delivery is guaranteed with confirmation of receipt. Class 2 Service is best suited for mainstream computing applications.
 - ❑ Class 3 transmission service provides connectionless, best-effort multiplexed datagram frame delivery with no acknowledgment. This class of service is the same as Class 2 service; however confirmation of receipt is not given. The service allows data transmission with great flexibility and efficiency; however, data frames may be discarded without notification if high-traffic or error conditions are encountered. If a data frame is discarded or corrupted, error recovery or notification (if any) is performed at the upper level protocol (ULP) level. Class 3 service is best suited for mass storage or video applications.
 - ❑ Class F transmission service is connectionless service similar to Class 2 service. This service multiplexes control frames at frame boundaries and is used by multiple Directors to communicate across interswitch links (ISLs) to configure, control, and coordinate the behavior of a multi-switch fabric.

Director Management

Management access to the Director is provided through two Ethernet LAN connections to the Director's control processor (CTP) cards (out-of-band management). The following out-of-band management access methods are provided:

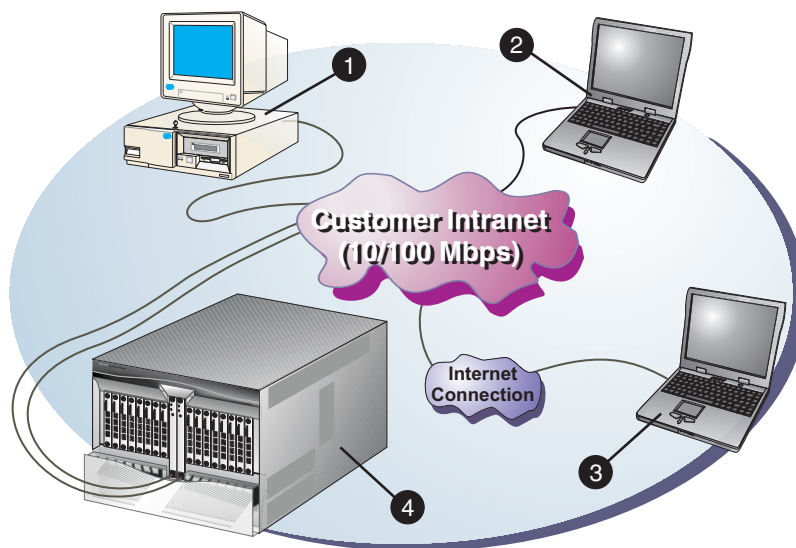
- Management through the SDCM application. The SDCM application includes the SD-64 Product Manager and Fabric Manager applications. This graphical user interface (GUI) resides on the SDCM server and provides a single point of management for all Directors. Refer to [Director Software Description on page 3-1](#) for information about the applications.

Operators at remote workstations can connect to the SDCM server through the local SDCM and SD-64 Product Manager applications to manage and monitor Directors controlled by the SDCM server. A maximum of five concurrent users (including a local user) can log in to the SDCM application. Refer to [Remote User Workstations on page 4-13](#) for information.

- Management using simple network management protocol (SNMP). An SNMP agent is implemented through the SDCM application that allows administrators on SNMP management workstations to access Director management information using any standard network management tool. Administrators can assign internet protocol (IP) addresses and corresponding community names for up to six SNMP workstations functioning as SNMP trap message recipients.
- Management through the Internet using the embedded web server interface installed on the Director. This interface supports configuration, statistics monitoring, and basic operation of the Director, but does not offer all the capabilities of the SD-64 Product Manager application. Administrators launch the web server interface from a remote PC by entering the Director's IP address as the Internet uniform resource locator (URL), then entering a user name and password at a login screen. The PC browser then becomes a management console.

[Figure 1-2 on page 1-6](#) illustrates out-of-band Director management. The figure shows the following elements connected through a customer-supplied intranet:

- ① Remote or SNMP management workstation.
- ② SDCM server.
- ③ Web browser.
- ④ SD-64 Director.



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Figure 1-2: Out-of-Band Director Management

Director Features

In addition to performance features, and out-of-band management, the Director provides:

- High-availability features.
- Connectivity features.
- Security features.
- Serviceability features.

High-Availability Features

Pairs of critical field-replaceable units (FRUs) installed in the Director provide redundancy in case a FRU fails. When an active FRU fails, the backup FRU takes over operation automatically (failover) to maintain Director and Fibre Channel link operation.

NOTE: FPM cards do not automatically fail over and provide link operation after a failure. To continue operation, fiber-optic cables from the failed FPM card must be disconnected and reconnected to ports on a spare card.

A standard availability Director has all possible FRUs installed and is fully redundant. Standard redundancy is provided through dual sets of FRUs and spare (unused) ports on FPM cards.

- **CTP cards** - The Director contains two CTP cards. The redundant CTP card provides a backup connection to the SDCM server and ensures continued Director operation if the active CTP card fails.
- **SBAR assemblies** - The Director contains two serial crossbar (SBAR) assemblies. The redundant serial SBAR assembly ensures uninterrupted transmission and receipt of Fibre Channel frames between ports if the active SBAR card fails.
- **Power supplies** - The Director contains two power supplies that share the electrical operating load. If one power supply fails, the other supply handles the full load. Separate receptacles at the rear of the Director provide facility input power to each supply. For full redundancy, input power for each receptacle should come from a different source.
- **Fan modules** - The Director contains two fan modules, each containing three fans (six fans total). If one or more fans in a module fail, the redundant fan module provides cooling until the failed module is replaced. If the second fan module fails, software shuts off power to the Director to prevent system damage.
- **Ports** - The Director is delivered with eight FPM cards (32 ports). Any unused Fibre Channel port can be used in place of a failed port. To continue device operation, the fiber-optic cable from a failed port is reconnected to an unused operational port. Additional FPM cards (up to 16 total cards) can be installed to provide spare or additional Fibre Channel port connections.

Connectivity Features

The Director and associated SDCM application support the following Fibre Channel connectivity features:

- **Any-to-any connectivity** - Director software configures hardware routing tables for each source port to provide any-to-any port connectivity. Subject to user-defined restrictions (port blocking and zoning), the tables define the destination ports with which the source port is allowed to communicate.
- **Extended distance support** - Through the use of repeaters, any Director port can be configured for extended distance operation. By setting a port's buffer-to-buffer credit (BB_Credit) value to 60, the port can transmit data up to 100 kilometers.

- **Port blocking** - System administrators can block or unblock any Director port through the SDCM application. Blocking a port prevents an attached device from logging in to the Director or communicating with any attached device. A blocked port continuously transmits an offline sequence (OLS).
- **Zoning** - System administrators can partition attached devices into restricted-access zones. Devices in the same zone can recognize and communicate with each other through switched port-to-port connections. Devices in separate zones cannot recognize and communicate with each other.
- **Broadcast and multi-cast support** - The Director supports transmission of a Fibre Channel frame to all attached N_Ports (broadcast), or transmission of a Fibre Channel frame to a user-specified group of attached N_Ports (multi-cast).
- **State change notification** - The Director supports a state change notification function that allows attached N_Ports to request notification when other N_Ports change operational state.
- **Port binding** - The Director supports a feature that binds an attached Fibre Channel device to a specified Director port through the device's world wide name (WWN).

Security Features

The SDCM application offers the following security features:

- **Password protection** - Users must provide a user name and password to log in to the SDCM server and access managed Directors. Administrators can configure user names and passwords for up to 16 users, and can authorize or prohibit specific management permissions for each user.
- **Remote user restrictions** - Remote user access to Directors is either disabled or restricted to configured IP addresses.
- **SNMP workstation restrictions** - SNMP workstations can only access management information base (MIB) variables managed by the Director SNMP agent. SNMP workstations must belong to SNMP communities configured through the SDCM application. If configured, the agent can send authorization failure traps when unauthorized SNMP workstations attempt to access the Director.
- **Audit log tracking** - Configuration changes to the Director are recorded in an audit log stored on the SDCM server, where they are accessible to users for display. Log entries include the date and time of the configuration change, a description of the change, and the source of the change.
- **Port blocking** - System administrators can block or unblock any port to restrict device access to the Director.

- **Zoning** - System administrators can create zones that provide Director access control to increase network security, differentiate between operating systems, and prevent data loss or corruption. Zoning can be implemented in conjunction with server-level access control and storage device access control.

Serviceability Features

The Director and SDCM application offer the following serviceability features:

- Light-emitting diodes (LEDs) on Director FRUs and the front bezel that provide visual indicators of hardware status or malfunctions.
- System and threshold alerts, event logs, audit logs, link incident logs, threshold alert logs, and hardware logs that display Director, Ethernet link, and Fibre Channel link status at the SDCM server.
- Diagnostic software that performs power-on self tests (POSTs) and port diagnostics (internal loopback and external loopback tests).
- Automatic notification of significant system events (to support personnel or administrators) through alphanumeric pager, e-mail messages, or the call-home feature.

NOTE: Call-home notification requires installation of Compaq Proactive Service software. This service is offered at no additional charge for subsystems covered under an on-site warranty or on-site storage hardware support contract. To register or order Proactive Service software, contact your Compaq customer service representative.
- An RS-232 maintenance port at the rear of the Director (port access is password protected) that enables installation or service personnel to change the Director's IP address, subnet mask, and gateway address. The port also allows service personnel to run diagnostics and isolate system problems through a local or remote terminal.
- Redundant FRUs (logic cards, power supplies, and cooling fans) that are removed or replaced without disrupting Director or Fibre Channel link operation.
- A modular design that enables quick removal and replacement of FRUs without the use of special tools or equipment.
- FPM cards are added or replaced and fiber-optic cables are attached to ports without interrupting other ports or Director operation.
- Beaconing to assist service personnel in locating a specific port, FRU, or Director in a multi-switch environment. When port beaconing is enabled, the amber LED associated with the port flashes. When FRU beaconing is enabled, the amber (service required) LED on the FRU flashes. When unit beaconing is enabled, the system error indicator on the front bezel flashes. Beaconing does not affect port, FRU, or Director operation.

- Data collection through the SD-64 Product Manager application to help isolate system problems. The data includes a memory dump file and audit, hardware, and engineering logs.
- Status monitoring of redundant FRUs and alternate Fibre Channel data paths to ensure continued Director availability in case of failover. The SDCM application queries the status of each backup FRU daily. A backup FRU failure is indicated by an illuminated amber LED.
- SNMP management using the Fibre Alliance MIB that runs on the SDCM server. Up to 12 authorized management workstations can be configured through the SDCM application to receive unsolicited SNMP trap messages. The trap messages indicate operational state changes and failure conditions.
- SNMP management using the Fibre Channel Fabric Element MIB (Version 1.10), transmission control protocol/internet protocol (TCP/IP) MIB-II definition (RFC 1213), or a product-specific MIB that run on each Director. Up to six authorized management workstations can be configured through the SD-64 Product Manager application to receive unsolicited SNMP trap messages. The trap messages indicate operational state changes and failure conditions.

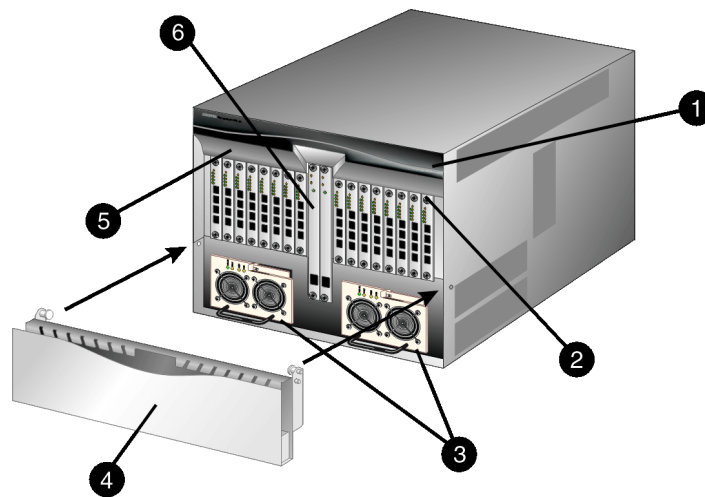
Chapter 2

Director Hardware Description

This chapter provides a hardware description of the StorageWorks SAN Director 64 and SANworks Director Connectivity Manager (SDCM) server, describes field-replaceable units (FRUs), and lists Director and SDCM server specifications.

Director Description

Figure 2-1 illustrates the front of the Director.



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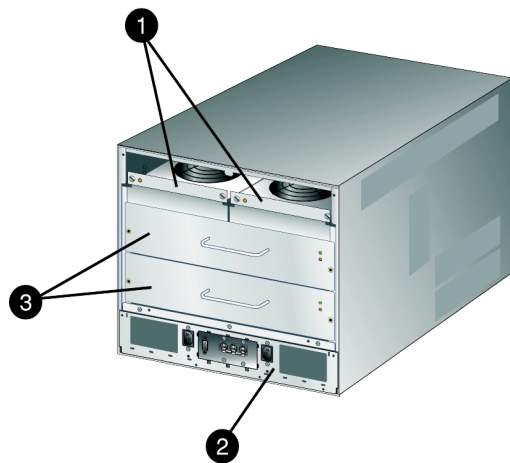
Figure 2-1: Director FRUs (Front Access)

2-2 SAN Director 64 Planning Guide

Director FRUs accessed from the front include:

- ❶ Power and system error light-emitting diodes (LEDs).
- ❷ Fiber port module (FPM) cards.
- ❸ Power supplies.
- ❹ Cable management assembly.
- ❺ Front bezel.
- ❻ Control processor (CTP) cards.

Figure 2-2 illustrates the rear of the Director.



SHR-2312

Figure 2-2: Director FRUs (Rear Access)

Director FRUs accessed from the rear include:

- ❶ Fan modules.
- ❷ Power module assembly.
- ❸ Serial crossbar (SBAR) assemblies.
- Backplane (not shown).

Cable Management Assembly

The cable management assembly at the bottom front of the Director provides routing for Ethernet cables attached to CTP cards and fiber-optic cables attached to Director ports. The assembly rotates up to provide front access to the redundant power supplies.

Front Bezel

The bezel at the top front of the Director includes an amber system error LED and a green power LED. The power LED illuminates when the Director is powered on and operational. If the LED extinguishes, a facility power source, alternating current (AC) power cord, or Director power distribution failure is indicated.

The system error LED illuminates when the Director detects an event requiring immediate operator attention, such as a FRU failure. The LED remains illuminated as long as an event is active. The LED extinguishes when the Clear System Error Light function is selected from the SD-64 Product Manager application. The LED blinks if unit beaconing is enabled. An illuminated system error LED (indicating a failure) takes precedence over unit beaconing.

CTP Card

The Director is delivered with two CTP cards. The active CTP card initializes and configures the Director after power on and contains the microprocessor and associated logic that coordinate Director operation. A CTP card provides an initial machine load (IML) button on the faceplate. When the button is pressed and held for three seconds, the Director reloads firmware and resets both CTP cards without switching off power or affecting operational fiber-optic links.

Each CTP card also provides a 10/100 megabit per second (Mbps) RJ-45 twisted pair connector on the faceplate that attaches to a customer-supplied Ethernet local area network (LAN) to communicate with the SDCM server or a simple network management protocol (SNMP) management station.

Each CTP card provides system services processor (SSP) and embedded port (EP) subsystems. The SSP subsystem runs Director applications and the underlying operating system, communicates with Director ports, and controls the RS-232 maintenance port and 10/100 Mbps Ethernet port. The EP subsystem provides Class F and exception frame processing, and manages frame transmission to and from the SBAR assembly. In addition,

a CTP card provides nonvolatile memory for storing firmware, Director configuration information, persistent operating parameters, and memory dump files. Director firmware is upgraded concurrently (without disrupting operation).

The backup CTP card takes over operation if the active card fails. Failover from a faulty card to the backup card is transparent to attached devices.

Each card faceplate contains a green LED that illuminates if the card is operational and active, and an amber LED that illuminates if the card fails. Both LEDs are extinguished on an operational backup card. The amber LED blinks if FRU beaconing is enabled.

FPM Card

Each FPM card provides four full-duplex generic ports (G_Ports) that transmit or receive data at 1.0625 gigabits per second (Gbps). G_Port functionality depends on the type of cable attachment. FPM cards use non-open fiber control (OFC) Class 1 laser transceivers that comply with Section 21 of the Code of Federal Regulations (CFR), Subpart (J) as of the date of manufacture.

Depending on device connections, G_Ports behave as follows:

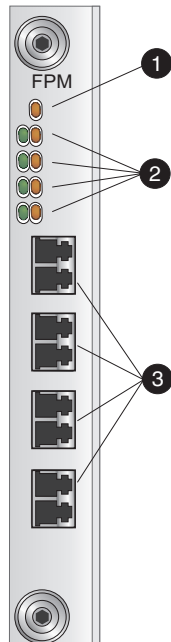
- If the G_Port is attached to a Fibre Channel device, the port functions as a fabric port (F_Port). An F_Port is the interface on a Director that connects to a device node port (N_Port).
- If the G_Port is attached to another Director or switch to form an interswitch link (ISL), the port functions as an expansion port (E_Port). A multi-switch fabric is formed through multiple Directors and ISLs.

Single-mode or multi-mode fiber-optic cables attach to FPM cards through small form factor (SFF) pluggable optical transceivers. The fiber-optic transceivers provide duplex LC connectors, and can be detached from FPM cards (through a 10-pin interface) for easy replacement. Two fiber-optic transceiver types are available:

- **Shortwave Laser** - Shortwave laser transceivers provide connections for transferring data over short distances (2 to 500 meters) through 50-micron or 62.5-micron multi-mode fiber.
- **Longwave Laser** - Longwave laser transceivers provide connections for transferring data over long distances (up to 20 kilometers) through 9-micron single-mode fiber.

Figure 2-3 illustrates the faceplate of an FPM card. The card faceplate contains:

- ❶ An amber LED (at the top of the card) that illuminates if any port fails or blinks if FRU beaconing is enabled.
- ❷ A bank of amber and green LEDs above the ports. One amber LED and one green LED are associated with each port and indicate port status as follows:
 - ❑ The green LED illuminates (or blinks if there is active traffic) and the amber LED extinguishes to indicate normal port operation.
 - ❑ The amber LED illuminates and the green LED extinguishes to indicate a port failure.
 - ❑ Both LEDs extinguish to indicate a port is operational but not communicating with an N_Port (no cable attached, loss of light, port blocked, or link recovery in process).
 - ❑ The amber LED flashes and the green LED either remains on, extinguishes, or flashes to indicate a port is beaconing or running online diagnostics.
- ❸ Four duplex LC connectors for attaching fiber-optic cables.



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Figure 2-3: FPM Card LEDs and Connectors

The Director is delivered with eight FPM cards installed (32 ports), but provides chassis slots for up to 16 FPM cards (64 ports total). An FPM card is a concurrent FRU and can be added or replaced while the Director is powered on and operating.

Power Supply

Redundant, load-sharing power supplies step down and rectify facility input power to provide 48-volt direct current (VDC) power to Director FRUs. The power supplies also provide overvoltage and overcurrent protection. Either power supply can be replaced while the Director is powered on and operational.

Each power supply has a separate backplane connection to allow for different AC power sources. The power supplies are input rated at 85 to 264 volts alternating current (VAC). The faceplate of each power supply provides the following status LEDs:

- A green **PWR OK** LED illuminates if the power supply is operational and receiving AC power.
- An amber **FAULT** LED illuminates if the power supply fails.
- An amber **TEMP** LED illuminates if the power supply shuts down due to an over temperature condition.
- An amber **I LIM** LED illuminates if the power supply is overloaded and operating at the current limit (15.6 amperes).

Power Module Assembly

The power module assembly is located at the bottom rear of the Director. The module is a nonconcurrent FRU, and the Director must be powered off prior to scheduled removal and replacement. The module provides:

- A power switch (circuit breaker) that controls AC power distribution to both power supplies. The breaker is set manually, or is automatically tripped by internal software if thermal sensors indicate the Director is overheated.
- Two single-phase AC power connectors. Each connector is input rated at 85 to 264 VAC.
- A 9-pin maintenance port that provides a connection for a local workstation or dial-in connection for a remote workstation. Although the port is typically used by maintenance personnel, operations personnel use the port to configure network addresses.

- An input filter and AC system harness (internal to the FRU) that provides the wiring to connect the AC power connectors to the power switch and power supplies (through the backplane).

Fan Module

Two fan modules, each containing three fans (six fans total), provide cooling for Director FRUs, as well as redundancy for continued operation if a fan fails.

The fan module can be replaced while the Director is powered on and operating, provided the module is replaced within ten minutes (after which software powers off the Director). An amber LED for each fan module illuminates if one or more fans fail or rotate at insufficient angular velocity.

SBAR Assembly

The Director is delivered with two SBAR assemblies. The active SBAR is responsible for Fibre Channel frame transmission from any Director port to any other Director port. Connections are established without software intervention. The assembly accepts a connection request from a port, determines if a connection can be established, and establishes the connection if the destination port is available. The assembly also stores busy, source connection, and error status for each Director port.

The backup SBAR takes over operation if the active assembly fails, and provides the ability to maintain connectivity and data frame transmission without interruption. Failover to the backup assembly is transparent to attached devices.

Each SBAR assembly mounts flush on the backplane, and the FRU comprises the card and a steel carriage. The carriage provides protection for the back of the card, distributes cooling airflow, and assists in aligning the assembly during installation. The rear of the carriage contains a green LED that illuminates if the assembly is operational and active, and an amber LED that illuminates if the assembly fails. Both LEDs are extinguished on an operational backup assembly. The amber LED blinks if FRU beaconing is enabled.

Backplane

The backplane provides 48 VDC power distribution and connections for all logic cards. The backplane is a nonconcurrent FRU. The Director must be powered off prior to FRU removal and replacement.

Director Specifications

This section lists physical characteristics, storage and shipping environment, operating environment, and service clearances for the Director.

Physical Characteristics

Dimensions:

Height: 39.7 centimeters (15.75 inches)

Width: 44.5 centimeters (17.5 inches)

Depth: 54.6 centimeters (21.5 inches)

Weight: 52.3 kilograms (115.0 pounds)

Power requirements:

Input voltage: 100 to 120 or 200 to 240 VAC

Input frequency: 50/60 Hz

Plan for single-phase or phase-to-phase connections and 5-ampere dedicated service.

Heat dissipation:

16 FPM cards (maximum): 490 watts (1,672 BTUs/hr)

Cooling airflow clearances (Director chassis):

Right and left side: 5.1 centimeters (2.0 inches)

Front and rear: 7.6 centimeters (3.0 inches)

Top and bottom: No clearance required

Shock and vibration tolerance:

60 Gs for 10 milliseconds without nonrecoverable errors

Acoustical noise:

55 dB "A" scale

Inclination:

10° maximum

Storage and Shipping Environment

Protective packaging must be provided to protect the Director under all shipping methods (domestic and international).

Shipping temperature:

-40° F to 140° F (-40° C to 60° C)

Shipping weight

76.4 Kilograms (168 lbs)

Storage temperature:

34° F to 140° F (1° C to 60° C)

Shipping relative humidity:

5% to 100%

Storage relative humidity:

5% to 80%

Maximum wet-bulb temperature:

29° C (84° F)

Altitude:

40,000 feet (12,192 meters)

Operating Environment

Temperature:

40° F to 104° F (4° C to 40° C)

Relative humidity:

8% to 80%

Maximum wet-bulb temperature:

27° C (81° F)

Altitude:

10,000 feet (3,048 meters)

Equipment Rack Service Clearances

Front: 1 meter (39.37 inches)

Rear: 1 meter (39.37 inches)

Right side: No clearance required

Left side: No clearance required

SDCM Server Description

The SDCM server is a notebook personal computer (PC) that provides a central point of control for up to 48 LAN-connected Directors. The server is mounted in a slide-out drawer in the Compaq-supplied cabinet. The SDCM server (or Internet access to the Director's embedded web server application) is required to install, configure, and manage the Director. Although the Director operates normally without an SDCM server, the server is required to monitor Director operation, log events and configuration changes, and report failures. [Figure 2-4](#) illustrates the SDCM server.



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Figure 2-4: SDCM Server

The SDCM server is dedicated to operation of the SDCM, SD-64 Product Manager, and Fabric Manager applications. The applications provide a graphical user interface (GUI) and management services, and implement Web and other server functions. Refer to [Director Software Description on page 3-1](#) for information about the applications.

NOTE: The SDCM server and SDCM application provide a GUI to monitor and manage multiple Compaq Directors, and are a dedicated hardware and software solution that should not be used for other tasks. Compaq tests the SDCM application installed on the SDCM server, but does not compatibility test other third-party software. Modifications to the SDCM server hardware or installation of additional software (including patches or service packs) may interfere with normal operation.

United States English is the only language supported by the server keyboard and the SDCM, SD-64 Product Manager, and Fabric Manager applications.

The SDCM server provides an auto-detecting 10/100 Mbps LAN connector. This connection is provided through a personal computer memory card international association (PCMCIA) slot at the right side of the server. The server attaches to the customer-supplied LAN segment containing Directors.

SDCM Server Specifications

The following list summarizes hardware specifications for the SDCM server notebook platform. Current platforms may ship with more enhanced hardware, such as a faster processor, additional random-access memory (RAM), or a higher-capacity hard drive or removable disk drive.

- Notebook PC with color monitor, keyboard, keyboard-mounted trackpad (mouse), and U. S. power cord.
- Intel Celeron processor with a 600 megahertz (MHz) or greater clock speed, running the Microsoft Windows NT 4.0 operating system.
- Two gigabyte (GB) or greater internal hard drive.
- 128 megabyte (MB) or greater RAM.
- CD-ROM drive.
- 1.44 MB 3.5-inch disk drive.
- 100 MB external disk (Zip) drive.

Remote User Workstations

Operators at remote workstations with the client SDCM application installed can connect to the SDCM server to manage and monitor all Directors controlled by the server. A maximum of eight concurrent remote users (plus the local SDCM server user) can log in to the SDCM application. The client application downloads and installs to remote workstations (from the SDCM server) using a standard web browser. The applications operate on platforms that meet the following minimum system requirements:

- Desktop or notebook PC with color monitor, keyboard, and mouse, using an Intel Pentium processor with a 200 MHz or greater clock speed, and using the Microsoft Windows 95, Windows 98, Windows 2000, Windows NT 4.0, or Linux 2.2 operating system.
- Unix workstation with color monitor, keyboard, and mouse, using a:
 - ❑ Hewlett-Packard HA PA-RISC processor with a 360 MHz or greater clock speed, using the HP-UX 11 or higher operating system.
 - ❑ Sun Microsystems UltraSPARC-II processor with a 300 MHz or greater clock speed, using the SunOS Version 5.5.1 or higher operating system, or Solaris Version 2.5.1 or higher operating system.
 - ❑ IBM PowerPC microprocessor with a 233 MHz or greater clock speed, or POWER3 microprocessor with a 333 MHz or greater clock speed, using the AIX Version 4.3.3 or higher operating system.
- At least 15 MB available on the internal hard drive.
- 32 MB or greater RAM.
- Video card supporting 256 colors at 800 x 600 pixel resolution.
- Ethernet network adapter.
- Java-enabled Internet browser, such as Microsoft Internet Explorer (Version 4.0 or later) or Netscape Navigator (Version 4.0 or later).

Embedded Web Server Interface

Administrators or operators with a browser-capable PC and an Internet connection can monitor and manage the Director through an embedded web server interface. The interface provides a GUI similar to the SD-64 Product Manager application, and supports Director configuration, statistics monitoring, and basic operation. Refer to [User Interface on page 3-4](#) for additional information about the embedded web server interface.

Director Kit Contents

Compaq offers the following stock keeping units (SKUs) associated with the SD-64 Director:

- 32-port base configuration for the SD-64 Director (DS-DMGGD-AA). Each Director includes:
 - ❑ A fully-redundant hardware configuration with eight FPM cards, 32 shortwave SFF optical transceivers, and cable management assembly installed.
 - ❑ Two standard U.S. AC power cords (3-prong, 8-foot) that connect each Director power supply to separate facility AC power outlets. Use these power cords if the Director is not installed in a Compaq-supplied equipment rack.
 - ❑ Two power distribution unit (PDU) power cords (8-foot) that connect each Director power supply to separate cabinet PDUs. Use these power cords if the Director is installed in a Compaq-supplied 19-inch equipment rack.
 - ❑ One torque tool (including integrated 5/32" hex adapter) for removing and replacing Director logic cards.
 - ❑ Four multi-mode fiber-optic loopback plugs.
 - ❑ One 10-foot asynchronous RS-232 null modem cable with 9-pin connectors.
 - ❑ One rack-mount kit (including installation hardware and instructions) for the Series 9000 equipment rack.
 - ❑ Hardcopy technical publications, including the *Compaq StorageWorks SAN Director 64 Installation Guide*, release notes, license, and warranty information.
 - ❑ The *Technical Publications CD-ROM for the Compaq StorageWorks SAN Director 64*.
- SDCM kit (DS-DMGGO-AA). Each kit includes:
 - ❑ A shelf-mount notebook PC (SDCM server) that includes a color monitor, keyboard, keyboard-mounted trackpad (mouse), standard U. S. power cord (2-prong with AC power adapter), 17-inch PDU male-to-female adapter cord, 40-inch PDU extension cord, installed operating system, application software, Windows NT 4.0 user manual, declaration of conformity, and warranty information. The Windows NT license key is printed on a label attached to the bottom of the PC.
 - ❑ One parallel-port 100 MB Zip drive that connects to the SDCM server. The Zip drive includes a standard U. S. power cord (2-prong with AC power adapter), 17-inch PDU male-to-female adapter cord, 40-inch PDU extension cord, and a Zip drive kit with user manual, software diskette, and tools Zip disk.

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- Two 16-inch power adapter cables (PDU-to-standard U.S. AC power).
- One universal slide-out shelf (including installation hardware and instructions) for the Series 9000 or M Series equipment racks.
- Software diskettes and CD-ROMs that include the *SDCM Management Applications* CD, *SDCM Server Restore* CD, *Microsoft Windows NT 4.0* CD, and two blank Zip disks.
- Optional longwave laser FPM card kit for the SD-64 Director (DS-DMGGD-AC). Each kit includes:
 - One FPM card with four longwave SFF optical transceivers installed.
 - One single-mode fiber-optic loopback plug.
 - Installation instructions.
- Optional shortwave laser FPM card kit for the SD-64 Director (DS-DMGGD-AD). Each kit includes:
 - One FPM card with four shortwave SFF optical transceivers installed.
 - One multi-mode fiber-optic loopback plug.
 - Installation instructions.
- Optional combination FPM card kit for the SD-64 Director (DS-DMGGD-AE). Each kit includes:
 - One FPM card with three shortwave and one longwave SFF optical transceivers installed.
 - Installation instructions.
- Optional rack-mount kit (including installation hardware and instructions) for the M Series equipment racks (DS-DMGGD-AE).

Chapter 3

Director Software Description

This chapter describes the firmware, backup and restore features, and graphical user interface (GUI) delivered with the StorageWorks SAN Director 64 and associated SANworks Director Connectivity Manager (SDCM) server.

Director Firmware

Director firmware provides services that manage and maintain Fibre Channel connections between ports. Although the Director hardware transmits Fibre Channel frames between source and destination ports, the firmware maintains routing tables required by the hardware to perform these switching functions. Director firmware also provides functions for system configuration, control, maintenance, and redundancy management, including:

- **System Management Services** - This function configures, controls, and monitors Director operation. The subsystem:
 - Centrally manages all configuration and status information.
 - Implements a simple network management protocol (SNMP) agent to allow access by external SNMP managers using the Fibre Channel Fabric Element management information base (MIB), standard transmission control protocol/internet protocol (TCP/IP) MIB-II definition, or Director-specific MIB.
 - Manages network connections from the SDCM server.
- **Fabric Services** - This function supports the fabric controller (login server) and name server. Fabric services also implements a replication manager that synchronizes node port (N_Port) registration databases between redundant control processor (CTP) cards and allows transparent CTP failover.

- **Fibre Port Services** - This function provides a physical driver for hardware components, including Fibre Channel port module (FPM) cards and serial crossbar (SBAR) assemblies.
- **Fibre Channel Protocol Services** - This function provides the Fibre Channel transport logic that allows upper layer protocols used by fabric services to communicate with devices attached to fiber-optic ports.
- **Network Services** - This function provides TCP/IP transport layers to access management service subsystems from attached management clients. These clients include the SDCM server or an SNMP management station.
- **Application Services** - This function supports all software subsystems for system initialization, logging, and debugging.
- **Operating System Services** - This function includes boot and loader software, a command line monitor for engineering fault isolation, a serial maintenance port driver, and other support for the operating system.

Backup and Restore Features

The SDCM server provides two backup and restore features. One feature backs up (to the SDCM server) or restores the configuration file stored in nonvolatile random-access memory (NV-RAM) on a Director's CTP card. The other feature backs up (to the Zip drive) or restores the entire SDCM data directory. The backup and restore features operate as follows:

- **NV-RAM configuration** - The NV-RAM configuration for any managed Director is backed up or restored through the SD-64 Product Manager application. This backup file is required to restore configuration data if both CTP cards are removed and replaced. The file is typically not required in a redundant Director; however, the feature may be useful to save a special-purpose configuration for test. Configuration data (stored in NV-RAM on each Director) backed up to the SDCM server includes:
 - ❑ Identification data, such as the Director name, description, and location.
 - ❑ Port configuration data, such as port names, blocked states, extended distance settings, and link incident (LIN) alerts.
 - ❑ Operating parameters, such as buffer-to-buffer credit (BB_credit), error detect timeout value (E_D_TOV), resource allocation timeout value (R_A_TOV), switch priority, and preferred domain ID.
 - ❑ Active zoning configuration.
 - ❑ SNMP configuration parameters, such as trap recipients, community names, and write authorizations.

- **SDCM data directory** - Critical information (for all managed Directors) stored in this directory is backed up or restored using the QuikSync application from Iomega. The application is configured to automatically back up the contents of the data directory to a removable Zip disk when the SDCM server is rebooted or when directory contents change. The SDCM data directory includes:
 - ❑ All SDCM configuration data (Director definitions, user names, passwords, user rights, nicknames, session options, SNMP trap recipients, e-mail recipients, and Ethernet event notifications).
 - ❑ All log files (SDCM logs and individual SD-64 Product Manager logs).
 - ❑ Zoning library (all zone sets and zone definitions).
 - ❑ Firmware library.
 - ❑ Call-home settings.
 - ❑ Configuration data for each managed Director (stored on the SDCM server and in NV-RAM on each Director).

Software Overview

This section describes the Management Services and SDCM applications. The SDCM application includes the SD-64 Product Manager and Fabric Manager applications. The applications provide a GUI and management services for monitoring and controlling Directors.

Management Services Application

The Management Services application runs on the SDCM server and provides management services to the SDCM, SD-64 Product Manager, and Fabric Manager applications, and implements Web and other server functions. The SDCM server is dedicated to the SDCM and associated applications, and should not be used for other tasks. Loading additional applications or use of the server for other purposes may impact SDCM server performance.

The Management Services application provides the following services to the SDCM, SD-64 Product Manager, and Fabric Manager applications:

- Session management for one or more SDCM server network connections.
- Providing a centralized database repository for configuration files, system logs, firmware upgrades, and other entities.
- Remote support and fault isolation services.

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- Establishing and maintaining network connections to managed Directors.
- Product configuration management.
- Event and audit logging.
- Alert processing and user notification.
- Initiation of the call-home procedure.

NOTE: Call-home notification requires installation of Compaq Proactive Service software. This service is offered at no additional charge for subsystems covered under an on-site warranty or on-site storage hardware support contract. To register or order Proactive Service software, contact your Compaq customer service representative.

- Network management and file transfer protocol (FTP) processing.

The SDCM server also provides hypertext transfer protocol (HTTP) server functionality. Use of this protocol with a standard Web server allows the download of client SDCM, SD-64 Product Manager, and Fabric Manager applications from the SDCM server to remote workstations. The server is configured to limit the maximum number of concurrent connections to four.

User Interface

The SDCM server implements the SDCM application, along with the SD-64 Product Manager and Fabric Manager applications, to provide the user interface for operators to control and monitor multiple Directors. These applications can also operate on workstations attached to the customer intranet that function as remote clients.

SDCM Application

The SDCM application provides a common Java-based GUI for all managed Compaq Directors. The application operates locally on the SDCM server or through a network connection from a remote user workstation. The application operates independently from all Directors managed by the SDCM server. Application users can perform the following common functions:

- Display the operational status for each Director.
- Define user names, passwords, and user rights for access to the SDCM server and SDCM application.
- Define access rights to the SDCM server and managed Directors locally or from remote user workstations.
- Configure e-mail notification for system events.

- Display SDCM audit, event, session, and product status logs.
- Open an instance of the SD-64 Product Manager application to manage and monitor a specific Compaq Director.
- Show routes (data paths) between two end devices attached to directors in a multiswitch fabric.
- Open the Fabric Manager application to display all managed fabrics and to manage and monitor each fabric.
- Identify new Directors and their associated network addresses to the SDCM server for access through the SDCM and SD-64 Product Manager applications.

Product View

When the SDCM application opens, the default display is the Product View ([Figure 3-1](#)). Managed Directors appear as icons at the right panel of the window. A navigation control panel with a series of icons appears at the left side of the window. The internet protocol (IP) address of the SDCM server appears in the title bar of the window.

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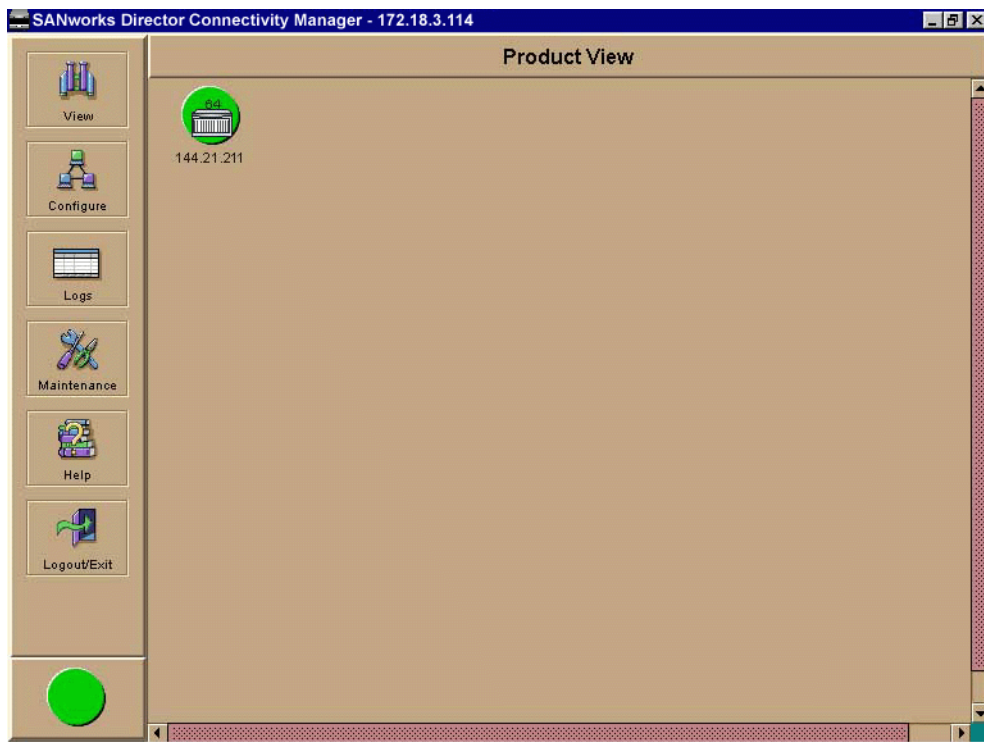


Figure 3-1: Product View

A label below each Director icon identifies the managed Director by its configured name or IP address. A colored alert symbol behind each Director icon indicates the operational status of the Director as follows:

- A green circle indicates the Director is fully operational.
- A yellow triangle indicates a redundant component failure or degraded operational status.
- A red diamond with a yellow background indicates a critical failure and the Director is not operational.
- A grey square indicates the Director status is unknown (network connection failure).

By clicking (selecting) a Director icon or selecting from pop-up menu options, a user opens the SD-64 Product Manager application for a Director. Refer to [SD-64 Product Manager Application on page 3-10](#) for additional information.

The navigation control panel at the left side of the Product View provides View, Configure, Logs, Maintenance, Help, and Logout/Exit icons (with associated pop-up menus) that allow users to perform SDCM tasks.

An alert panel at the bottom of the navigation control panel displays a colored icon (green circle, yellow triangle, red diamond with yellow background, or grey square) that indicates the most degraded or critical status of any Director in the Product View. For example, if one Director is degraded but all other Directors are fully operational, a yellow triangle displays in the alert panel and as a background to the icon representing the degraded Director. The remaining managed Director icons have a green circle as the background.

Fabric View

When the Fabric option is selected from the View icon, the Fabric View appears ([Figure 3-2 on page 3-8](#)). Fibre Channel fabrics managed by the application appear as pentagonal icons at the right panel of the window. A navigation control panel with a series of icons appears at the left side of the window. The IP address of the SDCM server appears in the title bar of the window.

A label below each fabric icon identifies the managed Fibre Channel fabric by its world wide name (WWN) or user-assigned nickname. A number in the center of the pentagonal icon indicates the number of Directors or fabric switches in the fabric. By clicking (selecting) a fabric icon or selecting from pop-up menu options, a user opens the Fabric Manager application. Refer to [Fabric Manager Application on page 3-11](#) for additional information.

The navigation control panel at the left side of the Fabric View provides the same administrative, operations, and maintenance task icons (with associated pop-up menus) provided by the Product View.

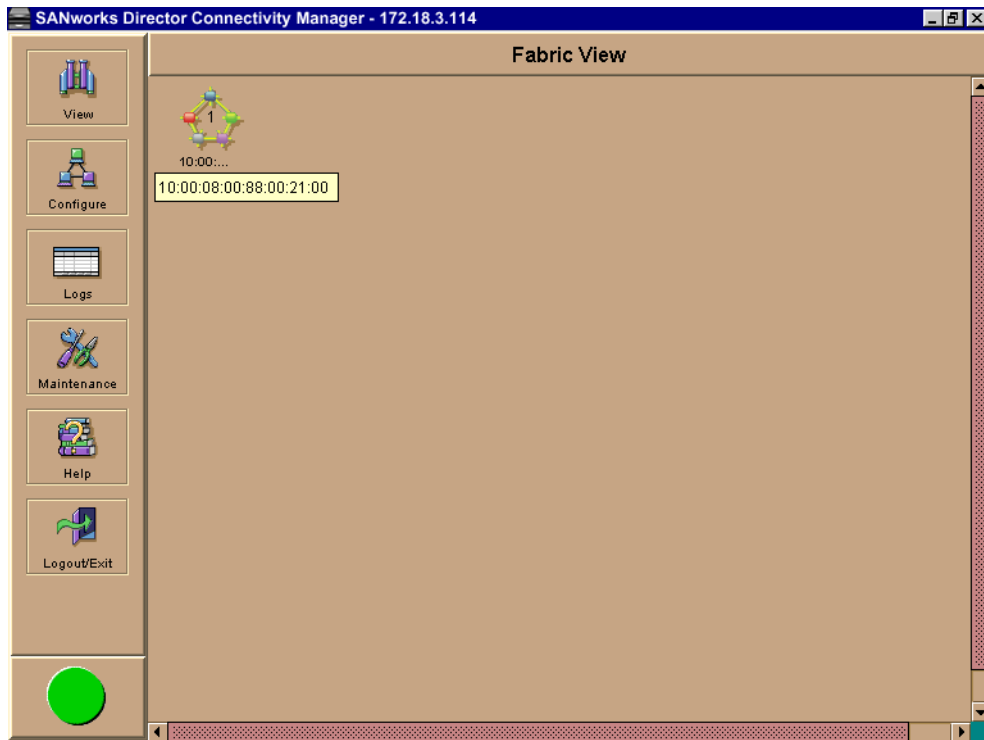


Figure 3-2: Fabric View

An alert panel at the bottom of the navigation control panel displays a colored icon (green circle, yellow triangle, red diamond with yellow background, or grey square) that indicates the most degraded or critical status of any element within a fabric in the Fabric View.

Session View

When the Session option is selected from the View icon, the Session View displays (Figure 3-3 on page 3-9). A list of remote users logged into the SDCM application appears at the right panel of the window, and a navigation control panel with a series of icons appears at the left side of the window. The IP address of the SDCM server appears in the title bar of the window.

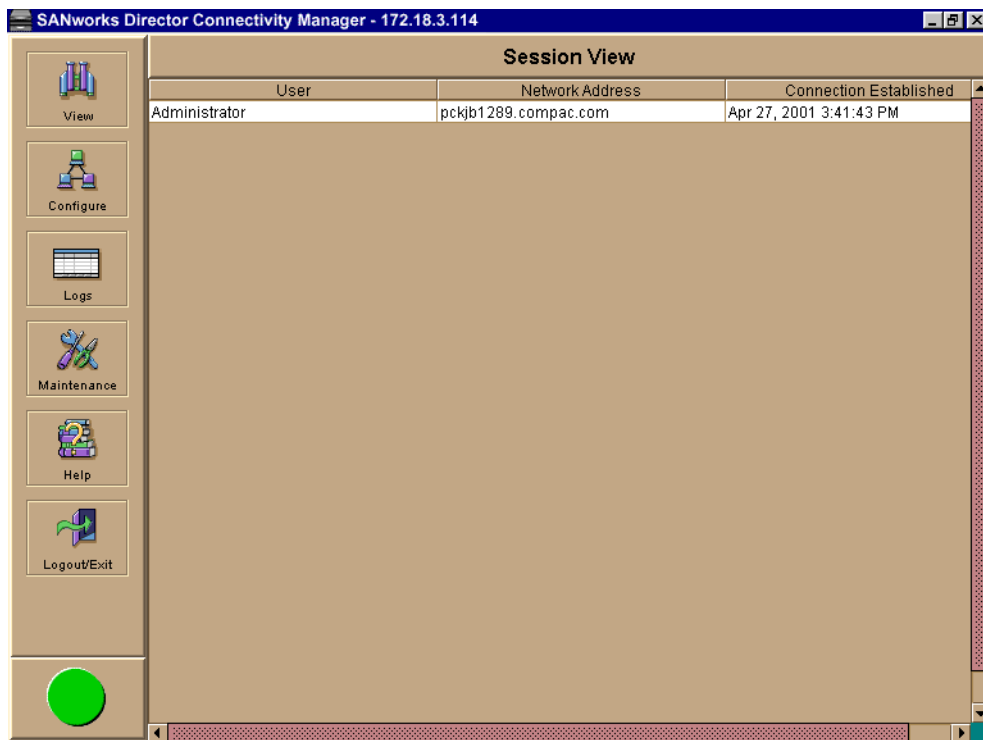


Figure 3-3: Session View

The user list provides:

- The IP address of the remote PC or workstation.
- The name of the user logged in from a remote personal computer (PC) or workstation (a maximum of four users can log in concurrently).
- The date and time the remote user established a connection to the SDCM application.

The navigation control panel at the left side of the Fabric View provides the same administrative, operations, and maintenance task icons (with associated pop-up menus) provided by the Product View.

An alert panel at the bottom of the navigation control panel displays a colored icon (green circle, yellow triangle, red diamond with yellow background, or grey square) that indicates the most degraded or critical status of any Director.

SD-64 Product Manager Application

The SD-64 Product Manager application works in conjunction with the SDCM application, and is a Java-based GUI for managing and monitoring multiple Directors. The application operates locally on the SDCM server, or through a network connection from a remote PC or workstation.

Click a Director icon at the right panel of the Product View (Figure 3-1 on page 3-6) to open the SD-64 Product Manager application for that managed Director. When the application opens, the default display is the Hardware View (Figure 3-4).

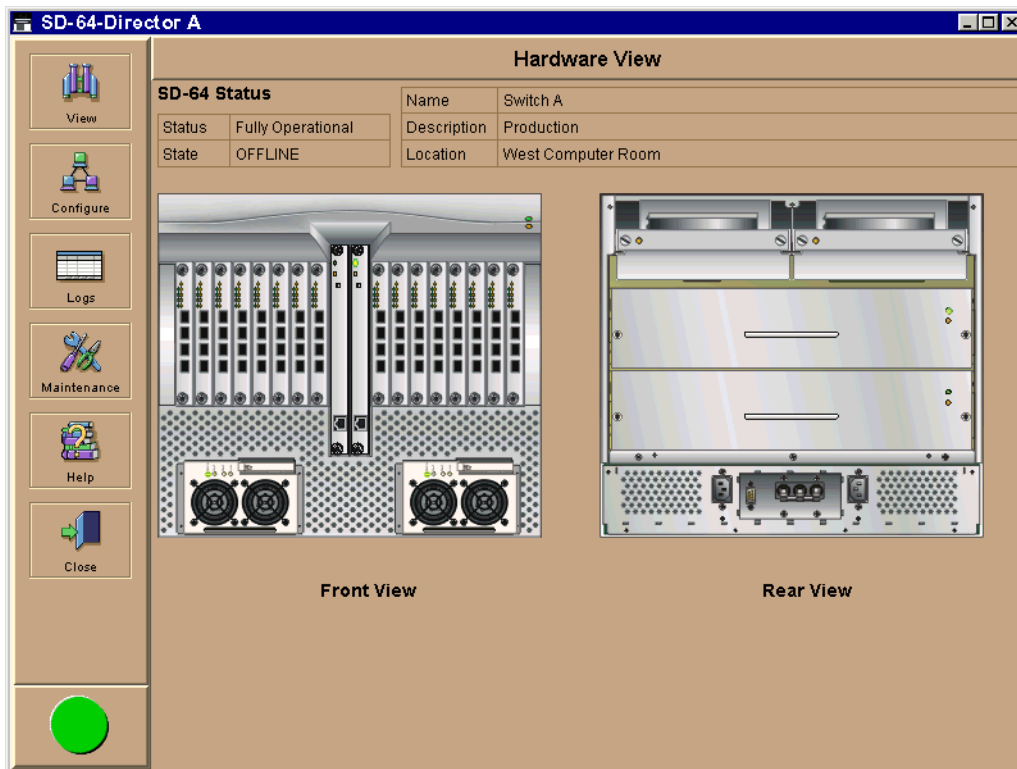


Figure 3-4: Hardware View

An SD-64 Director Status table appears at the top of the window, a graphical representation of Director hardware (front and rear) appears at the right panel of the window, and a navigation control panel with a series of icons appears at the left side of the window.

The graphical representation of the Director emulates the hardware configuration and operational status of the corresponding real Director. For example, if the Director is fully redundant and fully populated, this configuration is reflected in the Hardware View.

Colored symbols appear on the graphical field-replaceable units (FRUs) to represent failed or degraded status. The colors and shapes are consistent with status displays on other windows in the SDCM and Fabric Manager applications. The light-emitting diodes (LEDs) also highlight to emulate real LED operation.

The navigation control panel at the left side of the Hardware View provides View, Configure, Logs, Maintenance, Help, and Close icons (with associated pop-up menus) that allow users to perform Director-specific tasks.

An alert panel at the bottom of the navigation control panel displays a colored icon (green circle, yellow triangle, red diamond with yellow background, or grey square) that indicates Director status. For example, for a single port failure, an entire FPM card failure, or a redundant FRU failure, a blinking red and yellow diamond appears on the card or FRU illustration in the Hardware View; however, the alert panel displays a yellow triangle to indicate degraded operation. If a blinking red and yellow diamond appears over a nonredundant FRU, the alert panel displays a red and yellow diamond, indicating a critical failure and the Director is not operational.

When the mouse cursor is moved over a FRU in the Director graphic, the FRU border highlights in blue and a pop-up identification label appears. Mouse selections (right or left click) open dialog boxes or menus that display FRU properties or allow users to perform operations and maintenance tasks.

Fabric Manager Application

The Fabric Manager application works in conjunction with the SDCM application, and is a Java-based GUI for managing and monitoring multiple Fibre Channel fabrics. The application operates locally on the SDCM server, or through a network connection from a remote PC or workstation. The Fabric Manager application is used to configure zoning for a fabric.

Click a pentagonal fabric icon at the Fabric View ([Figure 3-2 on page 3-8](#)) to open the Fabric Manager application for that managed fabric. When the application opens, the default display is the Topology View ([Figure 3-5 on page 3-12](#)). A graphical representation of the fabric topology appears at the right side of the window, and a navigation control panel with a series of icons appears at the left side of the window.

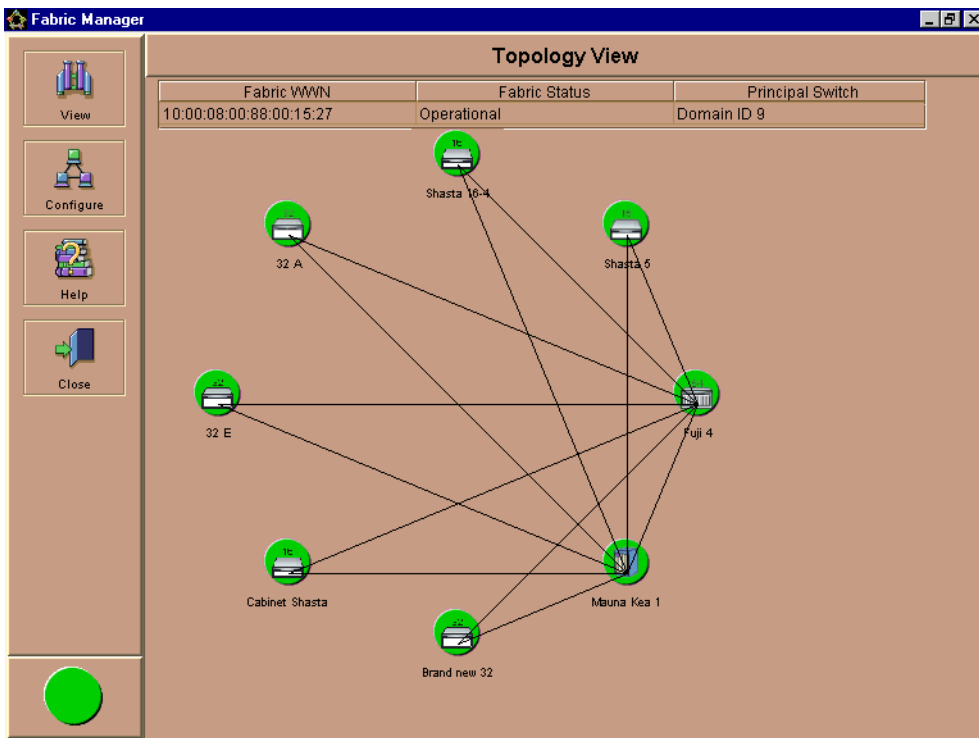


Figure 3-5: Topology View

The Topology View displays fabric elements (Directors or switches) and interswitch links (ISLs) for a fabric. The graphical representation of the fabric emulates the configuration and status of the corresponding real fabric. A single Director without ISLs is still considered a fabric. A status table at the top of the window displays the fabric's operational status, WWN, and the Domain ID of the principal switch.

Colored symbols appear on the graphical fabric elements to represent operational, degraded, or failed status. The colors and shapes are consistent with status displays on other windows in the SDCM and SD-64 Product Manager applications. A fabric element without a colored status symbol represents a product that is not managed by the SDCM server on which the Fabric Manager is running (status information is therefore not available).

The navigation control panel at the left side of the Topology View provides View, Configure, Help, and Close icons (with associated pop-up menus) that allow users to perform fabric-specific tasks.

When the mouse cursor is moved over a fabric element or an ISL, the element or connection highlights in blue and a pop-up identification label appears. Mouse selections (right or left click) open dialog boxes or menus that display element properties or naming options, or allow users to perform operations and maintenance tasks.

An alert panel at the bottom of the navigation control panel displays a colored icon (green circle, yellow triangle, red diamond with yellow background, or grey square) that indicates the most degraded or critical status of any element within the fabric.

Embedded Web Server Interface

The embedded web server interface provides a GUI accessed through the Internet (locally or remotely) to manage the SD-64 Director. This interface does not replace nor offer the management capability of the SDCM and SD-64 Product Manager applications (for example, the web server does not support all Director maintenance functions). In addition, the web server interface manages only a single Director. Web server users can perform the following functions:

- Display the operational status of the Director, FRUs, and Fibre Channel ports, and display Director operating parameters.
- Configure the Director (identification, date and time, operating parameters, and network parameters), ports, SNMP trap message recipients, zones and zone sets, and user rights (administrator and operator).
- Monitor port status, port statistics, and the active zone set, and display the event log and node list.
- Perform nondisruptive Director firmware upgrades and port diagnostics, reset ports, enable port beaconing, and set the Director online or offline.

The embedded web server interface can be opened from a standard web browser running Netscape Navigator 4.6 or higher or Microsoft Internet Explorer 4.0 or higher. At the browser, enter the IP address of the Director as the Internet uniform resource locator (URL). When prompted at a login screen, enter a user name and password. When the interface opens, the default display is the View panel ([Figure 3-6 on page 3-14](#)).

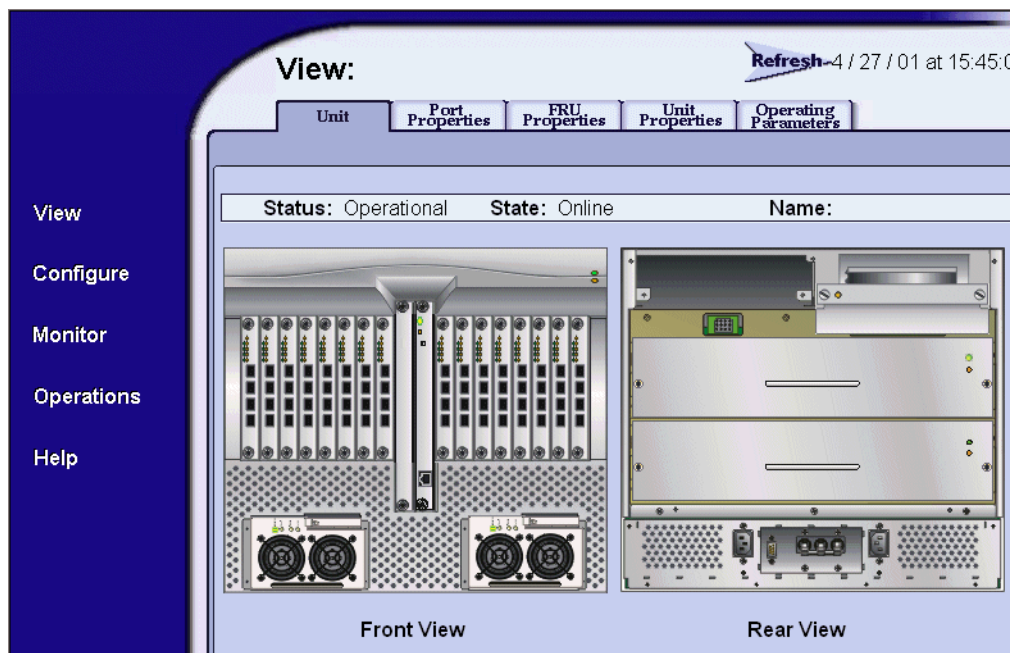


Figure 3-6: View Panel (Embedded Web Server Interface)

Task selection tabs appear at the top of the panel, a graphical representation of Director hardware (front and rear) appears at the right side of the panel, and menu selections (View, Configure, Monitor, Operations, and Help) appear at the left side of the panel. The task selection tabs allow users to perform Director-specific tasks, and are a function of the menu selected as follows:

- **View** - At the View panel, the Unit (default), Port Properties, FRU Properties, Unit Properties, and Operating Parameters task selection tabs appear.
- **Configure** - At the Configure panel, the Port (default), Switch, SNMP, Zoning, and User Rights task selection tabs appear.
- **Monitor** - At the Monitor panel, the Port List (default), Port Stats, Active Zone Set, Log, and Node List task selection tabs appear.
- **Operations** - At the Operations panel, the Port Beaconsing (default), Port Diagnostics, Port Reset, Online State, and Firmware Upgrade task selection tabs appear.
- **Help** - The Help selection opens online user documentation that supports the embedded web server interface.

Command Line Interface

The command line interface (CLI) allows users to access certain SDC Manager and SD-64 Product Manager application functions by entering commands through a telnet session. The CLI is not an interactive interface; a user prompt does not display to guide users through tasks. The primary purpose of the CLI is to automate management of a large number of directors using scripts. For information, refer to the *StorageWorks by Compaq SAN Director CLI Guide* (AA-RQ7AA-TE).

Chapter 4

Planning Considerations

This chapter describes planning considerations that should be evaluated to ensure the customer's enterprise takes advantage of the StorageWorks SAN Director 64 features. The chapter also provides planning considerations and recommendations for:

- Planning a Fibre Channel storage area network (SAN) configuration.
- Port connectivity and fiber-optic cabling.
- SANworks Director Connectivity Manager (SDCM) server, Ethernet local area network (LAN), and remote access support.
- Security provisions for the Director, SDCM server, and customer data paths through the Director (zoning).
- Multi-switch fabric support.

Planning a Fibre Channel SAN Configuration

A Fibre Channel SAN configuration is created using the SDCM server, one or more Directors or other Compaq managed products, and attached end devices such as servers and storage peripherals. Factors that affect initial SAN configuration planning include:

- Determining the business and technical reasons for implementing a Director installation and SAN technology.
- Integrating SAN technology with the enterprise's legacy architecture.

- Determining the Fibre Channel topology to be implemented.
- Capacity planning to meet operational, nondisruptive growth, and service requirements.

The following paragraphs provide general guidelines and factors to consider when implementing a Fibre Channel SAN configuration. However, planning and implementing the configuration is a complex and difficult task, and Compaq recommends you obtain planning assistance from our professional services organization.

Reasons for Implementing SAN Technology

When installing one or more Directors as part of a Fibre Channel SAN configuration, consider the enterprise's business and technical goals as part of the planning process. Business solutions provided through SAN implementation include:

- Cost reduction through storage device, server, and port consolidation. Dynamic connectivity provided by the Director ensures multiple servers can communicate with a single storage device (tape or disk), or that multiple storage devices can communicate with a single server. The Director also ensures additional storage capacity is not purchased only to provide more port connectivity. These capabilities reduce expenditures for unnecessary devices and allow obsolete devices and technologies to be retired.
- Migration from a proprietary to an open-systems interconnection (OSI) computing environment, and integration of channel and network architectures. OSI computing enables cross-platform communication and increases data availability to customer employees.
- Cost savings through higher availability of mission-critical applications and devices. High availability is ensured by multiple device connections through more than one port, or more than one Director. In addition, spare ports can be maintained (for failover) for devices that require high availability. Refer to [Port Connectivity and Fiber-Optic Cabling on page 4-5](#) for additional information.
- Improved security of business applications and data. The Director allows attached devices to be partitioned into restricted-access zones to limit unauthorized access. Refer to [Name Server Zoning on page 4-16](#) for additional information.
- Improved resource manageability. Distributed resources are consolidated and managed through Fibre Channel connectivity instead of physical relocation.

Technical solutions provided through Director installation and SAN implementation include:

- Improved reliability and serviceability. High reliability and serviceability are ensured by installing a Director with redundant field-replaceable units (FRUs) that can be concurrently removed and replaced while the Director is operational.
- Improved data transmission performance. While Fibre Channel implementation provides an improvement over comparable technologies, data traffic through Director must be identified and characterized for optimum performance. Traffic sources and destinations must be identified, and bandwidth and quality-of-service requirements for applications must be estimated.
- The ability to transmit data over longer distances. Through the use of repeaters, the Director can transmit Fibre Channel frames up to 100 kilometers (km). The purchase and installation of repeaters must be factored into the SAN design to meet long-distance requirements.
- Scalability to meet growth requirements. A Director with planned excess port capacity provides OSI connectivity for future servers, devices, and applications. Refer to [Capacity Planning on page 4-4](#) for additional information.

As part of the Director planning and installation process, define the enterprise's computing assets (operating systems, hardware, communication networks, database management systems, and business applications), and document all business and technical issues to be addressed. Ensure these issues are considered and the resulting implications are factored into the Director installation and SAN implementation plan.

Integrating SAN Technology

Prior to Director installation in a Fibre Channel SAN configuration, examine and document the enterprise's topology and physical infrastructure as follows:

- Ensure fiber-optic cables with small form factor (SFF) LC-to-LC connectors are installed and documented, and are of sufficient length to meet planned distance requirements. Refer to [Task 2: Plan Fiber-Optic Cable Routing on page 5-7](#) for additional information.

The SAN configuration may also include Directors, servers, and storage device host bus adapters (HBAs) that use subscriber connectors (SCs). If this is the case, ensure fiber-optic cables with LC-to-SC connectors are installed and documented as required.

- Determine if the SAN design will coexist with or replace the existing topology, and ensure Director interoperability with end devices provided by separate original equipment manufacturers (OEMs). Refer to [Task 3: Consider Interoperability with Fabric Elements and End Devices on page 5-7](#) for additional information.
- Document existing device node names and internet protocol (IP) addresses, along with naming and address assignment conventions. Refer to [Task 6: Plan Network Addresses on page 5-9](#) for additional information.

Fibre Channel Topologies

The Fibre Channel Director supports both point-to-point and multi-switch fabric topologies, and indirectly supports arbitrated loop topology. A combination of these topologies (hybrid topology) is also supported.

- **Point-to-point** - A dedicated point-to-point connection through the Director is simple to implement and should be considered for server-to-storage applications where high performance, high availability, or extended distances are required.
- **Multi-switch fabric** - Support of multi-switch fabric operation is a major feature of the Director. Consider installation of multiple Directors (or other Compaq switch elements) to form a high-availability fabric topology that supports multiple, full-bandwidth data transmission paths between servers and devices.
- **Arbitrated loop** - Although the Director does not support direct connection of arbitrated loop devices, such devices can communicate with the Director through commercially available fabric-loop switches. If peripheral loop devices are expected to communicate with fabric-attached devices, consider installation of such a switch (with the Director) to form a fabric-loop hybrid topology.

Capacity Planning

Consider the data traffic capacity of the enterprise (normal and peak load) as part of the Director planning and installation process. Capacity planning is a dynamic activity that must be performed when new devices, applications, or users are added to the enterprise. In particular, use capacity planning to:

- Ensure SAN traffic is distributed and balanced across servers, storage devices, and the multi-switch fabric.
- Identify traffic bottlenecks and provides for alternate paths through the multi-switch fabric during peak load times or when fabric elements are serviced.
- Assist in calculating scalability to satisfy nondisruptive growth requirements.

Port Connectivity and Fiber-Optic Cabling

This section provides planning recommendations for Director port connectivity and fiber-optic cabling. Specific recommendations are provided for:

- Port requirements (number and type of ports).
- Extended-distance ports.
- High availability considerations.
- Cabling and connectors.
- Routing fiber-optic cables.

Port Requirements

Plan for sufficient shortwave laser ports and longwave laser ports to meet the needs of the configuration. The number of ports required is equal to the number of device connections (including redundant connections), plus the number of interswitch links (ISLs) between Directors, plus the total number of spare port connections.

The Director is configured from a minimum of eight fiber port module (FPM) cards (32 ports) to a maximum of 16 FPM cards (64 ports). FPM cards provide four port connections and can be configured with shortwave transceivers, longwave laser transceivers, or a combination of both.

- Shortwave transceivers provide a connection for multi-mode cable with a core diameter of 50 microns and a cladding diameter of 125 microns (50/125), or multi-mode cable with a core diameter of 62.50 microns and a cladding diameter of 125 microns (62.5/125). A 50/125 micron cable link allows a maximum Director-to-device or Director-to-Director distance of up to 500 meters. A 62.5/125 micron cable link allows a maximum Director-to-device or Director-to-Director distance of up to 300 meters.
- Longwave transceivers provide a connection for single-mode cable with a core diameter of 9 microns and a cladding diameter of 125 microns (9/125). A 9/125 micron cable link allows a maximum Director-to-device or Director-to-Director distance of up to 20 kilometers.



CAUTION: The Director's non-open fiber control (non-OFC) laser transceivers are designed and certified for use only with fiber-optic cable and connectors with characteristics specified by Compaq. Use of other connectors or optical fiber can result in emission of laser power levels capable of producing injury to the eye if viewed directly. Use of non-specified connectors or optical fiber can violate the Class 1 laser classification.

Consider the following factors when determining the number and type of each transceiver to use:

- Distance between a Director and device or between Directors participating in an ISL as part of a multi-switch fabric.
- Cost effectiveness.
- Device restrictions or requirements with respect to existing fiber-optic cable (multi-mode or single-mode).

Data Transmission Distance

Data transmission distance is the primary factor governing the choice of transceiver type and optical fiber. If the transmission distance is less than 300 meters, multi-mode or single-mode optical fiber and any type of transceiver can be used. If the transmission distance is between 300 and 500 meters, 50/125-micron multi-mode or single-mode optical fiber and any type of transceiver can be used. If the transmission distance exceeds 500 meters, only single-mode optical fiber and a longwave laser transceiver can be used.

Variables such as the number of connections, grade of fiber-optic cable, device restrictions, application restrictions, buffer-to-buffer credit limits, and performance requirements can affect transmission distance.

Cost Effectiveness

Cost is the secondary factor governing the choice of transceiver type and optical fiber. Shortwave laser transceivers and multi-mode cable offer a less expensive solution if data transmission distance is not critical.

Device or Cable Restrictions

The choice of transceiver and cable type may be restricted or dictated by:

- **Device restrictions** - Some devices may be restricted to use of only one type of transceiver (shortwave or longwave). Refer to the supporting documentation delivered with the product for information.
- **Existing cable restrictions** - The enterprise may contain only one type of fiber-optic cable (multi-mode or single-mode), and the customer may be required to use the existing cables.

Extended-Distance Ports

Through the use of longwave laser transceivers and four repeaters spaced at 20 km intervals, the Director supports data transmission distances of up to 100 km. This extended distance feature is enabled on a port-by-port basis by activating the 10-100 km checkbox for a specified port at the SD-64 Product Manager application's Configure Ports dialog box. When a port is configured for extended distance operation, the buffer-to-buffer credit (BB_Credit) value for the port is automatically set to 60. This value provides sufficient buffering to handle frame processing for link distances up to 100 km.

When a Director port is configured to support extended link distances, the attached device (or attached Director in a multi-switch fabric) must support extended distance operation and be configured to use a higher BB_Credit value to maintain link efficiency.

If the extended distance feature is enabled for a port that is not installed or does not support extended distance operation, the configuration for the feature is ignored. In addition, a port configured for extended distance operation cannot transmit broadcast frames to other ports in a Fibre Channel fabric.

High-Availability Considerations

To provide high availability, multiple connections from a specific server, storage device, or application should be provided. Compaq recommends that multiple fiber-optic cable connections not be attached to the Director through a single FPM card. Spreading connections across multiple FPM cards eliminates an individual port or card as a single point of failure.

To improve performance, consider having multiple connections to a device. Refer to the device documentation to determine if this capability exists.

To provide high availability and load balancing for Fibre Channel traffic through a multi-switch fabric, multiple ISLs should be provided between Directors that participate in critical data transfer paths.

Multiple Directors

Multiple Directors can be installed in the enterprise to provide device availability and multi-switch fabric support.

- **Device availability** - Spreading connections across multiple Directors eliminates each Director as a single point of failure. Device availability, port availability, and port serviceability are also increased by using a configuration that has multiple Directors (with every device attached to at least two Directors).
- **Multi-switch fabric support** - The Director operational software provides the ability to interconnect Directors (through expansion port (E_Port) connections) to form a multi-switch fabric. Up to four interconnected Directors are supported in a single fabric.

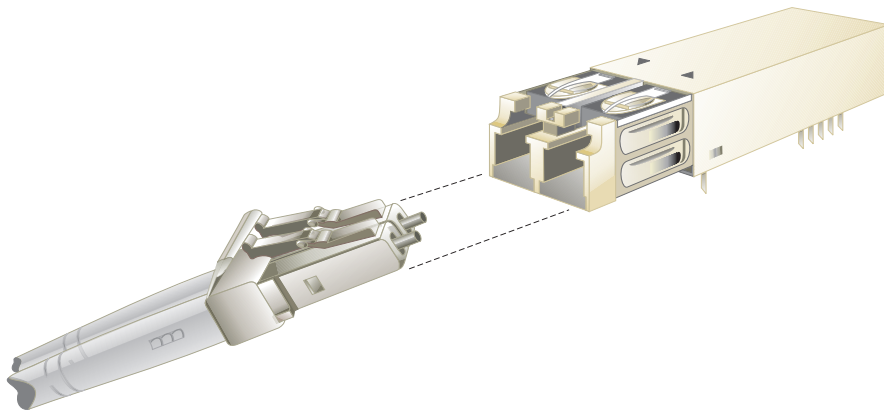
Spare Ports

Plan to maintain unused (spare) Director ports if port connections must be quickly moved and re-established after a failure. If an individual port or an entire FPM card fails, cards can be removed and replaced, spare port connections identified (through the SD-64 Product Manager application), and fiber-optic cables rerouted and reconnected while the Director is operational.

Although there is no requirement to provide spare ports, they are recommended to allow quick transfer of connections in case of failure. Installation of at least one spare FPM card is recommended. In addition, unused ports on any FPM card can be used as spare ports.

Cabling and Connectors

Each FPM card provides four SFF pluggable optic transceivers with duplex LC connectors for attaching fiber-optic jumper cables. [Figure 4-1 on page 4-9](#) illustrates an SFF transceiver and duplex LC connector.



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Figure 4-1: SFF Transceiver and LC Duplex Connector

Fiber-optic jumper cables are required to connect Director ports to servers, devices, distribution panels, or other Directors in a multi-switch fabric. Depending on the FPM card configuration, use one of the following types of cable:

- Graded-index multi-mode cable with a core diameter of 50 microns and a cladding diameter of 125 microns (50/125). The cable provides a transmission distance between two and 500 meters, and connects to shortwave ports that transmit light at an 850 nanometers (nm) wavelength. The cable typically has an orange jacket.
- Graded-index multi-mode cable with a core diameter of 62.50 microns and a cladding diameter of 125 microns (62.5/125). The cable provides a transmission distance between two and 300 meters, and connects to shortwave ports that transmit light at an 850 nm wavelength. The cable typically has an orange jacket.
- Dispersion-unshifted single-mode cable with a core diameter of nine microns and a cladding diameter of 125 microns (9/125). The cable provides a transmission distance between two meters and 20 kilometers, and connects to longwave ports that transmit light at a 1300 nm wavelength. The cable typically has a yellow jacket.

In addition, the SAN configuration may also include Directors, servers, and storage device HBAs that use subscriber connectors (SCs). If this is the case, fiber-optic jumper cables with LC-to-SC connectors are required.

Routing Fiber-Optic Cables

The Director has a maximum of 16 FPM cards (64 ports) that may require fiber-optic cable connections and subsequent cable routing. In a Fibre Channel protocol OSI environment, ports are numbered by physical port number only. Figure 4-2 shows FPM card numbers (0 through 15) and port numbers (00 through 63).

FPM Cards								CTP - 1 Card	CTP - 0 Card	FPM Cards							
15	14	13	12	11	10	9	8			7	6	5	4	3	2	1	0
63	59	55	51	47	43	39	35			31	27	23	19	15	11	07	03
62	58	54	50	46	42	38	34			30	26	22	18	14	10	06	02
61	57	53	49	45	41	37	33			29	25	21	17	13	09	05	01
60	56	52	48	44	40	36	32			28	24	20	16	12	08	04	00

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Figure 4-2: FPM Card and Port Numbers (OSI)

Follow a logical plan for routing fiber-optic cables to avoid confusing connections during installation and operation. Route cables from the access holes at the bottom or top of the equipment rack, through the rack side-rail channels, then through the cable management assembly at the bottom front of the Director. Connect cables to ports starting with the center FPM cards (7 and 8) adjacent to the control processor (CTP) cards and work outward. In addition, start with the bottom port of each FPM card and work upward.

Leave enough slack in the cables to allow cable movement for FPM card removal and replacement, or possible rerouting of the cable to another port. When routing fiber-optic cables and estimating cable lengths, consider:

- Cable routing inside the equipment rack to different FPM card locations, and installation position of the Director (top or bottom of the rack). Plan for 1.0 meter (39.37 inches) of extra cable for routing through restraint mechanisms and rerouting cables to other FPM cards.
- Cable routing outside the equipment rack. Plan for 1.5 meters (59.05 inches) of cable outside the rack to provide slack for service clearance, limited rack movement, and inadvertent cable pulls.
- Cabling distance to servers, storage devices, and Directors (for multi-switch fabric support).

The need for additional fiber-optic cabling could grow rapidly. More cables may be required for connections to additional servers or storage devices, or for connections to additional Directors as a multi-switch fabric is developed. The Director may need to be moved for more efficient connection to other units, but still maintain its original connections. To account for these possibilities, consider installing excess fiber-optic cable, especially in hard to reach places like underground trenches.

SDCM Server, LAN, and Remote Access Support

Out-of-band (non-Fibre Channel) console access to the Director is provided to perform operations and management functions. These functions are performed from one or more of the following consoles:

- Through the SDCM server that is LAN-attached to the Director's CTP card.
- Through a remote personal computer (PC) or workstation connected to the SDCM server through the Director LAN segment.
- Through a simple network management protocol (SNMP) management workstation connected through the Director LAN segment.
- Through a PC with a web browser and Internet connection to the Director through a LAN segment.
- Through a PC with a direct serial connection to the Director maintenance port (rear of the Director chassis). The maintenance port is used by installation personnel to configure switch network addresses.

SDCM Server

The SDCM server and an external zip drive support up to 48 Directors or other managed Compaq products. The server is used to configure the Director and SDCM, SD-64 Product Manager, and Fabric applications, monitor Director operation, change Director configurations, download firmware updates, and initiate diagnostics.

An SDCM server failure does not affect port connections or functions of an operational Director. The only operating effect of a server failure is loss of remote access, configuration, management, and monitoring functions.

SDCM Server Connectivity

The SDCM server provides an auto-detecting 10/100 Base-T Ethernet interface that connects to a customer-supplied LAN. Each Director CTP card also provides an auto-detecting 10/100 Base-T Ethernet interface that connects to the LAN. Customer-installed cables connect the SDCM server and managed Directors.

Although the Director provides two Ethernet connections to the LAN, only one connection is active at a time. The interface on the backup CTP card remains passive until a failure on the active CTP card occurs, at which point the redundant CTP card becomes active using the same media access control (MAC) address as the original interface.

The SDCM server is accessible from the SANworks Management Appliance for service and support of managed products. The Network View application running on the appliance communicates with the server and initiates the SDCM, SD-64 Product Manager, and Fabric Manager applications remotely. The appliance also provides connectivity to an authorized support center (to report the occurrence of significant system events) using a call-home feature. The call-home feature is enabled at the SD-64 Product Manager application.

NOTE: Call-home notification requires installation of Compaq Proactive Service software. This service is offered at no additional charge for subsystems covered under an on-site warranty or on-site storage hardware support contract. To register or order Proactive Service software, contact your Compaq customer service representative.

Connectivity Planning Considerations

Directors and the SDCM server are delivered in a Compaq-supplied Series 9000 or M Series equipment rack in accordance with customer specifications. Consider the following Ethernet connectivity issues when:

- **Installing rack-mount Directors** - When installing a Director, the length of Ethernet cable required to provide LAN connectivity is a function of rack position (top, bottom, or adjacent to the slide-out drawer). If a customer-supplied Ethernet hub is installed at the top of the equipment rack, plan for the following minimum cable lengths:
 - ❑ Top position: 150 centimeters (59.1 inches).
 - ❑ Second position: 190 centimeters (74.8 inches).
 - ❑ Third position: 235 centimeters (92.5 inches).
 - ❑ Bottom position: 275 centimeters (108.3 inches).

Each recommended length provides sufficient Ethernet cable inside the rack to route to Director CTP cards and to allow service clearance for card removal and replacement.

- **Interconnecting equipment racks** - To increase the number of Directors managed by one SDCM server, Ethernet hubs in one or more equipment racks must be connected. Plan for an Ethernet cable length that meets the distance requirement between the racks. In addition, plan for an additional 1.5 meters (59.1 inches) of cable outside the rack to provide slack for service clearance, limited rack movement, or inadvertent cable pulls. Store extra Ethernet cable in the rack or under the computer room raised floor.
- **Consolidating SDCM server operation** - For control and efficiency, all Directors in a multi-switch fabric should be managed by one SDCM server. When Directors in two or more racks are joined to form a fabric, the PC environment should be consolidated to one server and one or more clients. Plan for Ethernet cabling to interconnect racks and ensure all Directors and PC platforms participating in the fabric have unique IP addresses.

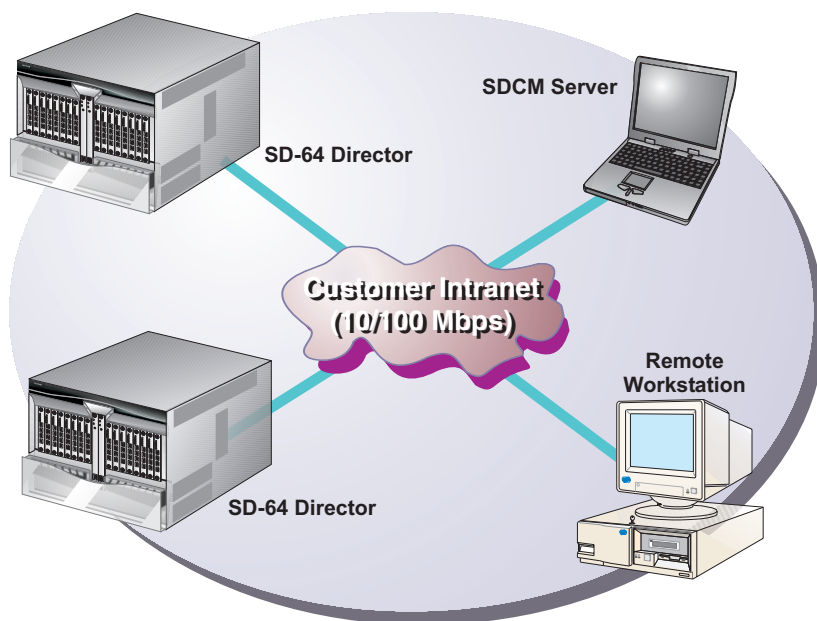
Remote User Workstations

Customer system administrators determine whether to allow access to Directors from remote workstations. If administrators allow remote sessions, they may restrict access to selected workstations by configuring the IP addresses of those workstations through the SDCM application. When a remote session is allowed, the remote user has the same rights and permissions as if the session were on the local SDCM server. Up to five SDCM application sessions can be simultaneously active (one local and four remote).

Remote workstations must have access to the customer intranet (LAN segment) on which the SDCM server is installed. Director administrative functions are accessed through the LAN and SDCM server. The customer intranet is part of the 10/100 Mbps LAN that provides access to managed Directors. This Director-to-SDCM server connection is part of the equipment rack installation and is required. Connection of remote workstations through the customer intranet is optional. This type of network configuration using an Ethernet connection through the SDCM server is shown in [Figure 4-3 on page 4-14](#).

If the SDCM server connection is provided through the customer intranet, all functions provided by the SDCM server are available to users throughout the enterprise.

NOTE: The Ethernet adapter in the SDCM server provides an auto-detecting 10/100 Mbps connection. Depending on speed restrictions imposed by other LAN-attached devices, the LAN segment that connects the SDCM server to managed Directors operates at either ten or 100 Mbps.



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Figure 4-3: Typical Network Configuration (One Ethernet Connection)

SNMP Management Workstations

An SNMP agent that runs on the SDCM server can be configured through the SDCM application. This agent implements the Fibre Alliance management information base (MIB). The agent can be configured to send SNMP trap messages to up to 12 recipients. In addition, there is a separate SNMP agent that runs on each Director that is configured through the Product Manager application. This agent implements the following MIBs:

- The Fibre Channel Fabric Element MIB (Version 1.10).
- A subset of the standard transmission control protocol/internet protocol (TCP/IP) MIB-II definition (RFC1213).
- The Director-specific MIB.

The Director SNMP agent can be configured to send trap messages to up to six recipients. SNMP management is only intended for Director monitoring; therefore, the default state of all MIB variables is read-only. When installed on a customer intranet, workstations communicate with Directors through the SDCM server.

Web Browser Access

The embedded web server interface provides a graphical user interface (GUI) accessed through the Internet (locally or remotely) to manage a single Director. If the embedded web server interface is to be implemented:

- Plan for an Internet connection to the LAN segment on which the Director or Directors are installed. The LAN connection is provided through the optional customer-supplied Ethernet hub or the corporate intranet.
- Ensure adequate security measures are implemented to preclude unauthorized access to Directors. Ensure IP addresses (uniform resource locators (URLs) for Internet access) of managed Directors, usernames, and passwords are tightly controlled.

Security Provisions

Security provisions are available to restrict unauthorized access to the Director and attached devices. Access to the Director (through the SDCM application, SD-64 Product Manager application, and web server interface) is restricted by implementing password protection. Access to attached computing resources (including applications and data) is restricted by implementing name server zoning.

Access to the SDCM and Product Manager applications requires configuration of a user name and password. Up to 16 user names and associated passwords can be configured, although only five users can log in concurrently (four remote and one local). Each user is assigned rights that allow access to specific sets of Director management operations. [Table 4-1 on page 4-16](#) explains the types of user rights available. A user may have more than one set of user rights granted.

The system administrator can also use the SDCM application to assign remote workstation access to Directors. Remote sessions can be allowed for anyone on a customer intranet, disallowed completely, or restricted to specific workstations. Remote users must log into the SDCM application with a user name and password, just as when logging in to the local SDCM server. Passwords are encrypted when sent across the network. By entering workstation IP addresses at the SDCM application, administrators can allow access from all user workstations or only from specific workstations.

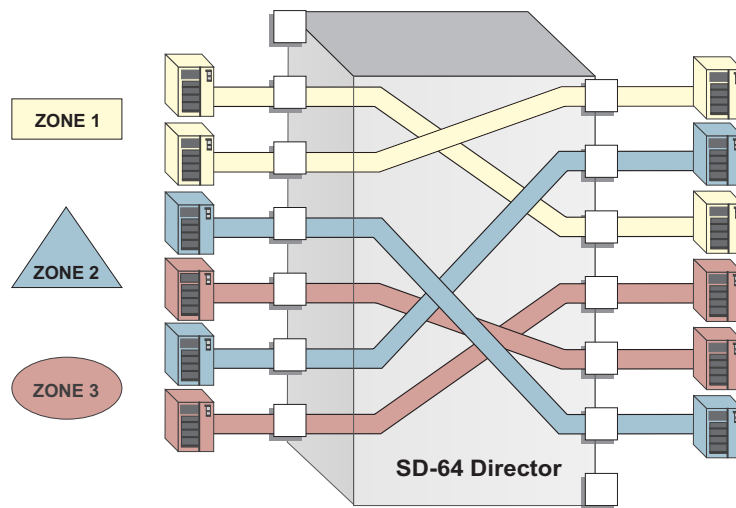
Table 4-1: Types of User Rights

User Right	Operator Access Allowed
View Only	The user may view Director configurations and status, but may not make changes. These rights are the default if no other user rights are assigned.
Operator	The operator may view status and configuration information in the Product Manager application and perform operational control changes such as blocking ports and placing the Director online or offline.
Product Administrator	The product administrator can make all control and configuration changes through the Product Manager application.
System Administrator	The system administrator can make all control and configuration changes, define users and passwords, and add or remove Directors (or other Compaq managed products) through the SDCM application.
Maintenance	The maintenance operator can perform all Director control and configuration changes through the Product Manager application, and perform diagnostics, log maintenance, firmware loads, and data collection.

For access through the web server interface, the system administrator provides IP addresses of Directors to authorized users, assigns access usernames, and controls associated passwords.

Name Server Zoning

The Director supports a name server zoning feature that partitions attached devices into restricted-access groups called zones. Devices in the same zone can recognize and communicate with each other through switched port-to-port connections. Devices in separate zones cannot recognize name server information or communicate with each other. [Figure 4-4 on page 4-17](#) illustrates three zones (with four devices per zone).



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Figure 4-4: Director Zoning

Benefits of Zoning

System administrators create zones to increase network security measures, differentiate between operating systems, and prevent data loss or corruption by controlling access between devices (such as servers and data storage units), or between separate user groups (such as engineering or human resources). Zoning allows an administrator to establish:

- Logical subsets of closed user groups. Administrators can authorize access rights to specific zones for specific user groups, thereby protecting confidential data from unauthorized access.
- Barriers between devices that use different operating systems. For example, it is often critical to separate servers and storage devices with different operating systems because accidental transfer of information from one to another can delete or corrupt data. Zoning prevents this by grouping devices that use the same operating systems into zones.
- Groups of devices that are separate from devices in the rest of a fabric. Zoning allows certain processes (such as maintenance or testing) to be performed on devices in one group without interrupting devices in other groups.
- Temporary access between devices for specific purposes. Administrators can remove zoning restrictions temporarily (for example, to perform nightly data backup), then restore zoning restrictions to perform normal processes.

Configuring Zones

Zoning is configured through the Fabric Manager application by authorizing or restricting access to name server information associated with device node ports (N_Ports) that attach to Director fabric ports (F_Ports). A device N_Port can belong to multiple zones. Zoning is configured by:

- The eight-byte (16-digit) world wide name (WWN) assigned to the HBA or Fibre Channel interface installed in the device connected to the Director (recommended method).



CAUTION: If zoning is implemented by WWN, removal and replacement of a device HBA or Fibre Channel interface (thereby changing the device WWN) disrupts zone operation and may incorrectly include or exclude a device from a zone.

- The domain identification (ID) and physical port number of the Director port to which the device is attached.



CAUTION: If zoning is implemented by port number, a change to the Director fiber-optic cable configuration disrupts zone operation and may incorrectly include or exclude a device from a zone.

A zone contains a set of attached devices that can access each other. Zones are grouped into zone sets. A zone set is a group of zones that is enabled (activated) or disabled across all Directors in a multi-switch fabric. Only one zone set can be enabled at one time. Zone members are defined and zones or zone sets are created using the SDCM application. The Director supports the following zoning features:

- **Zone members** - The maximum number of members configurable for a zone is 4,096.
- **Number of zones** - The maximum number of configurable zones in a zone set is 1,023 (1,024 including the default zone).
- **Number of zone sets** - The maximum number of configurable zones sets is 64.
- **Active zone set** - The zone set that is active across all Directors in a multi-switch fabric. For the active zone set:
 - When a specific zone set is activated, that zone set replaces the active zone set.
 - If the active zone set is disabled, all devices attached to the fabric become members of the default zone.
 - All devices not included as members of the active zone set are included in the default zone.

- **Default zone** - The default zone consists of all devices not configured as members of a zone contained in the active zone set. If there is no active zone set, then all devices attached to the fabric are in the default zone. For the default zone:
 - ❑ The default zone is enabled or disabled separately from the active zone set.
 - ❑ If the default zone is disabled and there is no active zone set, then the zoning feature is completely disabled for the fabric and no devices can communicate with each other.
 - ❑ All devices are considered to be in the default zone if there is no active zone set.
- **RSCN service requests** - Registered state change notification (RSCN) service requests are transmitted to all N_Ports attached to the Director when the zoning configuration is changed.
- **Broadcast frames** - Class 3 broadcast frames are transmitted to all N_Ports attached to the Director, regardless of zone membership.

Joining Zoned Fabrics

Directors are linked through ISLs to form multi-switch fabrics. In a multi-switch fabric, the active zoning configuration applies to the entire fabric. Any change to the configuration applies to all Directors in the fabric.

When fabrics attempt to join, participating Directors exchange active zone configurations and determine if their configurations are compatible. If the configurations are compatible, the fabrics join. The resulting configuration is a single zone set containing zone definitions from each fabric. If the configurations cannot merge, E_Ports that form the ISL for each Director become segmented. The ports cannot transmit data frames between attached switches (class 2 or 3 traffic), but can transmit control frames (class F traffic).

Zoning configurations are compatible if there are no duplicate domain IDs, the active zone set name is the same for each fabric (or switch in the fabric), and zones with the same names in each fabric have identical members.

Factors to Consider When Implementing Zoning

Consider the following factors when planning to implement zoning for one or more Directors in the enterprise. In particular, consider the implications of zoning within a multi-switch fabric.

- **Reasons for zone implementation** - Determine if zoning is to be implemented for the enterprise. If so, evaluate if the purpose of zoning is to differentiate between operating systems, data sets, user groups, devices, processes, or some combination thereof. Plan the use of zone members, zones, and zone sets accordingly.
- **Zone members specified by port number or WWN** - Determine if zoning is to be implemented by port number or WWN. Because changes to port connections or fiber-optic cable configurations disrupt zone operation and may incorrectly include or exclude a device from a zone, zoning by WWN is recommended. However, if zoning is implemented by WWN, removal and replacement of a device HBA or Fibre Channel interface disrupts zone operation and may incorrectly include or exclude a device from a zone.
- **Zoning implications for a multi-switch fabric** - For a multi-switch fabric, zoning is configured on a fabric-wide basis, and any change to the zoning configuration is applied to all switches in the fabric. To ensure zoning is consistent across a fabric, there can be no duplicate domain IDs, the active zone set name must be consistent, and zones with the same name must have identical elements. Ensure these rules are enforced when planning zones and zone sets, and carefully coordinate the zoning and multi-switch fabric tasks.

Server and Storage-Level Access Control

To enhance the access barriers and network security provided by zoning through the Director, security measures for SANs should also be implemented at servers and storage devices.

Server-level access control is called persistent binding. Persistent binding uses configuration information stored on the server, and is implemented through the server's HBA driver. The process binds a server device name to a specific Fibre Channel storage volume or logical unit number (LUN), through a specific HBA and storage port WWN. For persistent binding:

- Each server HBA is explicitly bound to a storage volume or LUN, and access is explicitly authorized (access is blocked by default).
- The process is compatible with OSI standards. The following differences are transparently supported:
 - Different operating systems and applications.
 - Different storage volume managers and file systems.
 - Different fabric devices, including disk drives, tape drives, and tape libraries.

- If the server is rebooted, the server-to-storage connection is automatically re-established.
- The connection is bound to a storage port WWN. If the fiber-optic cable is disconnected from the storage port, the server-to-storage connection is automatically re-established when the port cable is reconnected. The connection is automatically re-established if the storage port is cabled through a different Director port.

Access control can also be implemented at the storage device as an addition or enhancement to redundant array of independent disks (RAID) controller software. Data access is controlled within the storage device, and server HBA access to each LUN is explicitly limited (access is blocked by default). Storage-level access control:

- Provides control at the storage port and LUN level, and does not require configuration at the server.
- Supports a heterogeneous server environment and multiple server paths to the storage device.
- Is typically proprietary and protects only a specific vendor's storage devices. Storage-level access control may not be available for many legacy devices.

Obtaining Professional Services

Planning and implementing the zoning feature is a complex and difficult task, especially for multi-switch fabrics. Compaq recommends you obtain planning assistance from our professional services organization before implementing the Director zoning feature.

Multi-Switch Fabric Support

A Fibre Channel topology that consists of one or more interconnected switch (or Director) elements is called a fabric. The Director operational software provides the ability to interconnect Directors (through E_Port connections) to form a multi-switch fabric.

Fabric elements cooperate to receive data from the N_Port of an attached device, route the data through the proper switch ports (F_Ports), and deliver the data to the N_Port of a destination device. The data transmission path through the fabric is typically determined by the fabric elements and is transparent to the user. Subject to zoning restrictions, devices attached to any of the interconnected switches can communicate with each other through the fabric.

A multi-switch fabric is typically complex and provides the facilities to maintain routing to all device N_Ports attached to the fabric, handle flow control, and satisfy the requirements of the classes of Fibre Channel service that are supported. Figure 4-5 illustrates a multi-switch fabric supported by three Directors.

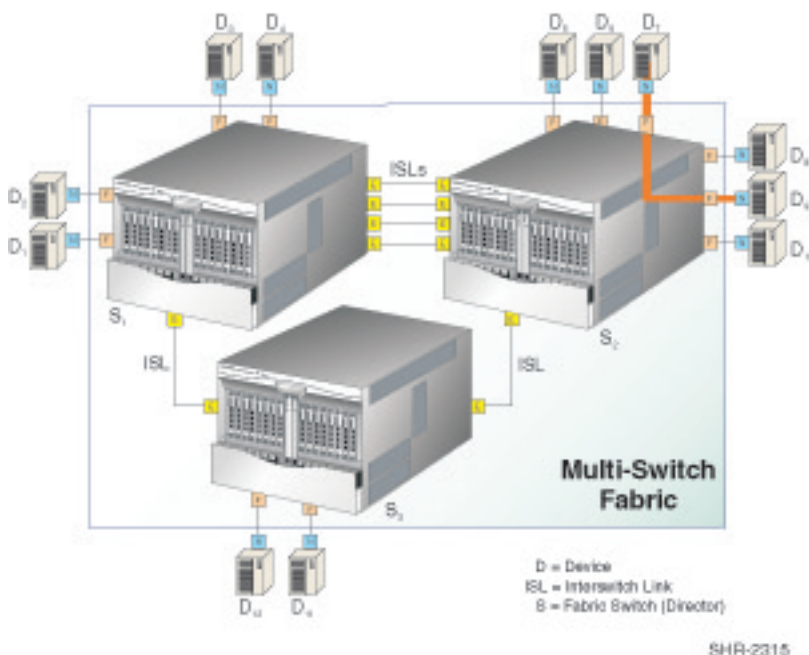


Figure 4-5: Example Multi-Switch Fabric

Fabric Topology Limits

Operation of multiple Directors in a fabric topology is subject to the following topology limits. Consider the impact of these limits when planning the fabric.

- **Fabric elements** - Each fabric element is defined by a unique domain identification (domain ID) that ranges between 1 and 31. A domain ID of 0 is invalid; therefore, the theoretical limit of interconnected Directors in a single fabric is 31. The supported limit of interconnected Directors in a single fabric is four. Because this number is subject to change, contact your Compaq marketing representative for the current number of interconnected Directors supported in a single fabric.
- **Open (heterogeneous) fabric** - To determine if interoperability is supported for a product, or if communication restrictions apply, refer to the supporting publications for the product or contact your Compaq marketing representative.

- **Number of ISLs** - The theoretical limit of ISLs per Director is 64. The maximum supported number of ISLs per Director is 32 (half the Director ports). For redundancy, at least two ISLs should connect any two Director-class fabric elements. Because this number is subject to change, contact your Compaq marketing representative for the current number of supported ISLs per Director.
- **Hop count** - The Fibre Channel theoretical limit of ISL connections traversed (hop count) in a single path through a fabric is seven. The maximum supported hop count in a single path through a fabric is three. Because this number is subject to change, contact your Compaq marketing representative for the current hop count supported by a single fabric path.

NOTE: The hop count is equal to the number of ISL connections traversed in a single path, not the total number of ISL connections between devices. As shown in [Figure 4-5 on page 4-22](#), the number of ISL connections between switch **S₁** and **S₂** is four, while the number of hops is one.

Factors to Consider When Implementing a Fabric Topology

Director-based fabrics offer scalable, high-performance, and high-availability connectivity solutions for the enterprise. To enable a multi-switch fabric, Directors must be defined to the SDCM application, and must be physically cabled to form the requisite ISL connections. In addition, Compaq recommends each Director in the fabric be assigned a unique preferred domain ID. When planning to implement a fabric topology, consider the following connectivity and cabling concepts:

- **Physical characteristics and performance objectives** - Most enterprises have unique configurations determined by the characteristics of end devices, fabric elements, cost, and the installation's performance objectives (such as high data transfer rate or high availability). These factors, along with nondisruptive growth and service requirements, must be evaluated when planning an initial fabric.
- **Distance requirements** - The distance between Directors in a fabric affects the type of ISL required. Consider the following variables:
 - If the distance between two Directors is less than 300 meters, any port type (shortwave or longwave laser) and any fiber-optic cable type (multi-mode or single-mode) can be used to create an ISL connection. In this case, cost or FPM card availability may be the determining factor.
 - If the distance between two Directors exceeds 500 meters, only longwave laser ports and single-mode fiber-optic cable can be used to create an ISL connection.

- ❑ Distance limitations can be increased and port type restrictions eliminated by using multiple Directors. Each Director retransmits received signals, thus performing a repeater function. However, cost may be a determining factor.

NOTE: Variables that can affect distance requirements include the number of connections, grade of fiber-optic cable, device restrictions, application restrictions, buffer-to-buffer credit limits, and performance requirements.

- **Bandwidth** - Use ISL connections to increase the total bandwidth available for data transfer between two Directors in a fabric. Increasing the number of ISLs between switches increases the corresponding total ISL bandwidth, but decreases the number of port connections available to devices. [Table 4-2](#) illustrates ISL transfer rate versus port availability for a two-switch fabric.

Table 4-2: ISL Transfer Rate Versus Fabric Port Availability (Two-Director Fabric)

Number of ISLs	ISL Data Transfer Rate	Available Fabric Ports
1	1.0625 Gbps	126
2	2.1250 Gbps	124
3	3.1875 Gbps	122
4	4.2500 Gbps	120
5	5.3125 Gbps	118
6	6.3750 Gbps	116
7	7.4375 Gbps	114
8	8.5000 Gbps	112

- **Load balancing** - Planning consideration must be given to the amount of data traffic expected through the fabric. Because the fabric automatically determines and uses the least cost (shortest) data transfer path between source and destination ports, some ISL connections may provide insufficient bandwidth while the bandwidth of other connections is unused.

Fibre Channel frames are routed through fabric paths that implement the minimum possible hop count. For example, in [Figure 4-5 on page 4-22](#), all traffic between devices connected to Director **S₁** and Director **S₂** communicate directly through ISLs that connect the Directors (one hop). No traffic is routed through Director **S₃** (two hops). If heavy traffic between the devices is expected, multiple ISL connections should be configured to create multiple minimum-hop paths. With multiple paths, the Directors balance the load by assigning traffic from different ports to different minimum-hop paths (ISLs).

When balancing a load across multiple ISLs, the Director attempts to avoid assigning multiple ports attached to a device to the same ISL. This minimizes the probability that failure of a single ISL will affect all paths to the device. Because port assignments are made incrementally as devices log into the fabric and ISLs become available, optimal results are not guaranteed.

Special consideration must also be given to devices that participate in frequent or critical data transfer operations. For example, in [Figure 4-5 on page 4-22](#), suppose device **D₇** is a server and device **D₉** is a storage unit and both devices participate in a critical nightly backup operation. Compaq recommends such a connection be routed directly through Director **S₂** (rather than the entire fabric) through zoned port connections.

- **Zoning** - For multi-switch fabrics, zoning is configured on a fabric-wide basis. Changes to the zoning configuration apply to all Directors in the fabric. To ensure the zoning configuration is maintained, be aware that certain rules are enforced when two or more Directors are connected through ISLs to form a fabric, or when two or more fabrics are joined.

After Directors are defined and physically cabled, they automatically join to form a single fabric through a user-transparent process. The user should be aware of the following fabric concepts, configuration characteristics, and operational characteristics:

- **Principal switch selection** - Every multi-switch fabric contains one principal switch. A principal switch is selected when Directors interconnect to form a fabric or when the existing principal switch is removed from the fabric. Setting this value determines the principal switch for the multiswitch fabric. Select either *Principal* (highest priority), *Default*, or *Never Principal* (lowest priority) from the *Switch Priority* drop-down list.

If all switches are set to *Principal* or *Default*, the switch with the highest priority and the lowest WWN becomes the principal switch

Note that at least one switch in a multiswitch fabric needs to be set as *Principal* or *Default*. If all of the switches are set to *Never Principal*, all of the interswitch links (ISLs) will segment. If all but one switch is set to *Never Principal* and the switch that was *Principal* goes offline, then all of the other ISLs will segment.

In the audit log you may notice that the *Principal* setting maps to a number code of 1, *Default* maps to a number code of 254, and *Never Principal* maps to a number code of 255. The number codes 2-253 are no longer in use.

- **Fabric WWN assignment** - The Fabric Manager application identifies fabrics using a fabric WWN. The fabric WWN is the same as the WWN of the fabric's principal switch. If a new principal switch is selected because of a change to the fabric topology, the fabric WWN changes to the WWN of the newly selected principal switch.

- **Domain ID assignment** - Each Director in a multi-switch fabric is identified by a unique domain ID that ranges between 1 and 31. A domain ID of 0 is invalid. Domain IDs are used in 24-bit Fibre Channel addresses that uniquely identify source and destination ports in a fabric.

Each Director is configured through the Product Manager application with a preferred domain ID. When a Director powers on and comes online, it requests a domain ID from the fabric's principal switch (indicating its preferred value as part of the request). If the requested domain ID is not allocated to the fabric, the domain ID is assigned to the requesting Director. If the requested domain ID is already allocated, an unused domain ID is assigned.

If two operational fabrics join, they determine if any domain ID conflicts exist between the fabrics. If one or more conflicts exist, the interconnecting ISL E_Ports segment to prevent the fabrics from joining. To prevent this problem, Compaq recommends all Directors be assigned a unique preferred domain ID. This is particularly important if zoning is implemented through port number (and by default domain ID) rather than WWN.

- **Path selection** - Directors are not manually configured with data transmission paths to each other. Participating Directors automatically exchange information to determine the fabric topology and resulting minimum-hop data transfer paths through the fabric. These paths route Fibre Channel frames between devices attached to the fabric, and enable operation of the fabric services firmware on each Director.

Paths are determined when the fabric topology is determined, and remain static as long as the fabric does not change. If the fabric topology changes (Directors are added or removed or ISLs are added or removed), Directors detect the change and define new data transfer paths as required. The algorithm that determines data transfer paths is distributive and does not rely on the principal switch to operate. Each Director calculates its own optimal paths in relation to other Directors.

Only minimum-hop data transfer paths route frames between devices. If an ISL in a minimum-hop path fails, Directors calculate a new least-cost path (which may include more hops) and route Fibre Channel frames over that new path. Conversely, if the failed ISL is restored, Directors detect the original minimum-hop path and route Fibre Channel frames over that path.

When multiple minimum-hop paths (ISLs) between Directors are detected, the switch firmware balances the data transfer load and assigns ISL as follows:

- The Director assigns an equal number of device entry ports (F_Ports) to each E_Port connected to an ISL. For example, if a Director has two ISLs and six attached devices, the load from three devices is transferred through each ISL.

- ❑ If a single device has multiple F_Port connections to a Director, the switch assigns the data transfer load across multiple ISLs to maximize device availability.

- **Frame delivery order** - When Directors calculate a new least-cost data transfer path through a fabric, routing tables immediately implement that path. This may result in Fibre Channel frames being delivered to a destination device out of order, because frames transmitted over the new (shorter) path may arrive ahead of previously-transmitted frames that traverse the old (longer) path. This can cause problems because many Fibre Channel devices cannot receive frames in the incorrect order.

A rerouting delay parameter can be enabled at the Product Manager application to ensure the Director provides correct frame order delivery. The delay period is equal to the error detect time out value (E_D_TOV) specified in the Product Manager application. Class 2 frames transmitted into the fabric during this delay period are rejected; Class 3 frames are discarded without notification. By default, the rerouting delay parameter is disabled.

NOTE: To prevent E_Port segmentation, the same E_D_TOV and resource allocation time out value (R_A_TOV) must be specified for each Director.

- **E_Port segmentation** - When an ISL activates, the two Directors exchange operating parameters to determine if they are compatible and can join to form a single fabric. If the Directors are incompatible, the connecting E_Port at each Director segments to prevent the creation of a single fabric. A segmented link transmits only Class F traffic; the link does not transmit Class 2 or Class 3 traffic. The following conditions cause E_Ports to segment:

- ❑ **Incompatible operating parameters** - Either the R_A_TOV or E_D_TOV is inconsistent between the two Directors.
- ❑ **Duplicate domain IDs** - One or more domain ID conflicts are detected.
- ❑ **Incompatible zoning configurations** - Zoning configurations for the Directors are not compatible.
- ❑ **Build fabric protocol error** - A protocol error is detected during the process of forming the fabric.
- ❑ **No principal switch** - No Director in the fabric is capable of becoming the principal switch.
- ❑ **No response from attached switch** - After a fabric is created, each Director in the fabric periodically verifies operation of all attached switches and Directors. An ISL segments if a switch or Director does not respond to a verification request.

- ❑ **ELP retransmission failure timeout** - a Director that exhibits a hardware failure or connectivity problem cannot transmit or receive Class F frames. The Director did not receive a response to multiple exchange link protocol (ELP) frames, did not receive a fabric login (FLOGI) frame, and cannot join an operational fabric.
- **Fabric services and state change notifications** - In a multi-switch fabric, Director-provided services such as name service, RSCNs, and zoning are provided on a fabric-wide basis. For example, if a fabric-attached device queries a Director name server to locate all devices that support a specified protocol, the reply includes all fabric devices that support the protocol that are in the same zone as the requesting device, not just devices attached to the Director.

RSCNs are transmitted to all registered device N_Ports attached to the fabric if either of the following conditions occur:

- ❑ A fabric-wide event occurs, such as a Director logging in to the fabric, a Director logging out of the fabric, or a reconfiguration because of a Director or ISL failure.
- ❑ A zoning configuration changes.
- **Zoning configurations for joined fabrics** - In a multi-switch fabric, zoning is configured on a fabric-wide basis, and any change to the active zone set is applied to all Directors. To ensure zoning is consistent across a fabric, the following rules are enforced when two Director fabrics (zoned or unzoned) join through an ISL:
 - ❑ **Fabric A unzoned and Fabric B unzoned** - The fabrics join successfully, and the resulting fabric remains unzoned.
 - ❑ **Fabric A zoned and Fabric B unzoned** - The fabrics join successfully, and fabric B automatically inherits the zoning configuration from fabric A.
 - ❑ **Fabric A unzoned and Fabric B zoned** - The fabrics join successfully, and fabric A automatically inherits the zoning configuration from fabric B.
 - ❑ **Fabric A zoned and Fabric B zoned** - The fabrics join successfully only if the zone sets can be merged. If the fabrics cannot join, the connecting E_Ports segment and the fabrics remain independent.

Zone sets for two Directors are compatible (the fabrics can join) only if the zone names for each Director are unique. The zone names for two Directors can be the same only if the zone member WWNs are identical for each duplicated zone name.

Obtaining Professional Services

Planning and implementing a multi-switch fabric can be a complex and difficult task. Compaq recommends you obtain planning assistance from our professional services organization before implementing a fabric topology.

Chapter 5

Configuration Planning Tasks

This chapter describes configuration planning tasks to be performed before installing one or more StorageWorks SAN Director 64s in a storage area network (SAN) configuration. A SAN configuration is created using one or more Directors, servers, and peripheral devices, and may or may not include a participation in a multi-switch fabric topology. The following planning tasks are described in the chapter:

- Task 1: Prepare Site Plan
- Task 2: Plan Fiber-Optic Cable Routing
- Task 3: Consider Interoperability with Fabric Elements and End Devices
- Task 4: Plan Console Management Support
- Task 5: Plan Ethernet Access
- Task 6: Plan Network Addresses
- Task 7: Plan SNMP Support (Optional)
- Task 8: Plan E-Mail Notification (Optional)
- Task 9: Establish Director and SDCM Server Security Measures
- Task 10: Plan Phone Connections
- Task 11: Diagram Planned Configuration
- Task 12: Assign Port Names and Nicknames
- Task 13: Complete Planning Worksheet
- Task 14: Plan AC Power
- Task 15: Plan a Multi-Switch Fabric (Optional)
- Task 16: Plan Zone Sets for Multiple Directors (Optional)

Task 1: Prepare Site Plan

For each Director, Series 9000, or M Series equipment rack installed, design a site plan that provides efficient work flow, operator convenience and safety, and adequate service clearances for the equipment rack. A customer manager should review the site plan with a service representative and consider:

- Location and relationship of the physical facilities such as walls, doors, windows, partitions, furniture, and telephones.
- Proximity of the Director to servers and storage peripherals, and if a multi-switch fabric is to be enabled, proximity of participating Directors to each other.
- Location of at least one analog phone line to aid in installation and serviceability.
- Availability of Ethernet local area network (LAN) connections and cabling to support remote user workstation and simple network management protocol (SNMP) management station access. Remote user and SNMP workstations are optional.
- Equipment rack locations, Ethernet cabling, and the internet protocol (IP) addressing scheme to support optional rack interconnection and SANworks Director Connectivity Manager (SDCM) server consolidation.
- Power requirements, including an optional uninterruptable power supply (UPS).
- Lengths of power cables and location of electrical outlets (for the Director and SDCM server) having the proper phase, voltage, amperage, and ground connection.



WARNING: An insulated grounding conductor identical in size, insulating material, and thickness to the grounded and ungrounded branch-circuit supply conductors (except it is green with or without one or more yellow stripes) shall be installed as part of the branch circuit supplying the Director. The grounding conductor described shall be connected to ground at the Director, or if supplied by a separately derived system, at the supply transformer or motor generator. The plug receptacles near the Director shall all be a grounding type, and grounding conductors serving these receptacles shall be connected to ground at the Director.

- Security necessary to protect the installation's physical integrity, while maintaining accessibility to the Director.
- Equipment rack front and rear service clearances, operator clearances, and maintenance access clearances.
- Weight of an equipment rack and Directors. Either multiple persons or a lift must be available during installation to remove the rack from the packing crate.
- Heat dissipation, temperature and humidity requirements.

Complete the planning checklists under this task. The checklists provide detailed planning activities and provide space for a planned completion date for each activity. The customer’s management information system (MIS) project manager should examine the checklists and determine the personnel and resources required for completing planning and installation tasks. Customer personnel might be used from the following functional areas:

- Systems programming personnel to update input/output (I/O) definitions to identify Directors.
- Ethernet management personnel to obtain IP addresses, gateway addresses, and subnet masks for Directors and the SDCM server, and a domain name system (DNS) host name for the SDCM server.
- Facilities planning personnel to outline the facility floor plan and to arrange for electrical wiring, receptacles and telephone lines.
- Installation planning personnel to determine fiber-optic and Ethernet cabling requirements, routing requirements, and to plan connectivity between each Director and attached devices.
- Trainers to determine training and education needs for operations, administration, and maintenance personnel.
- Administrators to determine Director port names and world wide name (WWN) nicknames, identify attached devices, and assign password levels and user names for Director access.

Table 5-1 lists physical planning and hardware installation tasks, and includes the task owner, due date, and comments.

Activity	Task Owner	Due Date	Comments
Locate the physical facilities.			
Connect the facility alternating current (AC) power circuits.			If more than one Director, consider separate power circuits for availability.
Obtain an uninterruptable power supply (optional).			Recommended.
Obtain an outside-access phone line.			Telephone for support personnel.
Order the equipment rack with one or more Directors.			

Table 5-1: Physical Planning and Hardware Installation Tasks (Continued)

Activity	Task Owner	Due Date	Comments
Order Fibre Channel devices and peripherals.			
Install Fibre Channel devices and peripherals.			
Route fiber-optic jumper cables.			
Determine proximity of the equipment rack (with Directors) to attached devices (multimode shortwave laser or singlemode longwave laser).			500 meters for 50/125 mm multimode cable. 300 meters for 62.5/125 mm multimode cable. 20 kilometers for 9/125 mm singlemode cable.
Order and deliver fiber-optic cables.			Cables are purchased by the customer separately. Plan to have them arrive and laid out before equipment rack delivery.
Set up local area network (LAN) connections for SDCM server and Directors.			
Set up LAN connections for remote workstation access (optional).			

Table 5-2 lists operational setup tasks and includes the task owner, due date, and comments.

Table 5-2: Operational Setup Tasks			
Activity	Task Owner	Due Date	Comments
Obtain IP address and subnet mask.			SDCM Server (if installing on a LAN with non-Director devices). Director (if installing on a LAN with non-Director devices). Remote user workstation (optional). SNMP management stations (optional).
Obtain gateway addresses for router or other gateway devices on company LAN.			To configure on SDCM server and Directors (if installing on a LAN with non-Director devices).
Assign host names.			SDCM server and Directors (optional).
Add host name to DNS database.			SDCM server and Directors.
Determine what level of user rights are to be used for up to 16 users.			
Determine if the call-home feature is to be used.			
Determine if the e-mail notification feature is to be used.			Obtain e-mail addresses for event notification and identify e-mail server.

Table 5-2: Operational Setup Tasks (Continued)

Activity	Task Owner	Due Date	Comments
Determine SNMP access to Directors.			Obtain SNMP trap recipient IP addresses. Determine SNMP information required (generic and Director-specific). Determine if write permission is required for modifying SNMP variables.
Determine if a multi-switch fabric is to be implemented.			
Determine if the zone management feature is to be used.			
Introduce staff to SDCM application.			
Introduce staff to SD-64 Product Manager and Fabric Manager applications.			
Introduce staff to remote session parameters.			
Introduce staff to Director recovery concepts and messages.			
Assign port names.			
Configure extended distance (10 to 100 km) ports.			
Configure link incident alerts.			
Configure Ethernet events.			

Task 2: Plan Fiber-Optic Cable Routing

Plan for sufficient singlemode and multimode fiber-optic cabling to meet the connectivity requirements for Director-attached servers and devices. If a multi-switch fabric is to be enabled, plan for sufficient cabling to meet interswitch link (ISL) connectivity requirements.

Plan for at least one meter (39.37 inches) of fiber-optic cable inside the equipment rack for routing through Director cable management assemblies and for rerouting cables to fiber port module (FPM) cards as required. Plan for an additional 1.5 meters (59.05 inches) of cable outside the rack to provide slack for service clearance, limited rack movement, and inadvertent cable pulls.



CAUTION: The Director's non-open fiber control (non-OFC) laser transceivers are designed and certified for use only with fiber-optic cable and connectors with characteristics specified by Compaq. Use of other connectors or optical fiber can result in emission of laser power levels capable of producing injury to the eye if viewed directly. Use of non-specified connectors or optical fiber can violate the Class 1 laser classification.

In addition, consider the following when planning cable routing:

- The need for additional fiber-optic cables could grow rapidly. Consider installing cable with extra fibers, especially in hard to reach places like underground trenches. Consider locating the equipment rack near a fiber-optic patch panel.
- Follow proper procedures when moving an installed equipment rack to prevent cable or connector damage.

Task 3: Consider Interoperability with Fabric Elements and End Devices

Compaq conducts a substantial level of testing to ensure Director interoperability with fabric elements and end devices provided by multiple original equipment manufacturers (OEMs). New devices are tested and qualified on a continual basis. Contact your Compaq representative for the latest information about fabric element, server, host bus adapter (HBA), and device interoperability.

Task 4: Plan Console Management Support

Plan to implement one or more of the following methods to provide console management and support for the Director:

- **SDCM server** - The rack-mounted SDCM server is used for Director installation, initial software configuration, changing the configuration, and monitoring Director operation.
 - ❑ When the SDCM, SD-64 Product Manager, and Fabric Manager applications are installed on the SDCM server, the server is used as a local user workstation.
 - ❑ The SDCM server can support up to 48 Directors or other managed Compaq products.
 - ❑ Managed Directors can be powered off and on without the SDCM server.
 - ❑ An SDCM server failure does not cause an operating Director to fail.
 - ❑ The SDCM server is fully operational, even if there is no user logged in to the Windows NT operating system. The SDCM server allows remote users to log in, and continues to monitor Directors in the background.
- **Remote user workstations** - If remote access to the SDCM server is required, plan to install user workstations with the SDCM, SD-64 Product Manager, and Fabric Manager applications configured. Administrators can use these remote workstations to configure and monitor Directors. Up to five SDCM application sessions can be simultaneously active (one local from the SDCM server and four remote). Sessions from remote user workstations are disabled if the SDCM server is powered off.
- **Web server interface** - If Internet access to the Director's embedded web server interface is required, plan for an Ethernet cable to connect to the Ethernet LAN. The SDCM server does not provide Internet access to the web server interface.

Task 5: Plan Ethernet Access

Directors and the SDCM server can be ordered in a Compaq-supplied Series 9000 or M Series equipment rack in accordance with customer specifications; however, this task is required to:

- **Connect equipment racks** - Customer-supplied Ethernet hubs in multiple equipment racks can be connected to provide SDCM server access to up to 48 Directors or managed Compaq products. Racks can be placed at any distance up to the limit of the 10/100 megabit per second (Mbps) LAN segment.

- **Consolidate SDCM server operation** - If SDCM server operation is to be consolidated to one primary server and one or more backup servers, plan for Ethernet cabling to interconnect equipment racks. Ensure all Directors and server platforms have unique IP addresses.
- **Install equipment racks on a public LAN** - If a public LAN segment is to be used, determine from the customer's network administrator how to integrate the Directors and SDCM server. Ensure all access, security, and IP addressing issues are resolved.
 - NOTE:** Compaq recommends Directors and the SDCM server be installed in a secure physical network domain to optimize security and avoid traffic problems.
- **Install remote user workstations** - Plan for access to the LAN segment containing the SDCM server if remote user workstations are required.

Task 6: Plan Network Addresses

Depending on the configuration of the LAN on which Directors and the SDCM server are installed, plan network addressing as follows:

- If installing Directors and the SDCM server on a dedicated (private) LAN segment, there is no requirement to change any default network addresses. If multiple equipment racks are connected, ensure all Directors and servers have unique IP addresses. If new IP addresses are required, consult with the customer's network administrator.
- If installing Directors and the SDCM server on a public LAN containing other devices, default network addresses may require change to avoid address conflicts with existing devices.

For the Director, change the IP address, gateway address, and subnet mask through a remote terminal connected to the Director's maintenance port.

For the SDCM server, change these addresses are through the TCP/IP Properties dialog box in Windows NT. In addition, assign and record a unique DNS host name for the SDCM server and each Director.

- Gateway addresses may need to be configured for Directors and the SDCM server if these devices connect to the LAN through a router or other gateway device.

The Ethernet connections for Directors and the SDCM server have the following network addresses:

- **Director:**
 - Media access control (MAC) address is unique for each Director. The MAC address is in **xx.xx.xx.xx.xx.xx** format, where each **xx** is a hexadecimal pair.

- Factory preset and default IP address is **10.1.1.10**.

If the Reset Configuration option is selected from the SD-64 Product Manager application, the Director resets to this address.

- Subnet mask is **255.0.0.0**.
- Gateway address is **0.0.0.0**.

■ **SDCM server:**

- MAC address is unique. The MAC address is in **xx.xx.xx.xx.xx.xx** format, where each **xx** is a hexadecimal pair.
- IP address of the Ethernet adapter is **10.1.1.1**.
- Subnet mask is **255.0.0.0**.
- Gateway address is blank.

Task 7: Plan SNMP Support (Optional)

As an option, network administrators can use the SDCM application to configure an SNMP agent that runs on the SDCM server. This agent can be configured to send generic SNMP trap messages to up to 12 recipients (SNMP management workstations).

Administrators can also use the SD-64 Product Manager application to configure an SNMP agent that runs on each Director. This agent can be configured to send generic SNMP trap messages to up to six recipients (SNMP management workstations).

Trap recipients can also access SNMP management information, and may be granted permission to modify SNMP variables as follows:

- Assign and record Director names, contact persons, descriptions, and locations to configure the Directors for SNMP management station access.
- Plan access to the Director LAN segment. This segment must connect to the LAN on which SNMP management workstations are installed.
- Obtain IP addresses and SNMP community names for management workstations that have access to Directors.

- Determine which (if any) management workstations can have write permission for SNMP variables.
- Obtain Director-specific trap information from Compaq to load onto SNMP management workstations.

For additional information on SNMP, refer to the *StorageWorks by Compaq SAN Director SNMP Guide* (AA-RQ7BA-TE).

Task 8: Plan E-Mail Notification (Optional)

As an option, network administrators can configure Director e-mail support. The following support considerations are required if the e-mail notification feature is used:

- Determine if e-mail notification is to be configured and used for significant system events.
- Determine which persons (up to five) require e-mail notification of significant Director events and record their e-mail addresses.
- Identify an attached e-mail server that supports the simple mail transfer protocol (SMTP) standard as defined in RFC 821.

Task 9: Establish Director and SDCM Server Security Measures

Effective network security measures are recommended for Directors and the SDCM server. Physical access to the network should be limited and monitored, and password control should be strictly enforced. When planning security measures, consider the following:

- Directors and the SDCM server are installed on a LAN segment and can be accessed by attached devices (including devices connected through a remote LAN). Access from remote devices is limited by installing the SDCM server and managed Directors in a secure physical network domain. Compaq recommends this approach.
- Access to the Director is possible through the maintenance port. This connection is for use by authorized service personnel only and should be carefully monitored.
- The number of remote workstations with access to the SDCM server and managed Directors can and should be restricted. Obtain IP addresses for workstations that should have exclusive access. Ensure adequate security measures are established for the configured workstations.

- Carefully manage users (up to 16) who have access to the SDCM, SD-64 Product Manager, and Fabric Manager applications, and assign user names, passwords, and user rights.
- Ensure adequate security controls are established for remote access software, including the embedded web server.

Task 10: Plan Phone Connections

Plan for one or more telephone connections near the SDCM server for service personnel use. While performing a diagnostic or repair action, a service representative or network administrator at the SDCM server may require voice technical support through a telephone connection.

Task 11: Diagram Planned Configuration

Determine peripheral devices that will connect to each Director, and if and where connectivity should be limited (zoning). These devices may include servers, storage control devices, and other Directors in a multi-switch fabric.

Part of this task may have been performed when the configuration was determined. Draw the configuration diagram, indicating distances if necessary. Transfer information from the configuration diagram to the Director planning worksheet as part of [Task 13: Complete Planning Worksheet on page 5-13](#).

Task 12: Assign Port Names and Nicknames

During the planning process, consider assigning names to Director ports based upon devices connected to the ports. Though not required, port naming provides convenience and ease of use. Port naming also documents devices that connect through individual ports, and identifies what is attached to each port. When it is necessary to change port connectivity, port names make it easier to identify the ports and attached end devices.

Also consider assigning nicknames to device and fabric WWNs. Though not required, nicknaming provides a useful substitute for the cryptic eight-byte WWN. Once a nickname is assigned, it is referenced throughout the SDCM application.

Transfer port names and nicknames to the Director planning worksheet as part of [Task 13: Complete Planning Worksheet on page 5-13](#).

Rules for Port Names

Port names can be up to 24 alphanumeric characters in length. Spaces, hyphens (-), and underscores (_) are allowed within the name. Each port name must be unique for a Director; however, the same port name can be used on separate Directors. Compaq recommends unique port names be used, particularly within a complex multi-switch fabric. Example port names include:

Lab server

Test system-2

Printer_001

Rules for Nicknames

Nicknames can be up to 32 alphanumeric characters in length. Spaces, hyphens (-), and underscores (_) are allowed within the name. Each nickname must be unique (corresponding to a unique WWN). Example nicknames include:

Fabric-1

Host system

DASD_001

Task 13: Complete Planning Worksheet

The planning worksheet included in this task is a four-page form that depicts Director port assignments. The worksheet lists each of the 64 Director ports, and provides fields to identify devices that connect to the ports. Transfer information from the configuration diagram (completed while performing [Task 11: Diagram Planned Configuration on page 5-12](#)) to the worksheet, and transfer port names and nicknames (assigned while performing [Task 12: Assign Port Names and Nicknames on page 5-12](#)). In addition, indicate all unused ports. Retain the planning worksheet as part of a permanent record.

Table 5-3: Director Planning Worksheet (Page 1 of 4)

StorageWorks SAN Director 64 Name: _____ Address: _____ Unit Name: _____			Attached Devices			
Port	Port Name	Location	Type	Model	Address	Zone
00						
01						
02						
03						
04						
05						
06						
07						
08						
09						
10						
11						
12						
13						
14						
15						

Table 5-4: Director Planning Worksheet (Page 2 of 4)

StorageWorks SAN Director 64 Name: _____ Address: _____ Unit Name: _____			Attached Devices			
Port	Port Name	Location	Type	Model	Address	Zone
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						

Table 5-5: Director Planning Worksheet (Page 3 of 4)

StorageWorks SAN Director 64 Name: _____ Address: _____ Unit Name: _____			Attached Devices			
Port	Port Name	Location	Type	Model	Address	Zone
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						

Table 5-6: Director Planning Worksheet (Page 4 of 4)

StorageWorks SAN Director 64 Name: _____ Address: _____ Unit Name: _____			Attached Devices			
Port	Port Name	Location	Type	Model	Address	Zone
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						

Task 14: Plan AC Power

Plan for facility power sources for each equipment rack. Directors in the rack operate at 50 to 60 Hertz (Hz) and 100 to 240 volts alternating current (VAC), and require a minimum dedicated 5-ampere service. If two power sources are supplied (optional but recommended for high availability), the equipment rack contains two customer-specified power distribution units (PDUs). Each PDU should be connected to a separate power circuit, or both should be connected to a UPS. Several types of power cables and plugs are available to meet local electrical requirements.



WARNING: An insulated grounding conductor identical in size, insulating material, and thickness to the grounded and ungrounded branch-circuit supply conductors (except it is green with or without one or more yellow stripes) shall be installed as part of the branch circuit supplying the Director. The grounding conductor described shall be connected to ground at the Director, or if supplied by a separately derived system, at the supply transformer or motor generator. The plug receptacles near the Director shall all be a grounding type, and grounding conductors serving these receptacles shall be connected to ground at the Director.

Keep all power cables out of high-traffic areas for safety and to avoid power interruption caused by accidentally unplugging the Director.

Task 15: Plan a Multi-Switch Fabric (Optional)

If a multi-switch fabric topology is to be implemented, carefully plan the physical characteristics and performance objectives of the topology. Include the proposed number of Directors (or other elements) in the fabric, characteristics of attached devices, cost, nondisruptive growth requirements, and service requirements.

When two or more Directors are connected through ISLs to form a fabric, the Directors must have compatible operating parameters, compatible name server zoning configurations, and unique domain identifications (IDs). Planning for a fabric must be carefully coordinated with planning for zoned configurations. Consider the following factors when planning for a multi-switch fabric:

- **Fabric topology limits** - Consider the following topology limitations:
 - The practical number of Director fabric elements. The theoretical maximum is 31, the practical limit is eight.

- ❑ The number of ISLs per element. The maximum is equal to half the Director port count, or 32.
- ❑ The hop count. The tested limit is three, the theoretical limit is seven.
- ❑ Distance limitations (limited by port type and cable availability).
- **Bandwidth** - Consider using multiple ISLs to increase the total bandwidth available between two Directors.
- **Load balancing** - If heavy traffic between devices is expected, consider installing multiple ISLs to create multiple minimum-hop paths for load balancing
- **Principal switch selection** - If required, plan which Director is to be assigned principal switch duties for the fabric.
- **Critical operations** - Consider routing paths that transfer data for critical operations directly through one Director and not a fabric.

Planning and implementing a multi-switch fabric is a complex and difficult task. Compaq recommends you obtain planning assistance from our professional services organization before implementing a fabric topology.

Task 16: Plan Zone Sets for Multiple Directors (Optional)

If name server zoning is to be implemented, carefully plan the characteristics and security objectives (differentiation of operating systems, data sets user groups, devices, or processes) of zone members, zones, and zone sets.

If a fabric topology is implemented, zoning is configured on a fabric-wide basis. Planning for zoned configurations must be carefully coordinated with planning a fabric topology. Consider the following factors when planning to implement name server zoning:

- **Zone and zone set naming conventions** - The Director conforms to the open fabric naming convention by using the following zone and zone set naming rules:
 - ❑ Zone and zone set names can be up to 64 characters in length.
 - ❑ The first character of the name must be an upper case alpha character (A through Z) or lower case alpha character (a through z).
 - ❑ Characters other than the first character can be upper or lower case alphanumeric characters (A through Z, a through z, or 0 through 9), a dollar sign (\$), hyphen (-), caret (^), or underscore (_).

- **Zone members specified by port number or WWN** - Consider if zoning is to be implemented by port number or WWN. Because changes to a port connections or fiber-optic cable configurations may disrupt zone operation, zoning by WWN is recommended.
- **Zoning implications for a multi-switch fabric** - To ensure zoning is consistent across a multi-switch fabric, Directors must have compatible operating parameters and unique domain IDs, the active zone set name must be consistent, and zones with the same name must have identical elements.
- **Server and storage device access control** - In addition to zoning, consider implementing server-level access control (persistent binding) and storage-level access control.

Planning and implementing zones and zone sets is a complex and difficult task, especially for multi-switch fabrics. Compaq recommends you obtain planning assistance from our professional services organization before implementing the Director's zoning feature.

Glossary

This glossary defines terms used in this guide or related to this product and is not a comprehensive glossary of computer terms.

A

access control

Method of control (with associated permissions) by which a set of devices can access other devices across a network. *See also* persistent binding and zoning.

active FRU

A redundant field-replaceable unit that is currently operating as the active and not the backup FRU. *Contrast with* backup FRU.

active zone set

Single zone set that is active in a multi-switch fabric. It is created when you enable a specified zone set. This zone set is compiled by checking for undefined zones or aliases.

agent

Software that processes queries on behalf of an application and returns replies.

alarm

Simple network management protocol (SNMP) message notifying an operator of a network or device problem.

alias server

Fabric software facility that supports multicast group management.

arbitration

Process of selecting one device from a collection of devices that request service simultaneously.

audit log

Log summarizing actions (audit trail) made by the user.

authentication

Verification of identity for a person or process.

B

backplane

The backplane provides 48 VDC power distribution and connections for all logic cards.

backup FRU

When an active FRU fails, an identical backup FRU takes over operation automatically (failover) to maintain Director and Fibre Channel link operation. *Contrast with* active FRU.

BB_Credit

See buffer-to-buffer credit.

beaconing

Use of light-emitting diodes on ports, port cards, field-replaceable units, and Directors to aid in the fault-isolation process; when enabled, active beaconing causes LEDs to flash for selected components.

BER

See bit error rate.

bidirectional

In Fibre Channel, the capability to simultaneously communicate at maximum speeds (100 Mbps) in both directions over a link.

bit error rate (BER)

Ratio of received bits that contain errors to total of all bits transmitted.

blocked port

Devices communicating with the port are prevented from logging into the Director or communicating with other devices attached to the Director. A blocked port continuously transmits the offline sequence.

bridge

Device that connects and passes packets between two network segments that use the same communications protocol.

broadcast

Send a transmission to all N_Ports on a fabric. *See also* multicast.

broadcast frames

Data packet, also known as a broadcast packet, whose destination address specifies all computers on a network.

buffer

Storage area for data in transit. Buffers compensate for differences in processing speeds between devices. *See also* buffer-to-buffer credit.

buffer-to-buffer credit (BB_Credit)

See buffer-to-buffer credit. Indicates the maximum number of frames a port can transmit without receiving a receive ready signal from the receiving device.

C

call-home

Product feature which requires installation of Compaq Proactive Service software and enables the SDCM server to automatically transmit system events (failure information) to a Compaq customer support center. The Compaq support center server accepts calls from the SDCM server, logs reported events, and can notify one or more support center representatives.

channel

Point-to-point link that transports data from one point to the other.

channel path

A single interface between a central processor and one or more control units along which signals and data can be sent to perform I/O requests.

class of Fibre Channel service

Defines the level of connection dedication, acknowledgment, and other characteristics of a connection. Class F, Class 2, and Class 3 services are supported.

Class F Fibre Channel service

Used by switches to communicate across interswitch links (ISLs) to configure, control, and coordinate a multi-switch fabric.

Class 2 Fibre Channel service

Provides a connectionless (not dedicated) service with notification of delivery or nondelivery between two N_Ports. In-order delivery of frames is not guaranteed.

Class 3 Fibre Channel service

Provides a connectionless (not dedicated) service without notification of delivery or nondelivery between two N_Ports. Also known as datagram.

community profile

Information that specifies which management objects are available to what management domain or SNMP community name.

concurrent maintenance

Ability to perform maintenance tasks, such as removal or replacement of field-replaceable units (FRUs), while normal operations continue without interruption. *See also* nondisruptive maintenance.

configuration data

Configuration data includes: identification data, port configuration data, operating parameters, SNMP configuration, and zoning configuration. A configuration backup file is required to restore configuration data if the control processor (CTP) card in a nonredundant Director is removed and replaced.

connectionless

Nondedicated link. Typically used to describe a link between nodes which allows the switch to forward Class 2 or Class 3 frames as resources (ports) allow.

connector

See optical fiber connector.

control processor (CTP) card

Circuit card that contains the Director microprocessor. The CTP card also initializes hardware components of the system after power-on. A 10 Mbps RJ-45 twisted pair connector is located on the CTP card to connect to an Ethernet LAN and communicate with the SDCM server or a specific management station.

control unit

A device that controls the reading, writing, or displaying of data at one or more input/output units.

CRC

See cyclic redundancy check.

CTP card

See control processor card.

cyclic redundancy check (CRC)

System of error checking performed at both the sending and receiving station using the value of a particular character generated by a cyclic algorithm. When the values generated at each station are identical, data integrity is confirmed.

D

DASD

Acronym for direct access storage device.

datagram

See Class 3 Fibre Channel service.

default

Pertaining to an attribute, value, or option that is assumed when none is explicitly specified.

default zone

Contains all attached devices that are not members of a separate zone.

destination identifier (D_ID)

Address identifier that indicates the targeted destination of a data frame.

device

Product (server or storage), connected to a managed Director, that is not controlled directly by the SD-64 Product Manager application. *See also* node.

diagnostics

Procedures used by computer users and service personnel to diagnose hardware or software error conditions.

dialog box

Dialog box is a window containing informational messages or data fields to be modified or filled in with desired options.

D_ID

See destination identifier.

Director

An intelligent Fibre Channel switching device providing any-to-any port connectivity between nodes (end devices) on a switched fabric. The Director sends data transmissions (data frames) between nodes in accordance with the address information present in the frame headers of those transmissions.

DNS name

Host or node name for a device or managed product that is translated to an internet protocol (IP) address through a domain name server.

domain ID

Number (1 through 31) that uniquely identifies a switch in a multi-switch fabric. A distinct domain ID is automatically allocated to each switch in the fabric by the principal switch.

domain name service (DNS)

See DNS name.

E

E_D_TOV

See error detect time-out value.

E_Port

See expansion port.

embedded web server

Administrators or operators with a browser-capable PC and Internet connection can monitor and manage a Director through an embedded web server interface. The interface provides a GUI similar to the SD-64 Product Manager application, and supports Director configuration, statistics monitoring, and basic operation.

error detect time-out value (E_D_TOV)

User-specified value that defines the time a Director waits for an expected response before declaring an error condition.

error message

Software message that indicates an error was detected. *See also* information message and warning message.

Ethernet

A widely implemented local area network (LAN) protocol that uses a bus or star topology and serves as the basis for the IEEE 802.3 standard, which specifies the physical and software layers. Baseband LAN allows multiple station access to the transmission medium at will without prior coordination and which avoids or resolves contention.

Ethernet hub

A customer-supplied device used to LAN-connect the SDCM server and managed Directors.

event code

Error code that provides the operator with information concerning events that indicate degraded operation or failure of a Director.

event log

Record of significant events that have occurred at the Director, such as FRU failures, degraded operation, and port problems.

expansion port (E_Port)

Physical interface on a Fibre Channel switch within a fabric, that attaches to an expansion port (E_Port) on another Fibre Channel switch to form a multi-switch fabric. *See also* segmented E_Port.

F

fabric

Fibre Channel entity that interconnects node ports (N_Ports_) and is capable of routing (switching) Fibre Channel frames using the destination ID information in the Fibre Channel frame header accompanying the frames.

fabric element

An active switch, Director, or node in a Fibre Channel switched fabric.

Fabric Manager application

Application that implements the management user interface for Fibre Channel fabrics. When a fabric instance is opened from the SDCM application's Fabric View, the Fabric Manager application is invoked.

fabric port (F_Port)

Physical interface on the Director that connects to an N_Port through a point-to-point full duplex connection.

failover

Automatic and nondisruptive transition of functions from an active FRU that has failed to a backup FRU.

FCC-IOC

See Fibre Channel input/output controller.

fiber

Physical media types supported by the Fibre Channel specification, such as optical fiber, copper twisted pair, and coaxial cable.

fiber optics

Branch of optical technology concerned with the transmission of light pulses through fibers made of transparent materials such as glass, fused silica, and plastic.

fiber port module (FPM) card

Each fiber port module card provides four Fibre Channel connections through duplex small form factor (SFF) pluggable fiber-optic transceivers.

Fibre Channel

Integrated set of standards recognized by the American national Standards Institute (ANSI) which defines specific protocols for flexible information transfer. Logically, a point-to-point serial data channel, structured for high performance.

Fibre Channel input/output controller (FCC-IOC)

A device that controls the embedded Fibre Channel port and configures the ports' ASICs.

field-replaceable unit (FRU)

Assembly removed and replaced in its entirety when any one of its components fails.

firmware

Embedded program code that resides and executes on the Director.

FPM card

See fiber port module card.

F_Port

See fabric port.

FRU

See field-replaceable unit.

G

gateway

A multi-homed host used to route network traffic from one network to another, and to pass network traffic from one protocol to another.

gateway address

A unique string of numbers (in the format xxx.xx.xxx.xxx) that identifies a gateway on the network.

generic port (G_Port)

Physical interface on a Director that can function either as a fabric port (F_Port) or an expansion port (E_Port) depending on the port type to which it connects.

G_Port

See generic port.

H

hardware log

Record of FRU insertions and removals for the Director.

HBA

See host bus adapter.

heterogeneous fabric

A fabric with both Compaq and non-Compaq products.

high availability

A performance feature characterized by hardware component redundancy and hot-swappability (enabling non-disruptive maintenance). High-availability systems maximize system uptime while providing superior reliability, availability, and serviceability.

hop

Data transfer from one fabric node to another node.

homogeneous fabric

A fabric consisting of only Compaq products.

hop count

The number of hops a unit of information traverses in a fabric.

host bus adapter (HBA)

Logic card that provides a link between the server and storage subsystem, and that integrates the operating systems and I/O protocols to ensure interoperability.

hot-swapping

Removing and replacing a device's components while the device continues to operate normally.

hub

In Fibre Channel, a device that connects nodes into a logical loop by using a physical star topology.

I

IML

See initial machine load.

information message

Software message that indicates to a user that a function is performing normally or has completed normally. *See also* error message and warning message.

initial machine load (IML)

Hardware reset for all installed CTP cards on the Director. It does not affect other hardware. It is initiated by pushing the white button on a Director's CTP card.

initial program load (IPL)

Process of initializing the device and causing the operating system to start. Initiated through a menu in the Product Manager, this option performs a hardware reset on the active CTP only.

interface

Hardware, software, or both, linking systems, programs, or devices.

internet protocol address

Unique string of numbers (in the format xxx.xxx.xxx.xxx) that identifies a device on a network.

interoperability

Ability to communicate, execute programs, or transfer data between various functional units over a network.

interswitch link (ISL)

Physical E_Port connection between two Directors in a fabric.

IP address

See internet protocol address.

IPL

See initial program load.

ISL

See interswitch link.

J

jumper cable

Optical cable that provides physical attachment between two devices or between a device and a distribution panel. *Contrast with* trunk cable.

L

latency

When used in reference to a Fibre Channel switching device, latency refers to the amount of time elapsed between receipt of a data transmission at a switch's incoming F_Port (from the originating node port) to retransmission of that data at the switch's outgoing F_Port (to the destination N_Port). The amount of time it takes for data transmission to pass through a switching device.

LIN

See link incident.

link

Physical connection between two devices in a switched fabric.

link incident (LIN)

Interruption to a Fibre Channel link due to loss of light or other cause.

load balancing

Ability to evenly distribute traffic over multiple interswitch links within a fabric. Load balancing on Compaq Directors takes place automatically.

logical unit number (LUN)

In Fibre Channel addressing, a logical unit number is a number assigned to a storage device which, in combination with the storage device's node port's world wide name, represents a unique identifier for a logical device on a storage area network.

loopback plug

In a fiber optic environment, a type of duplex connector used to wrap the optical output signal of a device directly to the optical input.

loopback test

Test that checks attachment or control unit circuitry, without checking the mechanism itself, by returning the output of the mechanism as input.

LUN

See logical unit number.

M

MAC address

See Media Access Control address.

maintenance port

Connector on the Director where a PC running an ASCII terminal emulator can be attached or dial-up connection made for specialized maintenance support.

managed product

Hardware product that can be managed with the SDCM application. For example, the SD-64 Director is a managed product. *See also* device.

management information base (MIB)

Related set of software objects (variables) containing information about a managed device and accessed via SNMP from a network management station.

Management Services application

Software application that provides back-end product-independent services to the SDCM application. Management Services runs only on the SDCM server, and cannot be downloaded to remote workstations.

management session

A management session exists when a user logs on to the SDCM application. The application can support multiple concurrent management sessions. The user must specify the network address of the SDCM server at logon time.

Media Access Control (MAC) address

Hardware address of a node (device) connected to a network.

MIB

See management information base.

multicast

Delivery of a single transmission to multiple destination N_Ports. Can be one to many or many to many. All members of the group are identified by one IP address. *See also* broadcast.

multi-switch fabric

Fibre Channel fabric created by linking more than one Director or switching device within a fabric.

N

name server

Program that translates names from one form into another. For example, the domain name service (DNS) translates domain names into IP addresses.

name server zoning

N_Port access management that allows N_Ports to communicate if and only if they belong to a common name server zone.

network address

Name or address that identifies a managed product on a transmission control protocol/internet protocol (TCP/IP) network. The network address can be either an IP address in dotted-decimal notation (containing four three-digit octets in the format xxx.xxx.xxx.xxx), or a domain name (as administered on a customer network).

nickname

Alternate name assigned to a world wide name for a node or Director in the fabric.

node

In Fibre Channel terminology, node refers to an end device (server or storage device) that is or can be connected to a switched fabric.

node port (N_Port)

Physical interface within an end device which can connect to an F_Port on a switched fabric or directly to another N_Port (in point-to-point communications).

nondisruptive maintenance

Ability to service FRUs (including maintenance, installation, removal and replacement) while normal operations continue without interruption. *See also* concurrent maintenance.

N_Port

See node port.

O

offline sequence (OLS)

Sequence sent by the transmitting port to indicate that it is attempting to initialize a link and has detected a problem in doing so.

OLS

See offline sequence.

optical cable

Fiber, multiple fibers, or a fiber bundle in a structure built to meet optical, mechanical, and environmental specifications. *See also* jumper cable, optical cable assembly, and trunk cable.

optical cable assembly

Optical cable that is connector-terminated. *See also* jumper cable and optical cable.

optical fiber connector

Hardware component that transfers optical power between two optical fibers or bundles and is designed to be repeatedly connected and disconnected.

out-of-band management

Transmission of management information using frequencies or channels (Ethernet) other than those routinely used for information transfer (Fibre Channel).

P

packet

Logical unit of information (usually in the form of a data frame) transmitted on a network. It contains a header (with all relevant addressing and timing information), the actual data, and a trailer (which contains the error checking function, usually in the form of a cyclic redundancy check).

password

Unique string of characters known to the computer system and to a user who must specify it to gain full or limited access to a system and to the information stored within it.

path

In a network, any route between any two ports.

persistent binding

A form of server-level access control that uses configuration information to bind a server to a specific Fibre Channel storage volume (or logical device) using a unit number.

port

Receptacle on a device to which a cable leading to another device can be attached.

port card

Field-replaceable hardware component that provides the port connections for fiber cables and performs specific device-dependent logic functions.

port card map

Map showing numbers assigned to each port card by card slot.

port name

Name that the user assigns to a particular port through the Product Manager.

POST

See power-on self test.

power-on self test (POST)

Series of self-tests executed each time the unit is booted or reset.

preferred domain ID

Domain ID that a Director or switch is assigned by the principal switch in a switched fabric. The preferred domain ID becomes the active domain ID except when configured otherwise by the user.

principal switch

The Director or switch that allocates domain IDs to itself and to all other switches in a fabric. There is always one principal switch in a fabric. If a switch is not connected to any other switches, it acts as its own principal switch.

product name

User-configurable identifier assigned to a managed product. Typically, this name is stored on the product itself. For the SD-64 Director, the product name can also be accessed by an SNMP manager as the system name.

R

R_A_TOV

See resource allocation time-out value.

redundancy

Performance characteristic of a system or product whose integral components are backed up by identical components to which operations will automatically failover in the event of a component failure. Redundancy is a vital characteristic of virtually all high-availability (24 hours per day, seven days per week) computer systems and networks.

remote access link

Connection to a device or program on a computer network via a (geographically) remote workstation.

remote notification

A process by which a system is able to inform remote users and/or workstations of certain classes of events that occur on the system. E-mail notification and the configuration of SNMP trap recipients are two examples of remote notification programs that can be implemented on Director-class switches.

remote user workstation

Workstation, such as a PC, using the SDCM and SD-64 Product Manager applications that can access the SDCM server over a LAN connection.

resource allocation time-out value (R_A_TOV)

User-specified value used to time out operations that depend on the maximum possible time that a frame could be delayed in a fabric and still be delivered.

RFI

Acronym for radio frequency interface.

S

SAN

See storage area network.

SANworks Director Connectivity Manager (SDCM) application

Application that implements the management user interface for Compaq Fibre Channel switching products, and as a launching point for the SD-64 Product Manager and Fabric Manager applications. The application runs locally on the SDCM server or on a remote workstation.

SANworks Director Connectivity Manager (SDCM) server

Notebook computer shipped with a Director to run the SDCM, SD-64 Product Manager, and Fabric Manager applications.

SBAR

See serial crossbar assembly.

SC

Acronym for subscriber connector.

SD-64 Product Manager application

Application that implements the management user interface for a specified SD-64 Director. When a product instance is opened from the SDCM application's Product View, the SD-64 Product Manager application is invoked.

SDCM application

See SANworks Director Connectivity Manager application.

SDCM server

See SANworks Director Connectivity Manager server.

segmented E_Port

E_Port that has ceased to function as an E_Port within a multi-switch fabric due to an incompatibility between the fabrics that it joins. *See also* expansion port.

SEL

Acronym for system error light.

serial crossbar (SBAR) assembly

Responsible for Fibre Channel frame transmission from any Director port to any other Director port. Connections are established without software intervention.

SFF

Acronym for small form factor (a type of Fibre Channel connector). *See also* fiber port module card.

simple Network management protocol (SNMP)

A protocol that specifies a mechanism for network management that is complete, yet simple. Information is exchanged between agents, which are the devices on the network being managed, and managers, which are the devices on the network through which the management is done.

SNMP

See simple network management protocol.

SNMP community

Also known as SNMP community string. An SNMP community is a cluster of managed products (in SNMP terminology, hosts) to which a server or managed product running the SNMP agent belongs.

SNMP community name

The name assigned to a given SNMP community. Queries from an SNMP management station to a device running an SNMP agent will only elicit a response if those queries are addressed with the correct SNMP community name.

SSP

See system services processor.

storage area network (SAN)

A high-performance data communications environment that interconnects computing and storage resources so that the resources can be effectively shared and consolidated.

subnet mask

Used by a computer to determine whether another computer with which it needs to communicate is located on a local or remote network. The network mask depends upon the class of networks to which the computer is connecting. The mask indicates which digits to look at in a longer network address and allows the router to avoid handling the entire address.

switchover

Changing a backup FRU to the active state, and the active FRU to the backup state.

switch priority

Value configured into each switch in a fabric that determines its relative likelihood of becoming the fabric's principal switch.

system services processor (SSP)

Controls the RS-232 maintenance port, the Ethernet port, and the operator panel of a Fibre Channel Director.

T

TCP/IP

See transmission control protocol/internet protocol.

topology

Logical and/or physical arrangement of stations on a network.

transmission control protocol/internet protocol (TCP/IP)

A suite of communication protocols used to connect host systems to the Internet. *See also* network address.

trap

Unsolicited notification of an event originating from an SNMP managed device and directed to an SNMP network management station.

trap host

SNMP management workstation that is configured to receive traps.

trunk cable

Cable consisting of multiple fiber pairs that do not directly attach to an active device. This cable usually exists between distribution panels. *See also* optical cable, *contrast with* jumper cable.

U

unblocked port

Devices attached to an unblocked port can login to the Director and communicate with devices attached to any other unblocked port.

unicast

Communication between a single sender and a single receiver over a network. Compare to *multicast* and *anycast* (communication between any sender and the nearest of a group of receivers).

V

vital product data (VPD)

System-level data stored by the backplane in the electrically erasable programmable read-only memory. This data includes serial numbers and identifies the manufacturer.

VPD

See vital product data.

W

warning message

Software message that indicates a possible error was detected. *See also* error message and information message.

world wide name (WWN)

Eight-byte address that uniquely identifies a switch, or a node (end device) on global networks.

WWN

See world wide name.

Z

zone

Set of devices that can access one another. All connected devices may be configured into one or more zones. Devices in the same zone can see each other. Those devices that occupy different zones cannot.

zone member

Specification of a device to be included in a zone. A zone member can be identified by the port number of the Director to which it is attached or by its world wide name. In multi-switch fabrics, identification of end-devices/nodes by world wide name is preferable.

zone set

See zone.

zoning

Grouping of several devices by function or by location. All devices connected to a connectivity product, such as the Director, may be configured into one or more zones. *See also zone.*

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