Non-EMC® SAN Products Data

Reference Manual

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Preface

This document provides data information for some vendor directors and switches, including descriptions, system architecture, and management. This document also provides installation guidelines and cabinet configuration examples.

E-Lab would like to thank all the contributors to this document, including EMC engineers, EMC field personnel, and partners. Your contributions are invaluable.

As part of an effort to improve and enhance the performance and capabilities of its product lines, EMC periodically releases revisions of its hardware and software. Therefore, some functions described in this document may not be supported by all versions of the software or hardware currently in use. For the most up-to-date information on product features, refer to your product release notes. If a product does not function properly or does not function as described in this document, please contact your EMC representative.

Audience

This material is intended for technical consultants, solutions architects, implementation specialists, end users, or anyone interested in learning more about the features of the EMC Connectrix director and switches.

Overview

Just as the primary function of a disk array is *storage capacity*, measured in gigabytes (Gb), the primary function of a Connectrix director or switch is to provide connectivity. Connectivity capacity, or bandwidth capacity, is currently measured in gigabits per second (Gb/s) or terabits per second (Tb/s) per second.

Fibre Channel directors and switches can be built with many different architectures. The bandwidth comparisons can be complicated by ASIC architectures and front-end against back-end bandwidth

characteristics. As a result of these complexities, E-Lab recommends normalizing the comparison of communication capacity between Fibre Channel Director products with a chassis-level metric of ports oversubscribed at a given line-rate. This strategy is an algebraic proxy for a gigabit per second metric, but it speaks more directly to the administrative complexities created by an oversubscribed Director.

For example, a product able to achieve no *oversubscription* when scaled to its maximum capacity will require the minimum amount of bandwidth monitoring and fewest corrective actions. A product with a high degree of oversubscription, in a response-time-sensitive environment may require a large amount of planning, monitoring, and unscheduled attention. A premium price for a product with no oversubscription may yield large administrative dividends.

The definition of oversubscription can vary by vendor. E-Lab's definition is: the ratio of bandwidth required to bandwidth available. When all ports, associated pair-wise, in any random fashion, cannot sustain full duplex at full line-rate, the switch is oversubscribed.

E-Lab's oversubscription analysis of the current Connectrix Director product set is provided in Table 1.

Table 1 Oversubscription

		Chassis			
	Measurements	**ED-10000M**	**ED-140M**	**ED-48000B**	**MDS 9513**
2 Gb/s	Maximum non-oversubscribed port count	256	140	256	264
	Maximum oversubscribed port count	N/A	N/A	N/A	528
	Oversubscription ratio at max config	N/A	N/A	N/A	2:1
4 Gb/s	Maximum non-oversubscribed port count	128	70	128	132
	Maximum oversubscribed port count	256	140	256	528
	Oversubscription ratio at max config	2:1	2:1	16:8	4:1

EMC Support Matrix and E-Lab Interoperability Navigator

For the most up-to-date information, always consult the *EMC Support Matrix* (ESM), available through E-Lab Interoperability Navigator (ELN), at: http://elabnavigator.EMC.com, under the **PDFs and Guides** tab.

The *EMC Support Matrix* links within this topology guide will take you to Powerlink where you are asked to log in to the E-Lab Interoperability Navigator. Instructions on how to best use the ELN

(tutorial, queries, wizards) are provided below this **Log in** window. If you are unfamiliar with finding information on this site, please read these instructions before proceeding any further.

Under the **PDFs and Guides** tab resides a collection of printable resources for reference or download. All of the matrices, including the ESM (which does not include most software), are subsets of the E-Lab Interoperability Navigator database. Included under this tab are:

- The *EMC Support Matrix*, a complete guide to interoperable, and supportable, configurations.
- Subset matrices for specific storage families, server families, operating systems or software product.
- Host connectivity guides for complete, authoritative information on how to configure hosts effectively for various storage environments.

Under the **PDFs and Guides** tab, consult the *Internet Protocol* pdf under the "Miscellaneous" heading for EMC's policies and requirements for the *EMC Support Matrix*.

Related documentation

Related documents include:

- The *EMC Networked Storage Topology Guide* has been divided into several TechBooks and reference manuals. The following documents, including this one, are available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com.
  - *Backup and Recovery in a SAN TechBook*
  - *Building Secure SANs TechBook*
  - *Extended Distance Technologies TechBook*
  - *Fibre Channel over Ethernet (FCoE): Data Center Bridging (DCB) Concepts and Protocols TechBook*
  - *Fibre Channel SAN Topologies TechBook*
  - *iSCSI SAN Topologies TechBook*
  - *Networked Storage Concepts and Protocols TechBook*
  - *Storage Virtualization and Replication Technologies TechBook*
  - *WAN Optimization Controller Technologies TechBook*
  - *EMC Connectrix SAN Products Data Reference Manual*
  - *Legacy SAN Technologies Reference Manual*

- *Non-EMC SAN Products Data Reference Manual*

- *EMC Support Matrix*, available through E-Lab Interoperability Navigator at http://elabnavigator.EMC.com >**PDFs and Guides**
- RSA security solutions documentation, which can be found at http://RSA.com > **Content Library**

All of the following documentation and release notes can be found at http://Powerlink.EMC.com. From the toolbar, select **Support > Technical Documentation and Advisories**, then choose the appropriate Hardware/Platforms, Software, or Host Connectivity/HBAs documentation links.

Hardware documents and release notes include those on:

- Connectrix B series
- Connectrix M series
- Connectrix MDS (release notes only)
- CLARiiON
- Celerra
- Symmetrix

Software documents include those on:

- EMC Ionix ControlCenter
- RecoverPoint
- Invista
- TimeFinder
- PowerPath

The following E-Lab documentation is also available:

- Host Connectivity Guides
- HBA Guides

For Cisco and Brocade documentation, refer to the vendor's website.

- http://cisco.com
- http://brocade.com

Authors of this TechBook

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EMC's first Connectrix offering. Mark is an active T11 participant, a committee within the InterNational Committee for Information Technology Standards, responsible for Fibre Channel Interfaces.

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Conventions used in this document

EMC uses the following conventions for special notices:

CAUTION

CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

IMPORTANT

An important notice contains information essential to software or hardware operation.

Note: A note presents information that is important, but not hazard-related.

Typographical conventions

EMC uses the following type style conventions in this document.

Normal	Used in running (nonprocedural) text for: • Names of interface elements (such as names of windows, dialog boxes, buttons, fields, and menus) • Names of resources, attributes, pools, Boolean expressions, buttons, DQL statements, keywords, clauses, environment variables, functions, utilities • URLs, pathnames, filenames, directory names, computer names, filenames, links, groups, service keys, file systems, notifications
Bold	Used in running (nonprocedural) text for: • Names of commands, daemons, options, programs, processes, services, applications, utilities, kernels, notifications, system calls, man pages Used in procedures for: • Names of interface elements (such as names of windows, dialog boxes, buttons, fields, and menus) • What user specifically selects, clicks, presses, or types
Italic	Used in all text (including procedures) for: • Full titles of publications referenced in text • Emphasis (for example a new term) • Variables
`Courier`	Used for: • System output, such as an error message or script • URLs, complete paths, filenames, prompts, and syntax when shown outside of running text
`Courier bold`	Used for: • Specific user input (such as commands)
`Courier italic`	Used in procedures for: • Variables on command line • User input variables
< >	Angle brackets enclose parameter or variable values supplied by the user
[ ]	Square brackets enclose optional values
|	Vertical bar indicates alternate selections - the bar means “or”
{ }	Braces indicate content that you must specify (that is, x or y or z)
...	Ellipses indicate nonessential information omitted from the example

Where to get help

EMC support, product, and licensing information can be obtained as follows.

Product information — For documentation, release notes, software updates, or for information about EMC products, licensing, and service, go to the EMC Powerlink website (registration required) at:

`http://Powerlink.EMC.com`

Technical support — For technical support, go to Powerlink and choose **Support**. On the Support page, you will see several options, including one for making a service request. Note that to open a service request, you must have a valid support agreement. Please contact your EMC sales representative for details about obtaining a valid support agreement or with questions about your account.

We'd like to hear from you!

Your feedback on our TechBooks is important to us! We want our books to be as helpful and relevant as possible, so please feel free to send us your comments, opinions and thoughts on this or any other TechBook:

`TechBooks@emc.com`

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CNT/Inrange Switches and Directors

This chapter contains information on CNT/Inrange switches and directors.

Note: For information on EMC® qualified third-party products, refer to the *EMC Select* document on Powerlink.

CNT/Inrange FC/9000

The CNT/Inrange FC/9000 64 is a Fibre Channel Enterprise Director, scalable from 24 ports to 64 ports. E-Lab Navigator lists the configurations supported by the FC/9000.

The FC/9000 can be used in a high-speed SAN designed to support data-intensive high-availability applications, such as backup and recovery, business continuance, and data and resource sharing.

Note: FICON and distance testing are not complete.

Fabric Management is performed by the IN-VSN Enterprise Manager in a client/server architecture installed on a PC, usually housed in or near the FC/9000 Director cabinet.

E-Lab Navigator lists specific versions of supported firmware, as well as fabric topology constraints associated with the FC9000.

Figure 1 shows the CNT/Inrange FC/9000 Director cabinet.

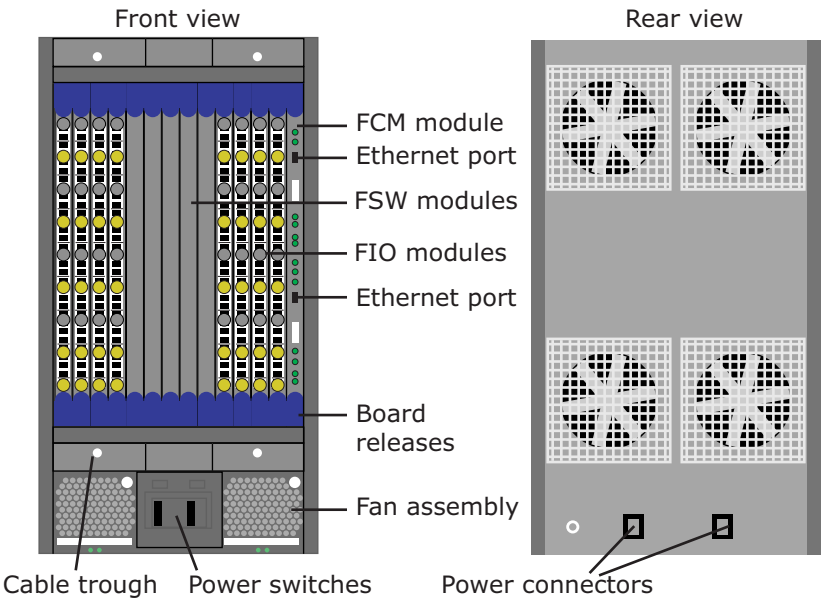


Figure 1 CNT/Inrange FC/9000

Component overview

FIO (FC/9000 XCAF or base I/O module)

FIO modules provide the physical connectivity between the FC/9000 backplane and the external devices connected to the FC/9000. The FC/9000 supports a minimum (base) configuration of three base FIO modules and a maximum of eight per chassis.

FIO modules are hot-swappable, containing a single processor, supporting memory, reset button, and front panel indictors to show current status: temperature, heartbeat, logged in/out, and activity (traffic).

The Extended Credit Addressing Facility (XCAF) FIO has two features: the ability to provide 64 buffer-to-buffer credits and FICON addressing.

Blank panels must be inserted where FIO modules are not present.

FSW (FC/9000 switching module)

FSW modules provide the physical and logical connectivity between FIO modules installed in the chassis. These modules provide the middle or cross-connect stage of the switch architecture.

The FC/9000 supports a minimum (base) configuration of four FSW modules and maximum of five (high-availability configuration) per chassis, with only four FSW on line at any time.

FSW modules are hot-swappable, containing a single processor, supporting memory, reset button, and front panel indictors to show current status: temperature, heartbeat, and activity (on line or off line).

Blank panels must be inserted where FSW modules are not present.

FCM (FC/9000 control module)

FCM modules provide the common control interface for the FC/9000 system. This module acts a proxy for all external communication to other modules from the IN-VSN Enterprise Manager. The FC/9000 requires a minimum of one FCM, or can have a maximum two for redundancy.

Each hot-swappable FCM module contains a single processor, supporting memory, reset button, and front panel indictors to show status: link, data, 100 Mb/s, online/offline, primary board, fault, 4-character display window.

Blank panels must be inserted where FCM modules are not present.

Power supply assembly

Power supplies are located in the front left and right sides of the chassis. The power supplies are hot swappable, redundant, and load sharing. The on/off switches are located in the front lower section of the switch.

Fan module assembly

A fan assembly in the rear of the chassis provides cooling for the FC/9000, drawing air through and pushing air out. In the event of a single fan failure, the remaining three fans will accelerate to maintain the cooling process. These fans are replaceable either within a unit or the entire unit (pair).

Backplane module

The backplane provides connectivity among all system modules, including the FIO, FSW, FCM, power supply, and fans. The backplane can be expanded with a special wiring harness and dipswitch configuration to provide connectivity for 128 ports.

The backplane provides:

- Port-to-port bus connection
- Interprocess communication at 100 Mb/s with redundancy
- Connection to expansion interface modules
- Power distribution bus connectivity
- Power supply alarm signals
- *DC fail* status
- *AC fail* status
- **Power supply present** status
- Fan status and control
- Slot geographical addressing
- Miscellaneous status and control

IN-VSN Enterprise Manager

The IN-VSN Enterprise Manager is the GUI used to manage the FC/9000. It is a software application that has two components based on a client/server architecture. The client periodically (every five seconds) polls the server through Ethernet (10/100 Mb/s) to send and retrieve changes to the FC/9000.

The IN-VSN Enterprise Manager Client can:

- Define module and port configurations
- Define zoning
- Monitor alarms
- Monitor system performance
- Invoke system diagnostics
- Implement some director parameters

The IN-VSN Enterprise Manager's client software application operates on Windows NT and Windows 2000 Professional platforms. The IN-VSN Enterprise Manager server software application requires a dedicated PC, operates on Windows NT and Windows 2000 Professional platforms, and has basic hardware compatibility requirements from CNT/Inrange. The server communicates with the FCM module through Ethernet (10/100 Mb/s) to send and retrieve changes to/from the FC/9000.

Features overview

Features of the CNT/Inrange FC/9000 include:

- High availability: fully redundant internal pathing, power, cooling and control; no single point of failure
- Non-disruptive code loads and hot-swappable GBICs
- Auto-discovering, self-configuring 1.0625 Gb ports; arbitrated loop (FC-AL), transitive loop (TL), switched fabric (FC-SW)
- Enterprise Manager SAN fabric management system IN-VSN Enterprise Manager
- Employment of orphan zoning by zoning, hard zoning, port zoning, and broadcast zoning, to guard against losing ports not proactively assigned to a defined zone
- Phone-home and pager direct-dial feature
- Statistical and diagnostic monitoring
- Class 2,3 Fibre Channel environments
- 64 ports available through 8-port I/O modules (8 ports per FIO module)
- GBIC Port Module (SE form factor) available in multimode fiber (shortwave)

- 64 buffer-to-buffer credits (BB_Credits) available per port
- Support for Class 2 and Class 3 Fibre Channel protocols
- Auto-negotiate function on all ports, to provide either switched F_Port or T_Port connections
- Full duplex 100 MB/s data rate per Fibre Channel port
- Supported port types: F_Port, FL_Port, TL_Port

Director Management (IN-VSN Enterprise Manager)

The IN-VSN Enterprise Manager:

- Provides centralized monitoring and control of multiple fabrics and all vital network functions from a single console. Using a Java-based and/or SNMP interface, multiple concurrent users can access levels of fabric information ranging from basic monitoring and configuration information to detailed performance data. Enterprise Manager is a configuration tool, as well as an application for management of SAN configuration, application and performance.
- Allows centralized configuration and management of fabric using client/server architecture.
- PC Management Server allows Server functionality and Client.
- Supports Windows NT 4.0 and Windows 2000 Professional Clients.
- Allows centralized management of Director.
- Provides support for online, nondisruptive code upgrades.
- Features 10/100 Mb Ethernet connections to FCM for out-of-band management.
- Provides extensive centralized logging: Event, Audit, Session logs, and SNMP support.

Availability management

Availability management includes:

- Management system helps you track the status of redundant power, cooling, and control.

- Phone home/email home provides instant notification of system or network issues.
- Front panel display allows quick check of fan operation, temperature, and port status.

Performance management

Performance management includes:

- Dynamic statistics display performance data for each online port.
- Zoning of FC/9000 ports allows efficient and secure communication among nodes.
- Event Log and Audit Log streamline the troubleshooting process and provide rapid error source identification.
- SNMP traps show whether defined limits have been exceeded.

References

Note the following for more information:

- http://www.cnt.com
- *IN-VSM FC9000 Fibre Channel Director Installation Manual*
- *IN-VSM FC9000 Fibre Channel Director Maintenance Manual*
- *IN-VSM FC9000 Fibre Channel Director Installation and Operation Manual*
- *IN-VSM FC9000 Fibre Channel Director Site Planning Guide Manual*

2 Nortel OPTera Metro

This chapter contains information on the Nortel OPTera Metro platform.

Note: For information on EMC-qualified third-party products, refer to the *EMC Select* document on Powerlink.

Introduction

The Nortel OPTera Metro platform is a true protocol- and bit-rate-independent fiber-optic transport system. The OPTera Metro supports the following protocols: SONET, ATM, Gigabit Ethernet, IP, FDDI, and all optical interfaces (OC-n).

Note these capacities:

- An ETSI- and NEBS-compliant unit, the OPTera Metro shelf can accommodate up to 10 Gb/s of capacity in less than 2 cubic feet of space.
- An OPTera Metro system can have one to eight pairs of shelves at multiple sites configured in a hubbed ring or point-to-point topology. Each site can have one or more shelves.
- A fully loaded system (16 shelves) can transport up to 32 protected or 64 unprotected channels (wavelengths) over each optical fiber.
- Each channel can operate from 50 Mb/s to 2.5 Gb/s. This allows a total transport capacity of 80 Gb/s.

A *shelf* is a basic building block of a Nortel OPTera DWDM system. A shelf contains a subsystem of components that convert optical signals into electrical, allow *adding* and *dropping* functionality, and multiplex and pass signals through the network.

A Nortel OPTera shelf holds:

- Optical Channel Interface (OCI); provides signal interface card.
- Optical Channel Laser and Detector (OLCD)
- Optical Channel Manager (OCM)
- Optical Multiplexer (OMX); provides add/drop filtering (ADF) to multiplex each OCLD optical wavelength signal onto the single mode fiber.
- Shelf Processor (SP); provides monitoring and control functionality.

Figure 2 on page 31 shows an example of a Nortel OPTera shelf.

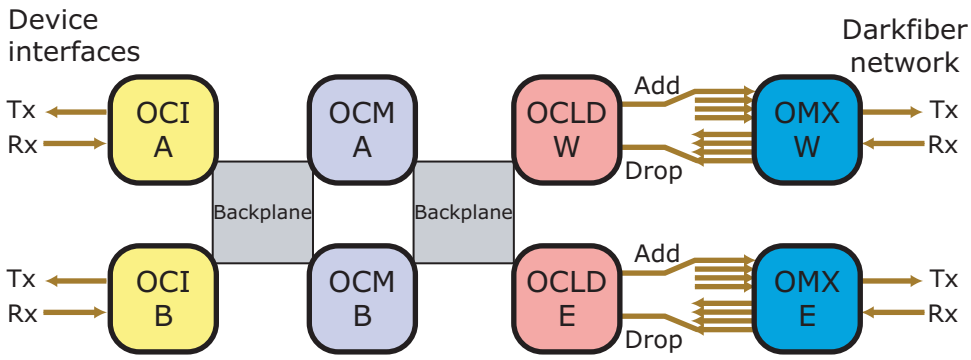


Figure 2 **Nortel OPTera shelf diagram**

The OCI interface provides the necessary connections to connect the OPTera to customer traffic. There are two types of OCI card(s): 1.25 Gb/s and 622 Mb/s. The Optical Channel and Detector (OCLD) receives electrical client signal from the back plane, converts electrical signal to DWDM wavelength, and provides 32-channel fault monitoring and two Fibre Channel optical connectors (connected to Fibre Channel pigtails from OMX modules).

The optical signals from the DWDM network are converted into electrical signals only on the shelf that drops them, creating a logical point-to-point topology between two shelves that carry the same optical wavelength band. (At least two shelves with the same wavelength band in two locations of the network are necessary.) All other bands pass through the shelf's optical filters.

Available OPTera Metro topologies

The point-to-point configuration (which is the basis for all other configurations) will include a local and remote site. The data will flow between the different sites using two links. Each link includes a transmit and receive single-mode fiber cable (dark fiber). The two links are usually described as *east-to-west* or *west-to-east*. The cabinets usually contain four shelves or bands, which make up the site. Figure 3 and Figure 4 show possible OPTera Metro DWDM topologies.

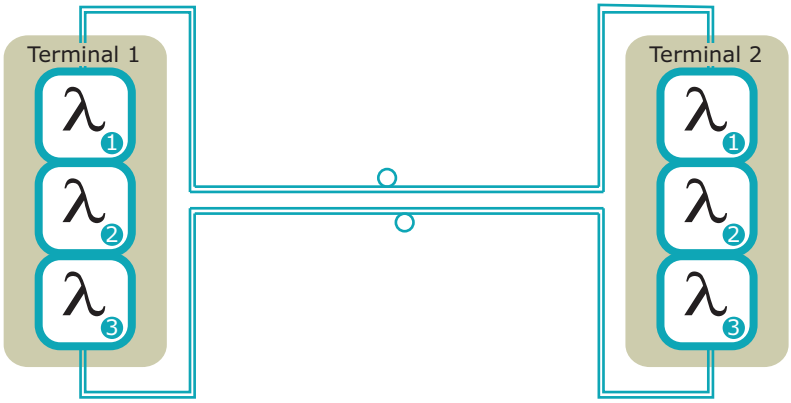


Figure 3 **Point-to-point protected topology**

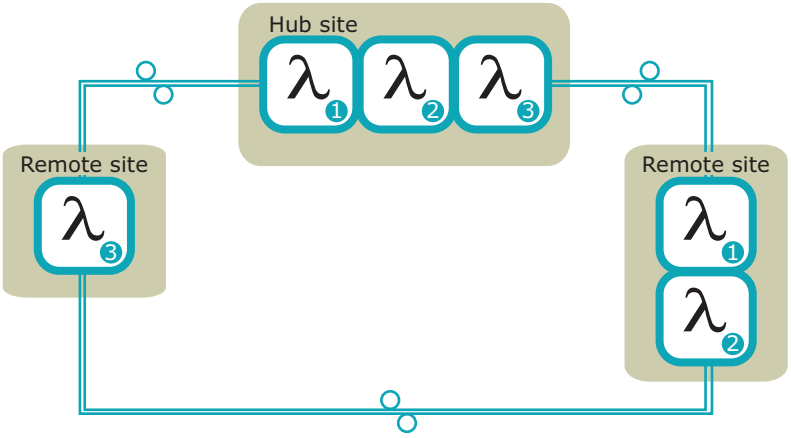


Figure 4 **Hubbed ring topology**

Nortel OPTera protection scheme

A protected channel connects an attaching device interface by using a single OCI card and two OCLD cards (each having the same wavelength) in one shelf of the shelf pair to two corresponding OCLD cards (each having the same wavelength) and a single OCI card in the second shelf of the shelf pair. The data flow between the OCI card and two OCLD cards within each shelf is managed by the two Optical Channel Manager (OCM) cards in each shelf.

This scheme creates two data paths inside the DWDM network. One path is active as long as signal integrity is maintained by the physical connections. Any disruption will fail over to the alternate data path using the second OCLD pair.

Note that this configuration neutralizes and single OCI, one on each shelf. A mixture of protected and unprotected channels is available in a single shelf.

Power budget calculations

Calculate the power budget as shown in the following example.

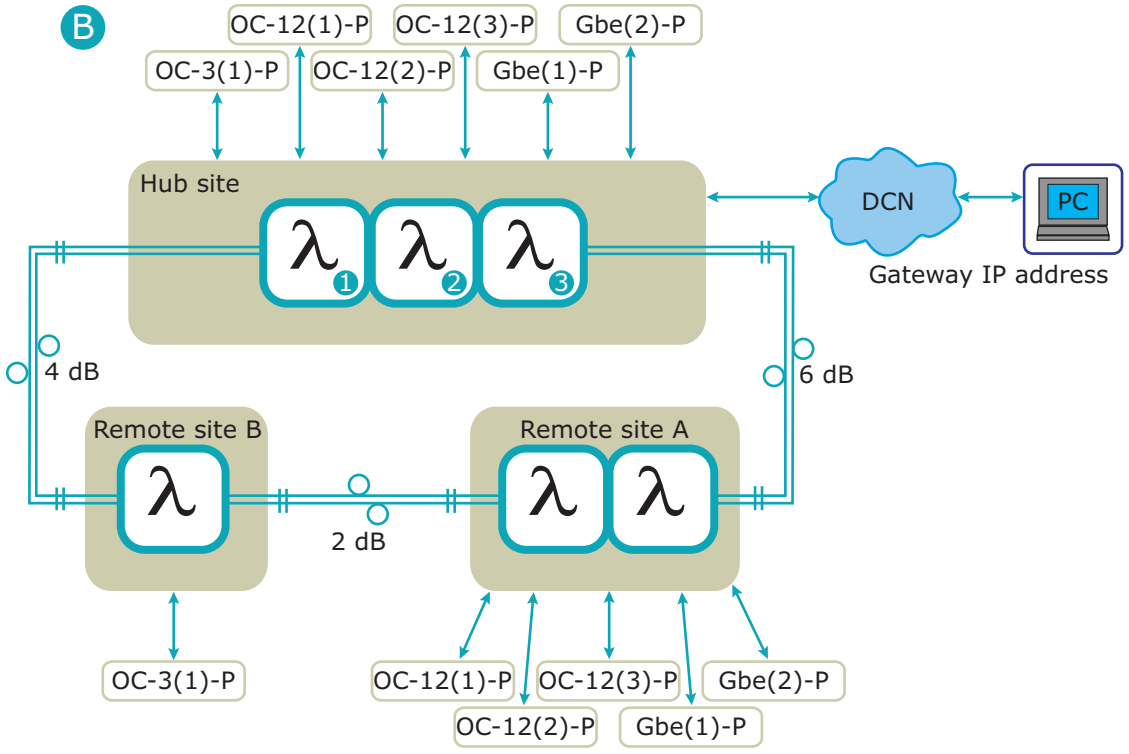


Figure 5 **OPTera protection scheme**

Note that this is only an approximation, and that a site survey is required before activation:

1. Fiber losses are calculated according to the distances times the specifications of the fiber cable. In this case 0.2 dB per km, so for the 30 km leg (30 km * 0.4 dB/km = 6 dB loss).
2. Each connector has approximately 0.5 dB loss per connector.
3. Add up all of the fiber losses, on all three legs, with the connector losses:

   6 dB + 2 dB + 4 dB + (0.5 dB * 6) = 15 dB

4. Add repair margin (10%): 15dB + 1.5 dB = 16.5 dB.
5. With a Maximum Link Budget (see Nortel OPTera end-of-life chart): 18.3 dB. Subtract total link budget (16.5 dB) from Maximum Link Budget (18.3 dB) and if result is Positive (1.8 dB), then link budget is within parameters.

Diagnostics and maintenance

For configuration, power budget calculation and troubleshooting details, consult the Nortel OPTera Metro technical publications.

Using the Symmetrix Fibre Channel director online utilities can complement repair and system diagnostics.

3

Ciena Products Data

This chapter contains data on Ciena products.

Note: For information on EMC-qualified third-party products, refer to the *EMC Select* document on Powerlink.

Ciena ONLINE7000

The Ciena ONLINE*7000* platform is a true protocol and bit-rate-independent fiber-optic transport system that supports the following protocols:

- SONET/SDH
- IP
- Ethernet
- GbE
- Fibre Channel
- FDDI
- ESCON
- FICON
- ATM

The ONLINE*7000* backplane is utilized for management (FCAPS capability: Fault Configuration, Administration, Provisioning and Service).

The ONLINE*7000* platform offers the following:

- Up to 33 protected wavelengths and 66 unprotected wavelengths
- Client interface through a Software Provisionable Transceiver: OC-3/12/48 (STM-1/4/16), GbE
- Bitrate Flexible Transceiver: 100 Mb/s to 2.5 Gb/s, including Fibre Channel, FICON, ESCON, D1 Video, HDTV, FDDI, Fast Ethernet, ATM, IP for long distance applications

Figure 6 on page 39 is a general UPSR protection diagram of a single Network Element (shelf) consisting of a general Main Shelf without Expansion shelf, accompanied by a top-down I/O flowchart (Figure 7 on page 40) in conjunction with card descriptions used for a two-node point-to-point/two-node ring configuration over extended distance.

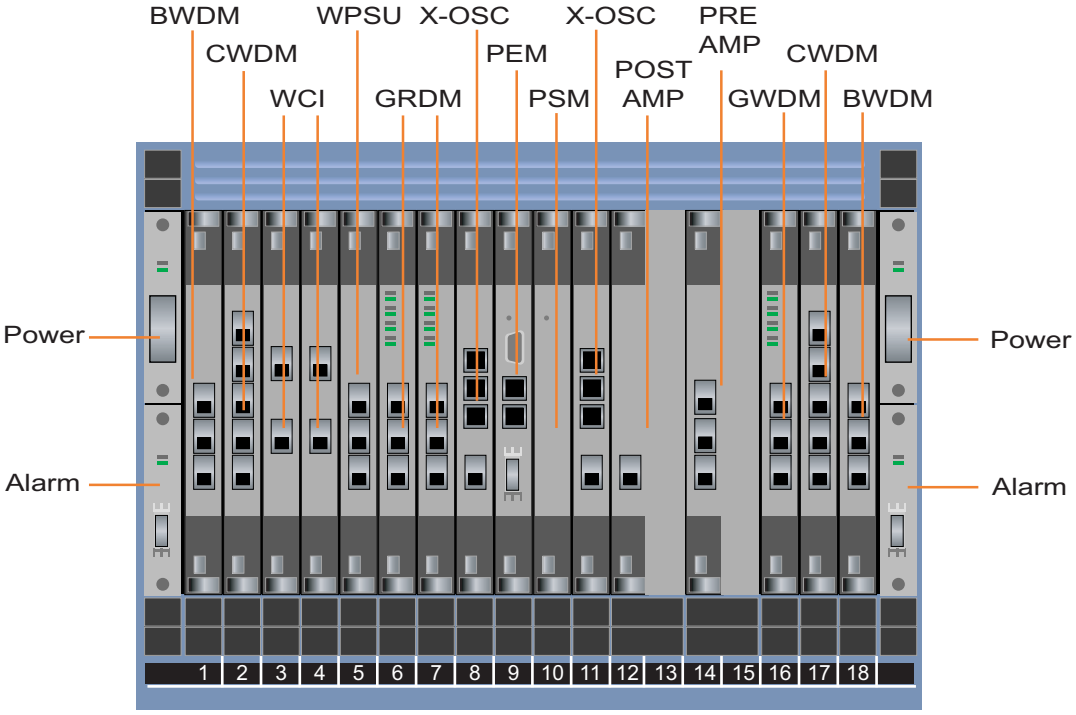


Figure 6 **ONLINE*7000* UPSR protection diagram for main shelf**

Within the ONLINE*7000* Network Element the cards are housed in at least two areas (Main Shelf and one or more Expansion Shelves) of a single DWDM node. The complexity and density of the multiplexing (number of GRDM cards) circuits determine the number of shelves utilized within the DWDM configuration.

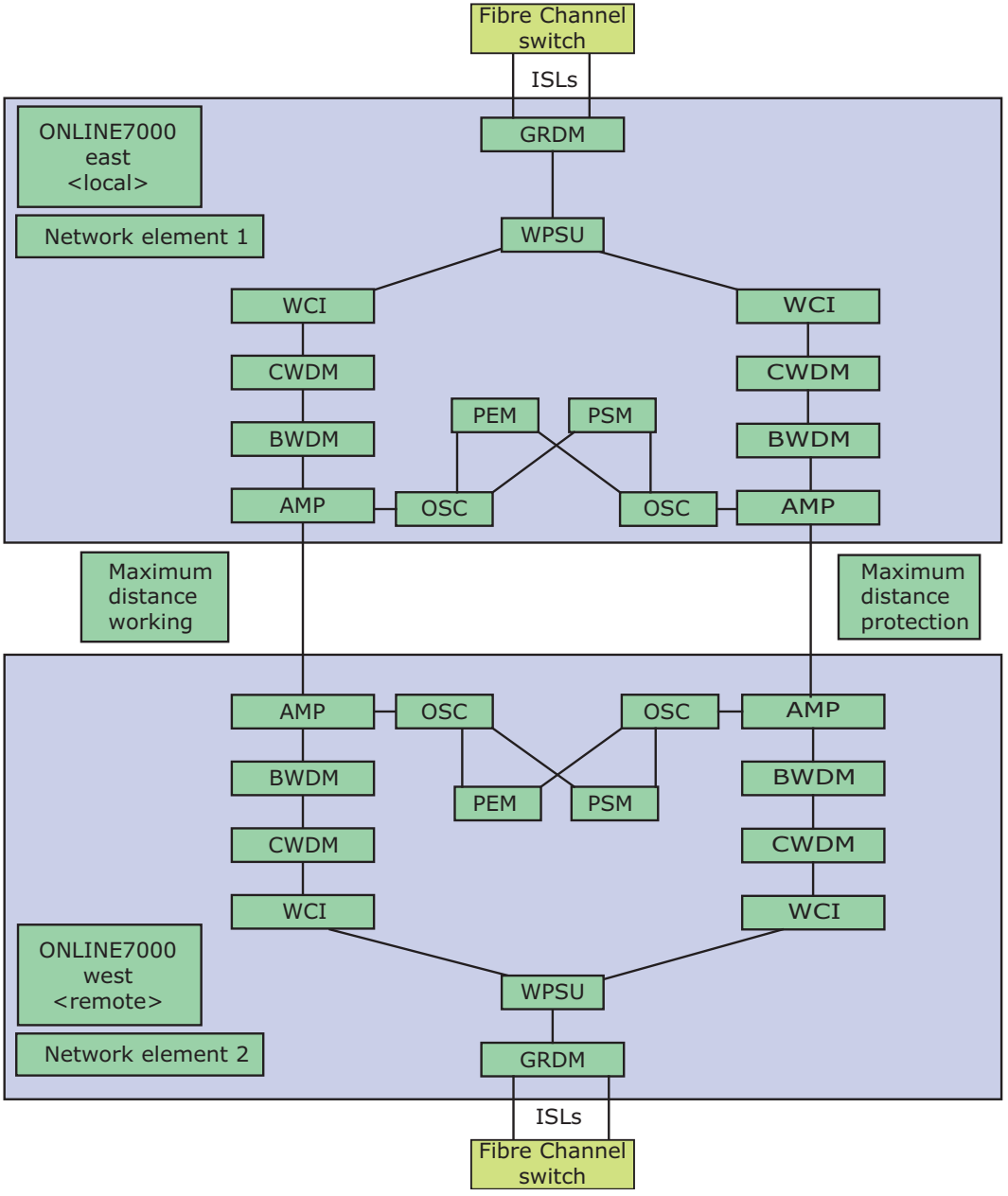


Figure 7 **I/O flowchart: Point-to-point/ring configuration over extended distance**

ONLINE*7000* card types

Note: All ports available on the following cards require MU cables.

GRDM CP: gigabit rate data mux circuit pack

GRDM cards are used for point-to-point traffic connections, and must be used in conjunction with 3RWCI CPs (Wave Channel Interface Circuit Packs responsible for Regeneration, Reshape, Retime of optical signals) by multiplexing two Gigabit Ethernet (GbE) or two Fibre Channel Channels MU ports (or tributaries) into a single (Tx, Rx) wavelength for transport across the ONLINE7000/9000/11000 system.

Conceptually bypassing the GRDM card is allowed, since WCIs support OC-48 bitrate capacity. However, Fibre Channel uses 1.0625 Gb/s, and WCIs accept only one port. GRDM accepts two ports and allows FC/GigE Performance monitoring.

The GRDM card accepts only MU Fibre Channel connections. GRDM will accept shortwave 850nm and longwave 1310nm connections. SC-to-MU cable converters are required in order to attach to EMC-supported switches.

Note: When an 850nm wavelength enters the GRDM, the wavelength out of the GRDM will be increased from 850nm to 1310nm.

Note: Do not mix protocols on the same GRDM card. (For example, Port 1 cannot use GbE if Port 2 uses Fibre Channel.)

WPSU: working protection splitter unit

Note: WPSUs are used in unidirectional path switched ring configurations (redundant path, redundant band with dedicated protection).

UPSR cards use optical couplers that have either one of these two capabilities:

- Splits a single (T_x, R_x) wavelength input from the GRDM card to two identical wavelengths utilized for working and protection lines.
- Combines two optical incoming signals into one output.

Direct connection to a WPSU is possible if the input received is an MU type OC-3 or 12 or OC-48 bandwidth connection.

WCI: wave converter interface (SONET/SDH input if there are no GRDMs)

The WCI converts the optical signal received by the WPSU card to an electrical pulse, and back again to an optical signal. WCI converts the 1310nm impulse from the WPSU to a frequency band (1530 to 1563.1 nm) utilized by the ONLINE*7000*.

Note: WCI supports up to 80 km.

Note: The number of WCIs should be double the number of GRDM cards in a UPSR protection configuration.

Note: WCI3RL is a card with 3R (reshape, regeneration, retime) capability, along with 160 km extended reach going from customer premise equipment to the WCI3RL.

CWDM: channel wave division multiplexer

The CWDM multiplexes up to three different wavelengths received from WCI cards into a single band and reroutes the single band to a CWDM on Network Element 1 of a two-node point-to-point connection. On the other side of the ring (Network Element 2 of a two-node point-to-point connection), CWDM demuxes the single band into a maximum of three different channels with the same band. CWDMs can also demultiplex the input of a BWDM to wavelength outputs to several WCI cards.

BWDM: band wave division multiplexer

This card multiplexes (adds) a band of three wavelengths coming from the CWDM and demultiplexes (drops) a band coming from the pre-amp. Working-line bands are in the range 1 through 5, and protection-line bands are 7 through 11.

Pre-amp: pre-amplifier

The pre-amp amplifies optical signals entering the node. The pre-amp is used in conjunction with a post-amp to compensate for signal loss caused by long spans between nodes, or it is used in conjunction with the Line CP if no post-amp is required in that span. pre-amps are field-replaceable and hot-swappable.

PEM: processor element module

PEMs contain the Software Application/Firmware on the Network Element (ONLINE*7000*). PEMs between multiple Network Elements share the same Global database (user privileges, circuits, Network Element configuration information, etc.) tables.

PSM: persistent storage module

PSMs contain nonvolatile storage of configuration and status information for the node. The PSM data store is implemented in Flash

EPROM and appears to the PEM CP as a networked removable storage device.

The PSM serves as a secondary storage for the Network Element configuration data. Also, the connections on the front panel differ for the PSM CP and the PEM CP.

PSMs are field-replaceable and hot-swappable.

OSC: optical supervisory channel

OSCs are utilized for internetwork element communication. This card transfers information stored in the Global database tables of the PEMs. Different versions of OSCs exist.

Functionality of the following OSCs is the same, but the OSCs differ in link budgets and distance coverage:

OSC	Link budget	Distance
OSC	25 dB	80 km
OSCE	35 dB	110 km
X-OSC	35 dB (approximate)	120 km (approximate)

Post-amp: post-amplifier

The post-amp circuit provides the following functions:

- Splits off the Optical Supervisory channel (OSC) 1510 nm wavelength from the other data channels on the line fiber and redirects it for termination at the OSC CP.
- Monitors and adjusts the remaining wavelengths optical power.
- Amplifies the optical channels from the node out to the line as necessary. Amplification is done using an Erbium-Doped Fiber Amplifier (EDFA).
- Allows monitoring EDFA output power through a test-access port.

ONLINE*7000* topologies

The ONLINE*7000* supports the following three topologies:

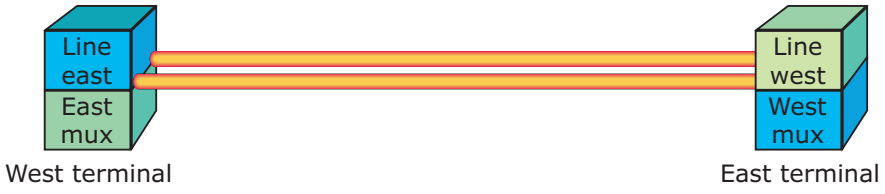


Figure 8 Point-to-point topology

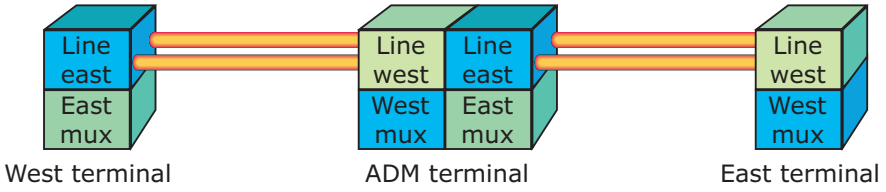


Figure 9 Line drop mode

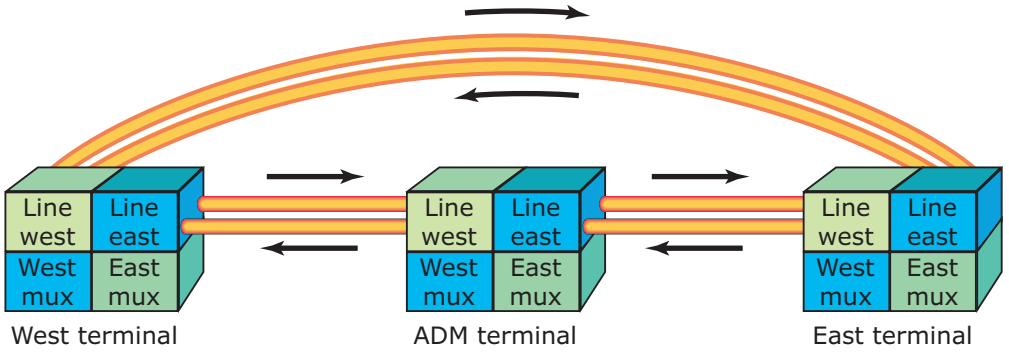


Figure 10 Ring network

ONLINE*7000* protection scheme

The ONLINE*7000* employs O-UPSR (Optical–Unidirectional Path Switched Ring) for data protection. In an O-UPSR ring, traffic is duplicated and sent around both sides of the ring simultaneously.

Note: The generic term for O-UPSR is ODPR (Optical Dedicated Protection Ring).

O-UPSR restoration is performed on a per-channel basis at those nodes where the channel enters or exits the ring (rather than at the intervening nodes). The destination node selects the better of the two signals and forwards the traffic to the subtending equipment.

Typically, the working path is selected unless it has failed or degraded. In the case of a failure or degradation, the destination node performs restoration by selecting the protected path.

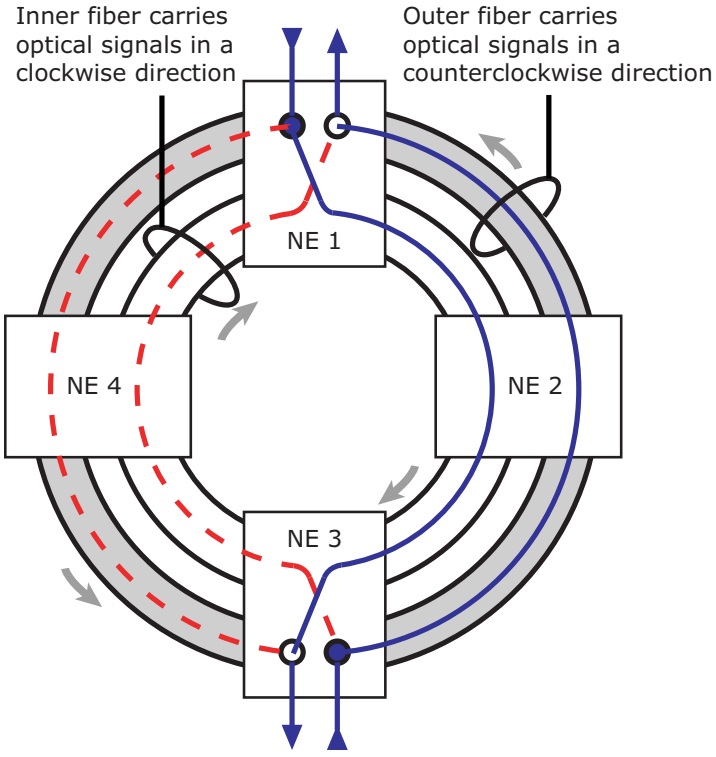


Figure 11 **O-UPSR ring configuration in normal mode**

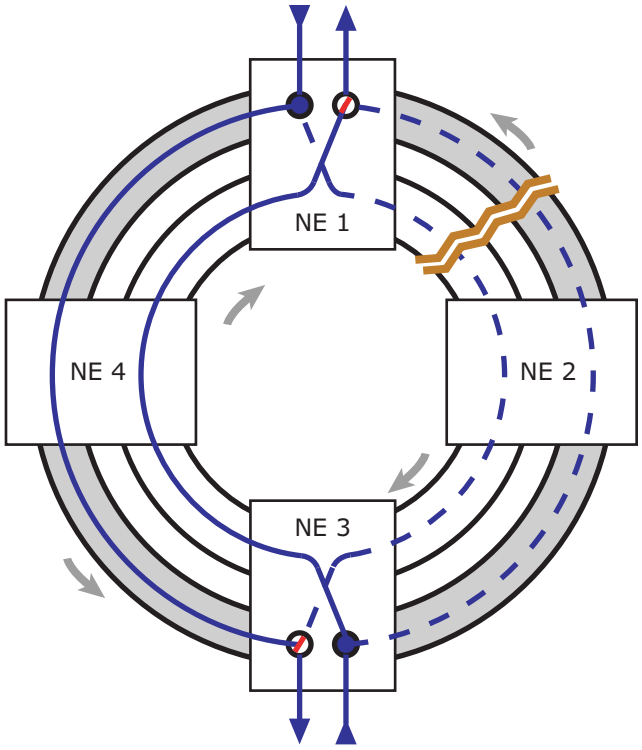


Figure 12 **O-UPSR ring configuration in failure mode**

Note: Optical UPSR dedicated protection: redundant path and bands.

Note: ONLINE7000 supports a maximum of 33 wavelengths utilizing a WPSU splitter on the tributary incoming links.

ONLINE*7000* power budget calculations

The link budget needed for the ONLINE*7000* to function must fall within the range of 33 dB or less. Ciena's power budget calculation is:

<LINK BUDGET> = [0.3 dB/km * <km fiber used>] +
[0.5 * (number of connects)] +
[<km fiber used> * 0.1 dB/km] + 1.0 dB

Where:

- <number of connects> = [number of Cross-connects + termination].
- <0.1 dB/km> is used to calculate the Maintenance Margin.

ONLINE*7000* diagnostics and maintenance

For configuration, power budget calculation, and troubleshooting details, consult the Ciena technical publications.

Additional information regarding the ONLINE*7000* is accessible at http://www.ciena.com.

Ciena CN 4200/CN4200 MC

Ciena CN 4200 and Ciena CN 4200 MC Advanced Services Platforms are multiservice switching, aggregation, and transport systems that allow carriers to groom, switch, and transpond a diversity of sub-wavelength client services onto higher-speed OTU1 (2.7 Gb/s) and OTU2 (10.7 Gb/s) transport streams. Using innovative timeslot technology, these service platforms can support a multitude of both like and unlike services. They can also directly transpond a variety of 10G services such as 10 GbE LAN/WAN PHY, 10G FC/FC1200 and OC-192/STM-64 into OTU2.

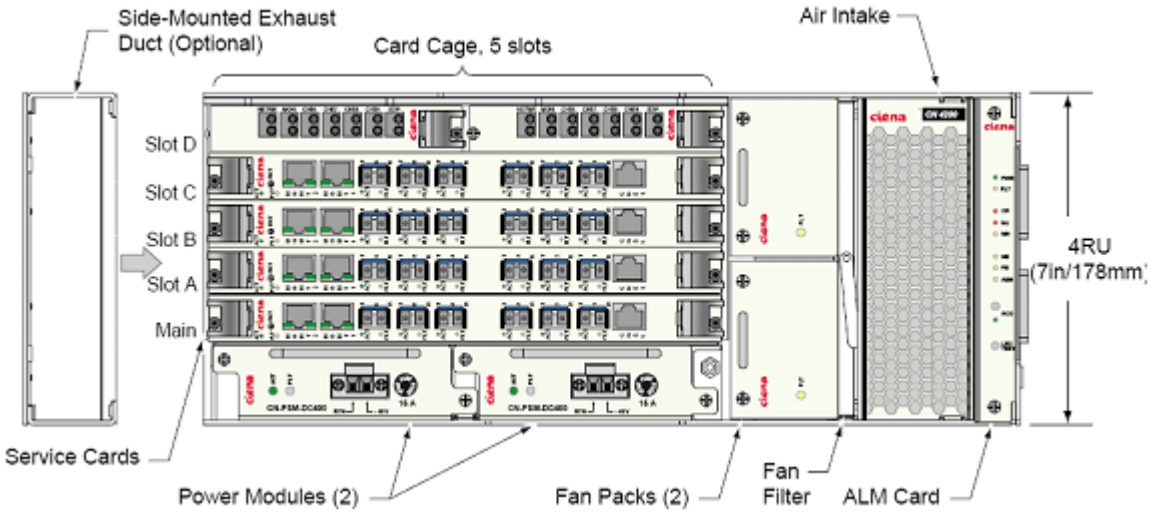


Figure 13 Ciena CN 4200 FlexSelect Advanced Services Platform

The full list of supported services includes:

- 10/100BaseT (supports jumbo frames)
- ESCON
- Fibre Channel, FC100, FC200, FC400, and 10G FC/FC1200
- FICON, both 1 G and 2 G
- Gigabit Ethernet and 1000BaseT (supports jumbo frames)
- OC-3/12/48/192
- STM-1/4/16/64

- 10 GbE WAN PHY
- 10 GbE LAN PHY (supports jumbo frames1)
- OTU1 and OTU2

For higher optical fiber efficiencies, the CN 4200 and CN 4200 MC support in-chassis CWDM and DWDM filters. These filters are designed in a modular fashion and accommodate growth up to 40 DWDM or 8 CWDM channels without service interruption. DWDM and CWDM channels can even be combined on the same fiber.

The CN 4200 and CN 4200 MC service platforms share a common transport architecture.

- The CN 4200 has four line card slots, each delivering client connectivity using OTU1 and/or OTU2 transport (Figure 14).
- The smaller CN 4200 MC, which is intended for more focused site service requirements, has two line card slots (Figure 15 on page 50).

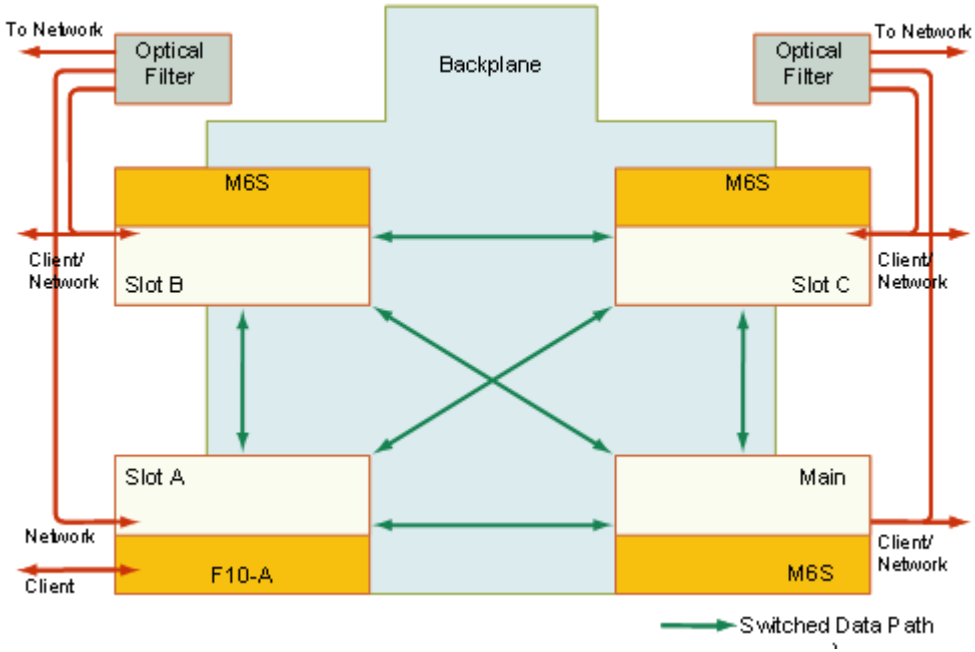


Figure 14 CN 4200 block diagram

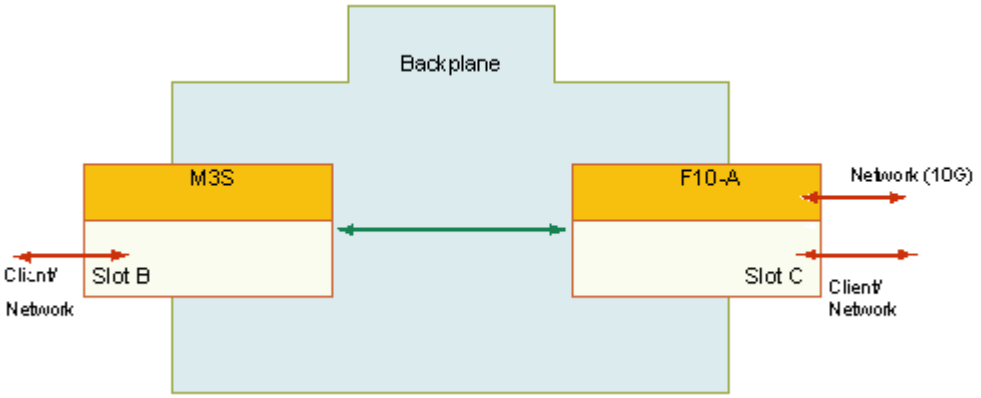


Figure 15 **CN 4200 MC block diagram**

Both systems employ a distributed switch architecture that provides sufficient grooming capability for stand-alone applications, yet is optimized for aggregation of services onto OTU1 and OTU2 wavelengths. Optional redundancy of interfaces and common elements guarantee operator-class service availability, with less than 25 ms automatic protection switching, faster than SONET/SDH.

Client service identities (e.g., ESCON, 1000BaseT) are software-provisionable rather than determined at the hardware layer, thereby offering a wide mix of services on the same card. The CN 4200 delivers standardized and rigorous performance monitoring metrics for all supported client services.

The CN 4200 and CN 4200 MC systems give operators a scalable solution for delivering multiservice transport and offer the following key features:

- High density multiservice transport platform supporting CWDM/DWDM
- Flexible assignment of ports as client or network ports
- Extensive performance monitoring on all client and network services
- Service-level loopbacks for fault isolation
- Front chassis accessibility for all connections and servicing

Available modules

This section provides information on available modules.

M6S/M3S

The M6S is a 6-port multiservice module with programmable interfaces using SFP pluggable optics. Each port can be provisioned with its own service identity. The M3S is a 3-port version of the same module. Each M6S/M3S also contains a switch fabric.

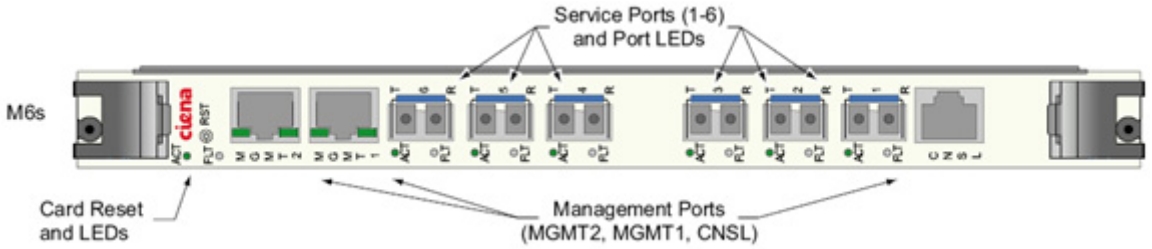


Figure 16 M6S module

The three RJ-45 ports (MGMT-1, -2, and CNSL) are used for remote and local management purposes, are accessible through the module's faceplate, and are only active if the module is functioning as the system controller. (Please note that although MGMT-1, -2 and CNSL are present in this figure, this is not an OA card.)

F10-T

The F10-T module (Figure 17 on page 52) is a highly-adaptable transponder/regenerator card designed exclusively for 10G services. It is equipped with two full-duplex optical ports, a pluggable XFP transceiver port, and a network port implemented in discrete DWDM

optics and intended for long-range transport. This port can be equipped with either a fixed or tunable wavelength transmitter.

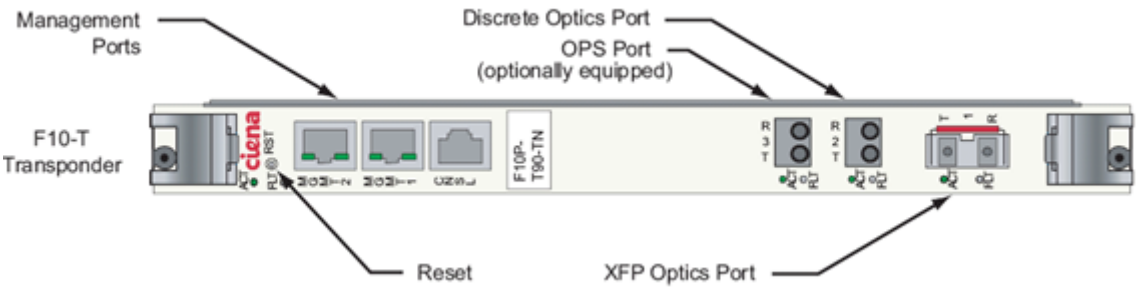


Figure 17 F10-T module

F10-A

The F10-A card (Figure 18) is a service aggregation and grooming module that combines 2.5G services (such as ODU1 and OC-48/STM-16), as well as time-slotted services (such as Gigabit Ethernet and FC200), into a G.709 OTU2 stream. External connectivity is provided by two pluggable SFP transceiver ports and a network port implemented in discrete DWDM optics and is intended for long-range OTU2 transport. This port can be equipped with either a fixed or tunable wavelength transmitter. The F10-A switch fabric is similar to that on the M6S.

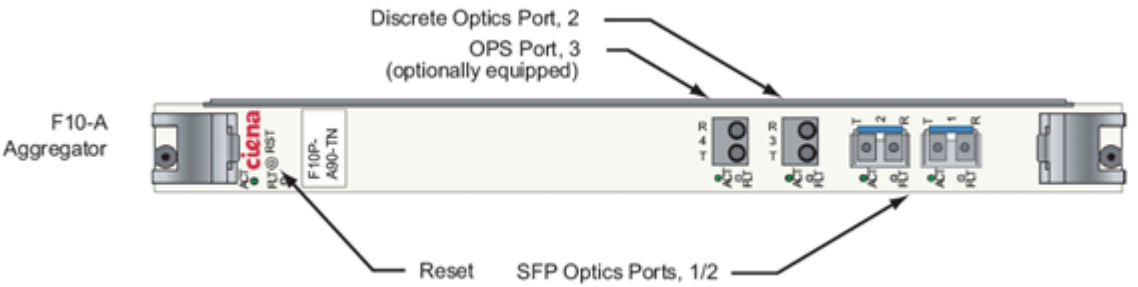


Figure 18 F10-A module

FC4-T

The FC4-T card (Figure 19 on page 53) is a service aggregation muxponder that combines three Fibre Channel client services into a single 10G OTU2 stream. The client services are software provisionable as either all FC200 or all FC400. (It does not support

mixed client data rates.) The aggregated 10G output of an FC4-T card can only be dissembled by another FC4-T. For this reason, FC4-T cards always work in pairs in a point-to-point manner.

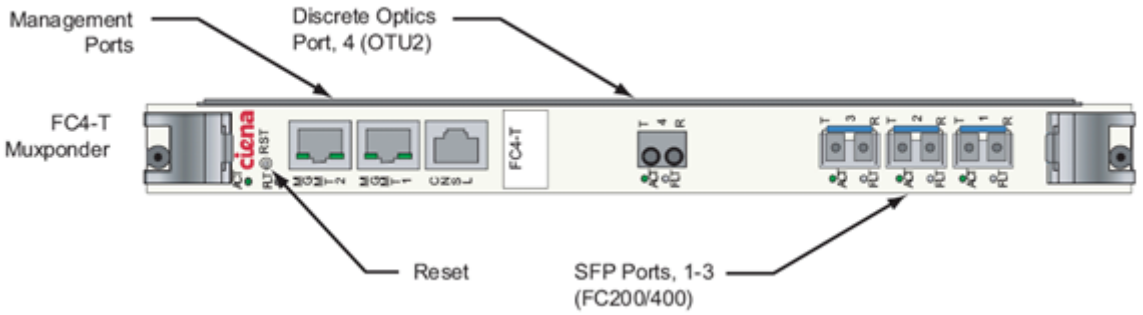


Figure 19 FC4-T module

Optical Protection Switch (OPS) modules

The CN 4200/CN 4200 MC systems offer three OPS modules for single (OPS-1), dual (OPS-2), and 850nm (OPS-2 850) protection switching, each which can be used for both client-side and network-side protection switching. Optical protection switches protect against line failures by detecting a decrease or loss of optical power in the primary signal source and, if found, switching to the protecting signal source.

OPS-1

The OPS-1 module (Figure 20) contains one optical protection switch and supports 1310nm, DWDM, and CWDM wavelengths on SMF.

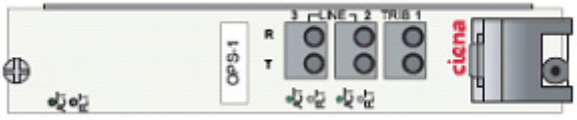


Figure 20 OPS-1 module

OPS-2 The OPS-2 module (Figure 21) incorporates two optical protection switches into one module and supports 1310nm, DWDM, and CWDM wavelengths on SMF.

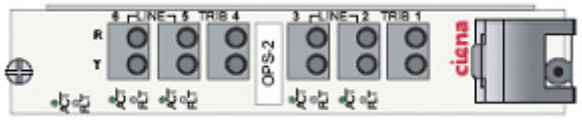


Figure 21 OPS-2 module

OPS-2 850 The OPS-2-850 module (Figure 22) incorporates two optical protection switches, but it dedicated solely to support 850 nm services on 50µm and 62.50 µm.

Note: There is no single switch 850nm module.

This module is composed of 50 µm MMF and components. Additional loss is experienced when connected to 62.5 µm MMF.

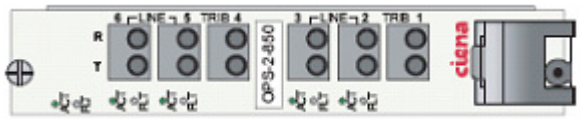


Figure 22 OPS-2 850 module

Optical Amplifier (OA) modules

The Optical Amplifier (OA) product suite comprises of the OAF-00-1-C (a fixed-gain optical amplifier), as well as the OAV-0S-U-C variable-gain optical amplifier. The OAs are C-band amplifiers and accommodate a single optical fiber for unidirectional transmission.

These amplifiers yield a bandwidth of 35nm and have a gain region of about 1530nm to 1565nm to coincide with Ciena's 100GHz and 200GHz DWDM channel plans.

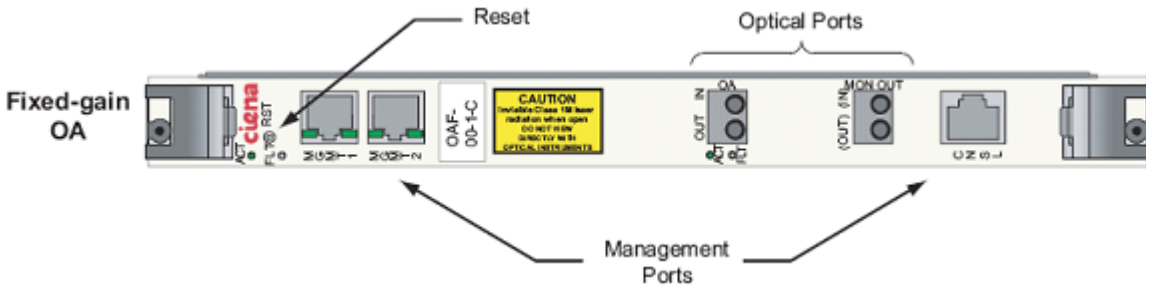


Figure 23 Fixed-gain Optical Amplifier module

The fixed-gain OA provides a constant gain and a flat gain shape across the DWDM C-band transport spectrum. The three RJ-45 ports that are used for remote and local management purposes (labeled MGMT-1, -2, and CNSL in Figure 13 on page 48) are accessible through the module's faceplate and are only active if the module is functioning as the system controller.

Optical Supervisory Channel (OSC) module

The Optical Supervisory Channel (OSC) module (Figure 24 on page 56) offers OSC connectivity to nodes that have no integrated OSC function. The OSC module provides an out-of-band full-duplex communications channel for remote node management, monitoring, and control, similar in purpose to the DCC of SONET/SDH.

Equipped with its own 1510nm mux/demux filter, the OSC travels the same fiber as the DWDM stream and always terminates on neighboring nodes. Because it is has a dedicated wavelength, the OSC data is entirely separate from the user data.

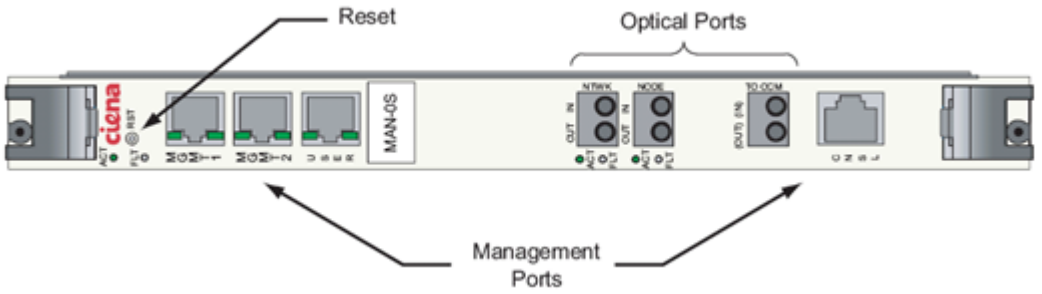


Figure 24 Optical Supervisory Channel (OSC) module

Common optical filters

The CN 4200/CN 4200 MC chassis accommodates the deployment of Ciena common optical filters for integrated optical multiplexing capabilities. The filter modules come in half-width and full-width form factors. These modules include:

- DWDM, 100GHz ITU grid provides for up to 40 wavelengths
- DWDM, 200GHz ITU grid provides for up to 16 wavelengths
- CWDM, 20nm ITU grid provides for up to 8 wavelengths
- Wide band filters for 1310nm and 1550nm/DWDM band mux/demux.

Service protection schemes

The CN 4200 and CN 4200 MC offer the following types of protection:

- 1+1 redundant path line card protection, which prevents service failures due to both fiber and line cards
- 1+1 switch fabric-based protection, which prevents service outages due to switch fabric, line cards, and optical transceiver failures as well as fiber cuts
- Optical protection switching, which is useful for guarding against service outages in the event of either a fiber break or far-end transmitter failure

Redundant path line card protection for the CN 4200/CN 4200 MC is used when the client supplies two client signals requiring path protection. In this case, the switching is performed by the client and not the CN 4200/CN 4200 MC. An example is when a CN 4200/CN 4200 MC is connected to an Ethernet switch implementing protection using IEEE 802.3ad Link Aggregation.

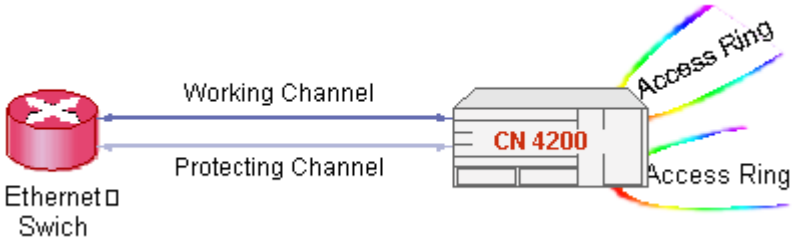


Figure 25 Redundant path line card protection

The advantage of line card protection is that during normal operation, with no failure conditions present, the client is free to use protection bandwidth as well as working bandwidth, doubling available bandwidth for the client.

For enhanced network protection requirements, the CN 4200/CN 4200 MC distributed switch fabric provides a robust 1+1 network protection solution that prevents service outages due to not only fiber cuts, but line card failures as well.

Using the system's switching capabilities, operators can establish 1+1 protection at both the channel (i.e., timeslot) and ODU path levels. With switch fabric protection, a signal failure on the trunk fiber or on a trunk card causes the system to switch to the protecting signal. Channel layer protection is most appropriate for multiservice OTU1 streams where the sub-wavelength services terminate at different sites. Multichannel ODU-layer protection should be used whenever the sub-wavelength services of a multiservice OTU1 stream terminate at the same sites. Single-channel ODU layer protection should be established for any OTU1 stream that carries a single, directly-mapped service such as an OC-48 or STM-16.

For OTU2 protection, the CN 4200/CN 4200 MC offers integrated optical switch protection on the 10G transport modules.

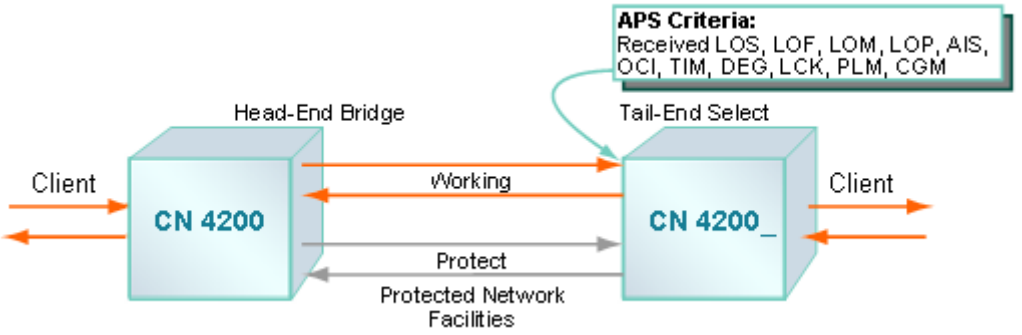


Figure 26 **CN 4200/CN 4200 MC optical protection switching**

Optical protection switching can also be implemented using the OPS modules. The discrete OPS modules allow network designers to deploy optical protection switching at several levels in the network to provide trunk protection, wavelength protection, or client protection. Trunk protection guards against network fiber breaks in the trunk line. Wavelength protection guards against wavelength failures, which may be the result of either a network fiber cut or a far-end transmitter failure. Client protection is positioned on the client interfaces of the transport cards, switching between working and protecting client ports and presenting a single protected channel to the client equipment.

Supported network topologies

This section describes supported network topologies.

Optically managed network topologies (wavelength level)

Using either CWDM or DWDM SFP transceivers and the appropriate optical filter modules, operators can implement any of the following optical transport topologies discussed in this section.

Point-to-point

Figure 27 on page 59 shows an unprotected configuration that interconnects two systems, residing at separate sites, over a single fiber pair. In this configuration one optical filter positioned at each node muxes/demuxes several WDM OTU1 transport signals.

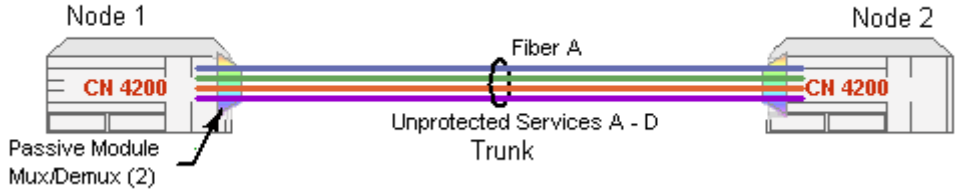


Figure 27 Unprotected point-to-point configuration

The CN 4200CN/CN 4200 MC also supports protected point-to-point topologies for maximum protection of client services. Figure 28 depicts one such configuration.

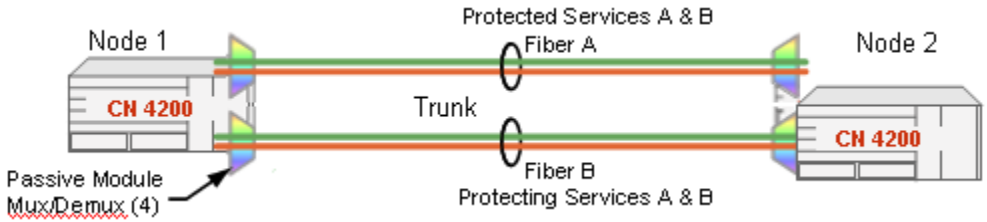


Figure 28 Protected point-to-point configuration

Linear add/drop point-to-point

The CN 4200/CN 4200 MC can also support a linear optical add/drop point-to-point configuration where two terminal nodes bracket some number of intermediate add-drop nodes. In Figure 29, the terminal nodes are 1 and 4 and the add/drop nodes are 2 and 3.

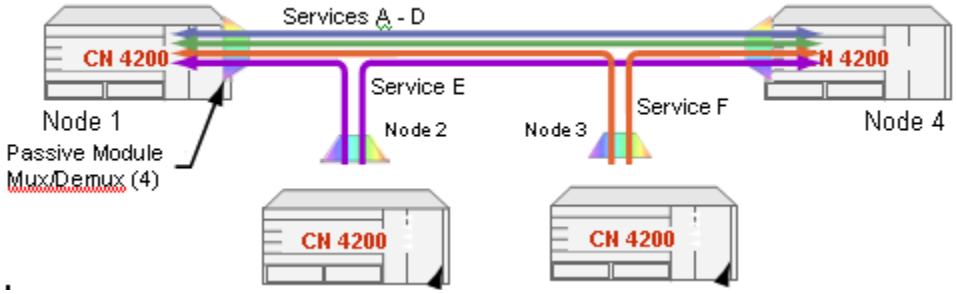


Figure 29 Linear Add/Drop configuration

Hubbed ring

A hubbed ring is composed of a hub and two or more add/drop or satellite nodes, as shown in Figure 30. All channels on the ring originate and terminate on the hub node. At add/drop nodes, certain channels are terminated (dropped and added) while channels not being dropped are passed through optically without being electrically regenerated.

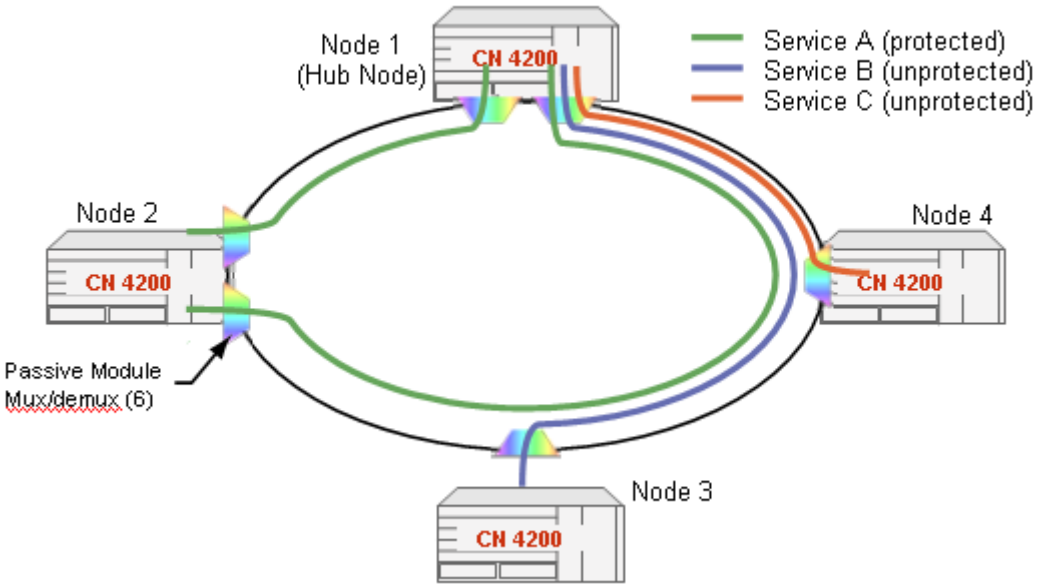


Figure 30 Hubbed ring configuration

Meshed ring

A meshed ring is a physical ring having the logical characteristics of a mesh, as shown in Figure 31. While traffic travels on a physical ring, the logical connections between individual nodes are meshed.

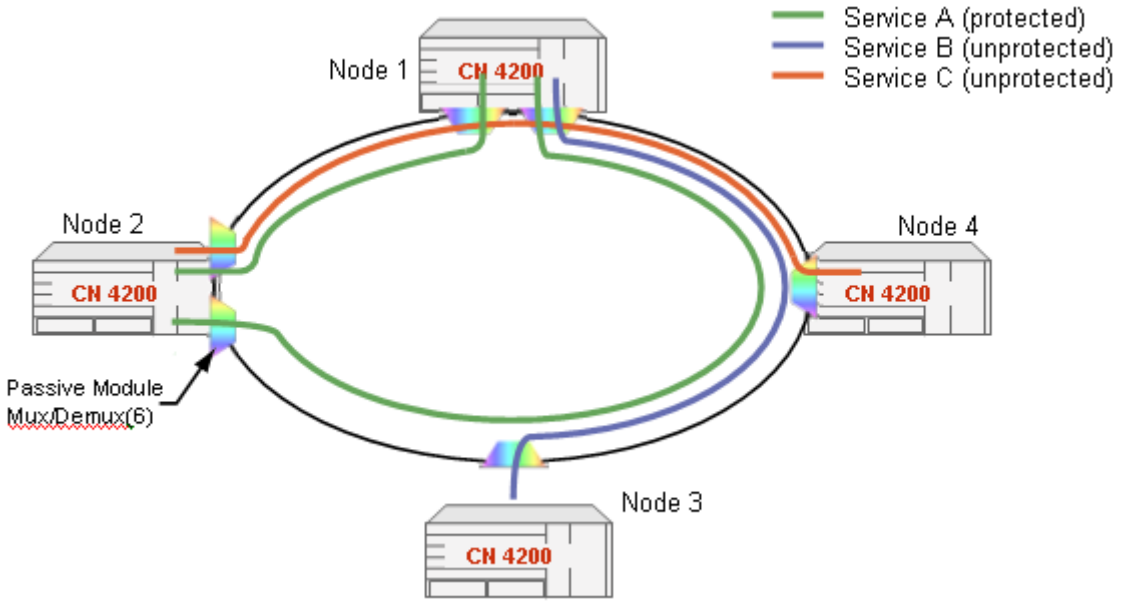


Figure 31 **Meshed ring configuration**

Electronically managed topologies (sub-wavelength level)

For any given aggregated wavelength, operators can implement the same basic topologies for the encapsulated client services as those described for wavelength-level networking. The logical connections are identical to those shown in the diagrams for the wavelength-level topologies (Figures 27 through 31) except that service aggregation is performed electronically by the distributed switch fabric rather than optically by optical filters.

Power budget calculations

Span margin

Margin is assigned depending on amplifiers present. The variable gain amplifier (OAV) with span loss compensation (see "Span loss compensation" on page 62) automatically adjusts for span margin. For fixed-gain amplifiers (OAFs), 0.4dB plus 3 percent of span loss needs to be added to the calculation. Ciena component specifications already include connectors.

Span loss compensation

Ciena's span loss compensation feature mitigates the effects of aging spans by dynamically adjusting the gain of a span's receive amplifier to offset any increased loss, such as that which occurs due to fiber aging. Span loss compensation acts on a per fiber basis, thus ensuring independent gain adjustments on each fiber in the span. Ordinarily, the affect of aging spans must be set aside as system margin during initial span engineering, but when this loss is offset through dynamic span loss compensation, much less margin (6 - 8dB for a regional system) need be held in reserve.

Diagnostics and maintenance

For configuration, power budget calculation, and troubleshooting details, consult the Ciena technical publications. Additional information regarding the CN 4200/ CN 4200 MC is accessible at http://www.ciena.com.

CIENA CN 2000

The CIENA CN 2000 is a SONET multiplexer performing the adaptation of Fibre Channel, Gigabit Ethernet, and ESCON to SONET, providing storage application transparent connectivity over SONET or DWDM networks.

The CN 2000 has two models:

- OUSP 2048 runs OUSP software release 2.04.
- OUSP 2048E runs OUSP software release 3.10.

The OUSP 2048 provides a total of six and the OUSP 2048E provides a total of eight configurable connections for Fibre Channel, ESCON, or Gigabit Ethernet into a SONET service (OC-3/OC-12/OC-48 or DS-3, which is only available on OUSP 2048E). These interfaces are then configured on the CN 2000 to reside on dedicated STS-1s (up to 96). The number of STS-1s provisioned determines the bandwidth available to the connection, and should be allocated to meet performance guidelines as required by the application.

The equivalent number of STS-1s for the support of wire rate of each of the protocols is:

- Fibre Channel — 20 STS-1
- Gigabit Ethernet — 24 STS-1
- ESCON — 4 STS-1

In many cases, however, applications require significantly less than wire rate. Therefore, less than the full rate of STS-1 can be provisioned, allowing for more circuits per line interface to be transported.

Note: Table 2 on page 65 contains examples of sub-rate provisioning.

If the OUSP is configured for service path protection, 96 STS-1s through two OC-48 connections are available, yielding 5 Gb/s total SONET bandwidth. 1+1 protection reduces this to 2.5 Gb/s (48 STS-1s). Figure 32 on page 64 and Figure 33 on page 64 show the rear view of the OUSP 2048 and 2048E models.

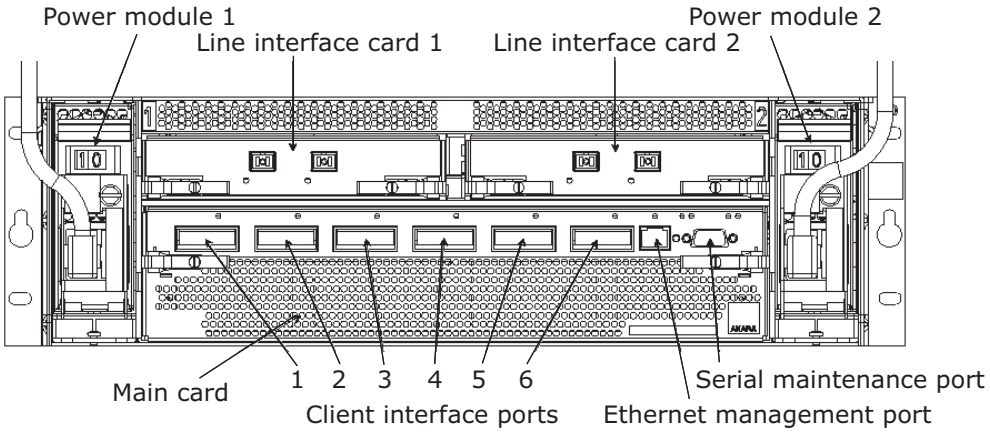


Figure 32 CIENA CN 2000, OUSP 2048 model (rear view)

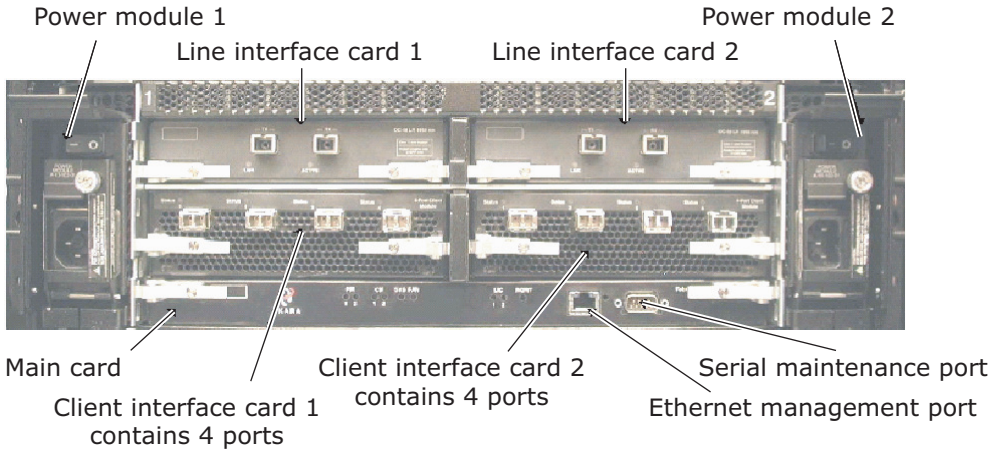


Figure 33 CIENA CN 2000, OUSP 2048E model (rear view)

Once the network connection is known, use Table 2 to allocate the appropriate number of STS-1s.

Table 2 Maximum number of Fibre Channel circuits on the OUSP

Line Interface	Network	Number of STS-1s per Fibre Channel circuit	Maximum number of circuits (1+1 Linear protection)	Maximum number of circuits (Service path protection)
OC-48	DWDM	20	2	4
OC-48	DWDM	10	4	6
OC-48	DWDM	8	6	6
OC-12	DWDM/SONET	12	1	2
OC-12	DWDM/SONET	6	2	4
OC-12	DWDM/SONET	2	6	6
OC-3	SONET	3	1	2
OC-3	SONET	1	3	6

OC-48 is the most com68mon interface into DWDM networks, with OC-12 being less common. OC-3 is the most common interface for SONET connectivity, with OC-12 being less common.

There are two ways to configure the CIENA CN 2000:

- Start a CLI session using Telnet, or
- Install the OUSM 7000 GUI and server.

The OUSM software requires a Solaris/Windows server and a Windows client. Refer to the CIENA documentation for additional details.

The following are the recommended configuration parameters for the CIENA CN 2000:

- Enable Extended Reach Mode (flow control on) for Fibre Channel and insure that auto negotiation for BB_Credit is configured.
- Enable the Link Reset on Protection switch (**lr-protocol-link-reset**).
- Set one CN 2000's synchronization mode as self-timed, and all others loop-timed.

- ESCON SRDF requires four STS-1s. If configured for fewer than four STS-1s and EMC FarPoint™ is used, the FarPoint buffers cannot exceed 500 KB.
- (Model OUSP 2048E only) Enable Auto Compression mode to get optimum throughput.

You must also enable Interop mode on Brocade switches.

Extended reach mode distance solution for Fibre Channel

In extended reach mode, the CN 2000 extends the reach of the Fibre Channel protocol by locally terminating the R_RDYs from the attached equipment and providing instantaneous R_RDY responses to received frames. The attached equipment still transparently performs Fibre Channel port login through the CN 2000.

Extended reach mode enables the attached equipment receiving data to control the maximum sustainable throughput over any distance. When an attached device slows the traffic flow by reducing or stopping the transmission of R_RDYs to the CN 2000, the CN 2000 buffers the frames in transit between the connected CN 2000s until the attached device resumes normal traffic flow.

Some frame loss still can occur if the buffers overflow due to extended traffic pauses, depending on the bandwidth provisioned for the service and the distance between the connected CN 2000s. To guarantee zero frame loss, the system must operate within the parameters defined under *Enhanced Distance Limits for Lossless Throughput During Endpoint Congestion*.

Enhanced distance limits for lossless throughput during endpoint congestion

When Fibre Channel extended reach or Gigabit Ethernet perfect Quality of Service is enabled, CIENA guarantees zero frame loss over the distance calculated using the following formula:

$$\text{Distance} \leq \frac{\text{BB\_Credit} * 108\ (\text{km} * \text{MB/s})}{\text{Throughput}}$$

Where:

- **Distance** the service path length in km.
- **BB_Credit** is **256** for OUSP 2048 and **1792** for OUSP 2048E.
- **Throughput** is the average traffic in MB/s) transmitted across the service path.

A service path can be extended indefinitely when the attached client equipment receiving the traffic is not congested. The receiving device is considered congested if it stops issuing R_RDYs (for Fibre Channel).

When the receiving client equipment is not congested, there is theoretically no limit to how far the service path can be extended.

If the limit defined in the calculation is exceeded and the receiving client equipment is congested, frames could be lost.

The *CN 2000 Installation, Configuration and Engineering Guide* (A0012103-A00 ICE GUIDE.pdf, available from the CIENA Corporation), contains additional information on flow control, transport latency, and data compression.

Figure 34 depicts the client (Fibre Channel and ESCON) and line (OC-N) connections for the CIENA solution.

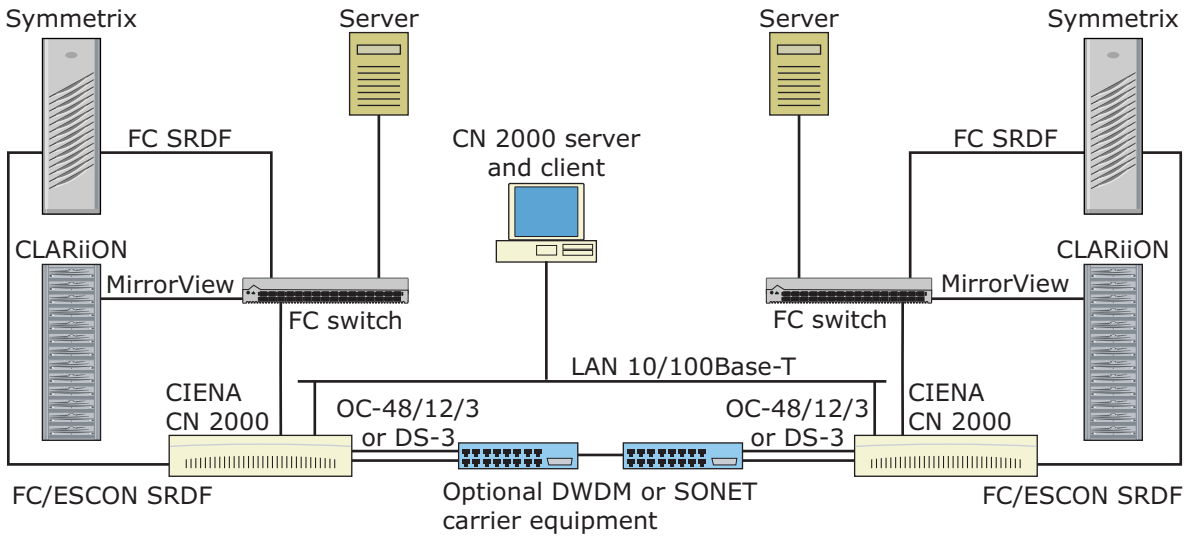


Figure 34 Typical CIENA CN 2000 distance extension setup

4

Cisco Products Data

This chapter contains data on Cisco products.

Note: For information on EMC-qualified third-party products, refer to the *EMC Select* document on Powerlink.

Cisco Nexus 5020

This section introduces the Nexus 5020 and contains the following information:

Note: EMC resells the Cisco Nexus switch. For Cisco switch documentation, visit http://cisco.com. EMC Connectrix® MDS release notes and data sheets can be found on Powerlink. EMC Connectrix Nexus 5000 release notes and the Nexus 5020 and 5010 data sheets can be found on Powerlink.

Description

The Nexus 5020 switch is a 2 RU, top-of-rack switch that provides Ethernet and Fibre Channel consolidation in a single physical cable. The Fibre Channel over Ethernet (FCoE) protocol is used to consolidate Ethernet and Fibre Channel traffic onto the same physical connection between the server and the switch. As a top-of-rack switch, all the servers in the rack connect to the Nexus 5020 switch, and it connects to the LAN or SAN.

The Nexus 5020 switch provides 10-Gigabit Ethernet and FCoE ports and both 10-Gigabit Ethernet and native 1-, 2-, and 4-Gbps Fibre Channel ports. The switches provide consolidated I/O connectivity to both production Ethernet LANs and Fibre Channel SANs in a cost-effective, high-performance, low-latency Ethernet switch.

Key features

The Nexus 5020 has the following features:

- Provides 1.04 terabits per second (Tb/s) throughput with very low latency.
- Forty fixed 10-Gigabit Ethernet, Cisco Data Center Ethernet, and FCoE Small Form Factor Pluggable Plus (SFP+) ports. Sixteen of the forty fixed ports support both Gigabit Ethernet and 10-Gigabit Ethernet. The default is 10-Gigabit Ethernet.
- Two expansion module slots that can be configured to support up to 12 additional 10-Gigabit Ethernet, Cisco Data Center Ethernet, and FCoE SFP+ ports, up to 16 Fibre Channel switch ports, or a combination of both.
- Serial console port and an out-of-band 10/100/1000-Mbps Ethernet management port.
- 1+1 redundant, hot-pluggable power supplies.
- 4+1 redundant, hot-pluggable fan modules to provide highly reliable front-to-back cooling.

Supported features

For the most up-to-date information on supported features, consult the *EMC Support Matrix* located on the E-Lab Interoperability Navigator.

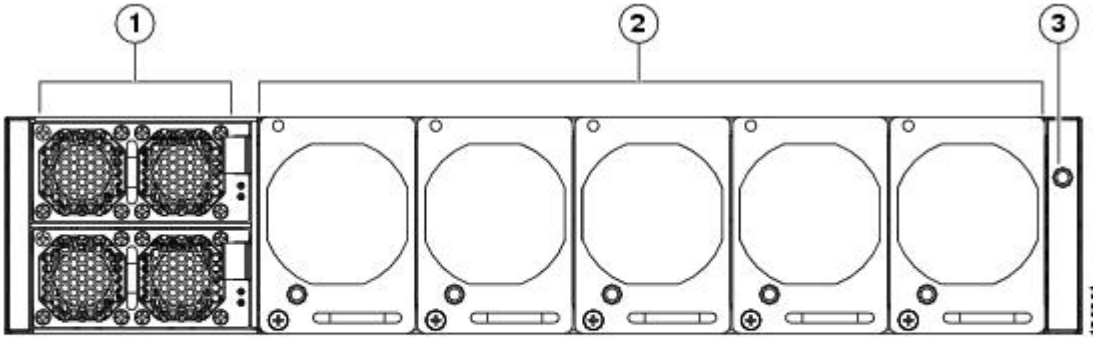
Unsupported features

For the most up-to-date information on unsupported features, consult the most current version of the appropriate Connectrix M Series release notes and product documentation on Powerlink.

Front view

The Nexus 5020 chassis is 2 RU (3.47 inches) tall, 17.3 inches wide, and 30.0 inches deep. It is designed to be mounted in a standard 19-inch rack. The switch has two power supplies and five fans modules on the front of the switch. Ports are at the rear of the switch.

The airflow is front to back. Figure 35 shows the front of the Nexus 5020 switch.

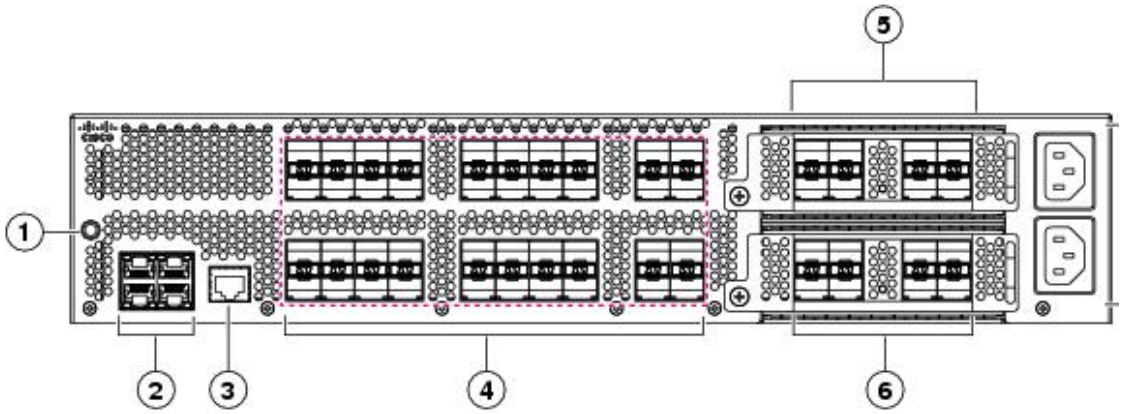


1	Two power supplies	3	System status LED
2	Five fan modules		

Figure 35 Nexus 5020 (front view)

Rear view

The rear of the Nexus 5020 chassis has 40 fixed 10-Gigabit Ethernet ports, 2 slots for optional expansion modules, an Ethernet connector with 2 cross-connect ports and 2 management ports, a console port, and 2 AC power connectors. Figure 36 on page 73 shows the rear of the Nexus 5020 switch.



1	System status LED	4	Slot 1, with 40 fixed 10-Gigabit Ethernet ports (highlighted in red).
2	Ethernet connector with two cross-connect ports on left side, and two network management1 (top) and management2 (bottom) ports on the right side	5	Slot 2 for an optional expansion module; shown here with a 4-port Fibre Channel plus 4-port 10-Gigabit Ethernet expansion module
3	Console port	6	Slot 3 for an optional expansion module; shown here with a 4-port Fibre Channel plus 4-port 10-Gigabit Ethernet expansion module

Figure 36 **Nexus 5020 (rear view)**

System architecture

Performance

- Layer 2 hardware forwarding at 1.04 Tb/s or 773.8 million packets per second (Mp/s)
- MAC address table entries: 16,000
- Low-latency cut-through design provides predictable, consistent traffic latency regardless of packet size, traffic pattern, or enabled-features

Fibre Channel ports

- Up to 16 4/2/1 Gb/s auto-sensing ports
- Port types:
  - Fibre Channel standard port type: E
  - Fibre Channel enhanced port types: SD and TE

Gigabit Ethernet Ports

- 40 fixed 10 Gigabit Ethernet ports
  - Two open slots accomodates up to 12 more GE ports

Virtual SANs (VSANs)

- Up to 32 VSANs supported

Media types

- Hot-pluggable 10 Gigabit Ethernet SFP+ optics
- 10 Gigabit Ethernet SFP+ Copper Twinax
- 4 Gigabit per second Fibre Channel SFPs

Classes of Fibre Channel service

- Class 3
- Class F

Fabric services

- Name Server
- Registered State Change Notification (RSCN)
- Login Services
- Name Server Zoning

Management

Interface

- Switch management using 10/100/1000 management or console ports
- CLI-based console to provide detailed out-of-band management

Mechanical specifications

- (HxWxD): 3.47 in. x 17.3 in. x 30.0 in. (8.8 x 43.9 x 76.2 cm) -2 RU
  - Height =: 3.47 in. (8.8 cm)
  - Width = 17.3 in (43.9 cm)

  - Depth = 30.0 in. (76.2 cm)
- Weight
  - With 1 power supply and 5 fan modules = 44 lbs (20 Kg)
  - AC power supply = 4 lbs (2 Kg)
  - Expansion module = 1 lb (0.5 Kg)
  - Fully loaded (2 power supplies/2 expansion modules = 50 lbs (23 Kg)

Environment

- Temperature
  - Operating: 32 to 104° F (0 to 40° C)
  - Non-operating: -40 to 158° F (-40 to 70° C)
- Humidity (RH), Non-condensing: 5 to 95%
- Altitude: 0 to 10,000 ft (0 to 3,000 m)
- Cooling: Airflow, front to back

Power

- AC-input voltage = 100-240 VAC
  - Rated = 200-240 Vrms
- AC-input Frequency (VinFrequency
  - Minimum = 47 Hz
  - Rated = 50-60 Hz
  - Maximum = 63 Hz
- Maximum power = 750W
- Heat dissipation = 2,566 BTU/hr

Supported management protocols

- SSHv2, Telnet, AAA, RADIUS, TACACS+, Syslog, SNMPv1, v2, and v3
- Enhanced SNMP MIB support, XML (NETCONF) support, Remote Monitoring (RMON), Advanced Encryption Standard (AES) for management traffic, unified username and passwords across CLI and SNMP
- Microsoft Challenge Handshake Authentication Protocol (CHAAP)
- Digital certificates for management between switch and RADIUS server

- Cisco Discovery Protocol (DCDP) v1, v2
- Role-based Access Control (RBAC)
- Switched Port Analyzer (SPAN) on physical, PortChannel, VLAN, and Fibre Channel interfaces, Enhanced Remote SPAN (ERSPAN)
- Ingress and egress packet counters per interface, Network Time Protocol (NTP)
- Power-on self-test (POST), Cisco GOLD: Ethernet and Fibre Channel
- Comprehensive bootup diagnostic tests

Management applications

- CLI
- Fabric Manager and Device Manager

Reliability, availability, and serviceability

Reliability, availability, and serviceability features include:

- Hot swappable SFP optics
- Redundance hot-swappable field replaceable power supplies and fans
- Hot-swappable expansion modules
- N+1 power redundancy
- N+1 fan module redundancy
- Online diagnostics
- SNMP traps for alerts

Further reading

Hardware documents can be located at http://www.cisco.com.

Cisco Nexus 5010

This section introduces the Nexus 5010 and includes the following information.

Description

The Nexus 5010 switch is a 1RU, top-of-rack switch that provides Ethernet and Fibre Channel consolidation in a single physical cable. The Fibre Channel over Ethernet (FCoE) protocol is used to consolidate Ethernet and Fibre Channel traffic onto the same physical connection between the server and the switch. As a top-of-rack switch, all the servers in the rack connect to the Nexus 5010 switch, and it connects to the LAN or SAN.

The Nexus 5010 switch is a part of a family of switches that provide 10-Gigabit Ethernet and FCoE ports and both 10-Gigabit Ethernet and native 1-, 2-, and 4-Gbps Fibre Channel ports. The switches provide consolidated I/O connectivity to both production Ethernet LANs and Fibre Channel SANs in a cost-effective, high-performance, low-latency Ethernet switch.

Key features

The Nexus 5010 has the following features:

- Twenty fixed 10-Gigabit Ethernet, Cisco Data Center Ethernet, and FCoE SFP+ ports. Eight of the twenty fixed ports support Gigabit Ethernet and 10-Gigabit Ethernet speed.
- One expansion module slot that can be configured to support up to 6 additional 10-Gigabit Ethernet, Cisco Data Center Ethernet, and FCoE SFP+ ports, up to 8 Fibre Channel switch ports, or a combination of 4 additional 10-Gigabit Ethernet, Cisco Data Center Ethernet, and FCoE SFP+ ports with 4 additional Fibre Channel switch ports.
- Serial console port and an out-of-band 10/100/1000-Mbps Ethernet management port.
- 1+1 redundant, hot-pluggable power supplies.
- 1+1 redundant, hot-pluggable fan modules to provide highly reliable front-to-back cooling.

Supported features

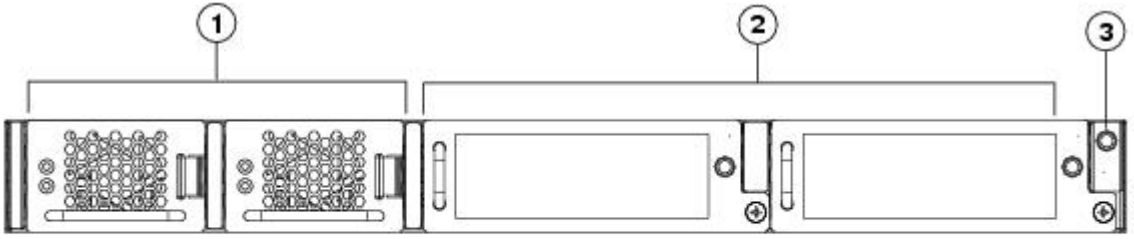
For the most up-to-date information on supported features, consult the *EMC Support Matrix* located on the E-Lab Interoperability Navigator.

Unsupported features

For the most up-to-date information on unsupported features, consult the most current version of the appropriate Connectrix M Series release notes and product documentation on Powerlink.

Front view

The Nexus 5010 chassis is 1 RU, 1.72 inches tall, 17.3 inches wide and 30.0 inches deep. It is designed to be mounted in a standard 19-inch rack. The switch has two power supplies and two fans modules on the front of the switch. Ports are at the rear of the switch. The airflow is front to back. Figure 37 on page 79 shows the front of the Nexus 5010 switch.

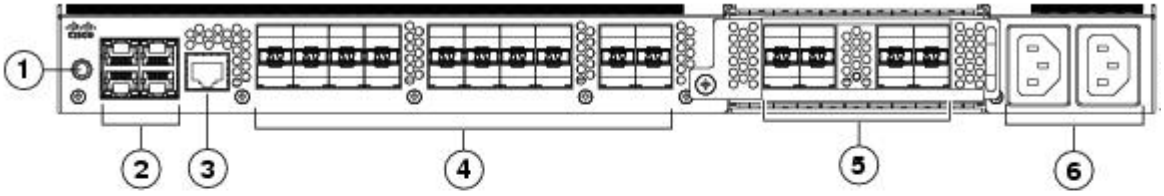


1	Two power supplies	3	System status LED
2	Two fan modules		

Figure 37 Nexus 5010 (front view)

Rear view

The rear of the Nexus 5010 chassis, shown in Figure 38, has 20 fixed 10-Gigabit Ethernet ports, 1 slot for an optional expansion module, an Ethernet connector with 2 cross-connect ports and 2 management ports, a console port, and 2 AC power connectors.



1	System status LED	4	Slot 1, with 20 fixed 10-Gigabit Ethernet ports (highlighted in red).
2	Ethernet connector with two cross-connect ports on left side, and two network management1 (top) and management2 (bottom) ports on the right side	5	Slot 2 for an optional expansion module
3	Console port	6	AC power connectors

Figure 38 Nexus 5010 (rear view)

System architecture

Performance

- Layer 2 hardware forwarding at 1.04 Tb/s or 773.8 million packets per second (Mp/s)
- MAC address table entries: 16,000
- Low-latency cut-through design provides predictable, consistent traffic latency regardless of packet size, traffic pattern, or enabled-features

Fibre Channel ports

- Up to eight 4/2/1 Gb/s auto-sensing ports
- Port types:
  - Fibre Channel standard port type: E, N_Ports for NPV mode
  - Fibre Channel enhanced port types: SD and TE

Gigabit Ethernet Ports

- 20 fixed 10 Gigabit Ethernet ports
  - One open slot accomodates up to six more GE ports

Virtual SANs (VSANs)

- Up to 32 VSANs supported

Media types

- Hot-pluggable 10 Gigabit Ethernet SFP+ optics
- 10 Gigabit Ethernet SFP+ Copper Twinax
- 4 Gigabit per second Fibre Channel SFPs
- 10 Gigabit Long-range SFPs

Classes of Fibre Channel service

- Class 3
- Class F

Fabric services

- Name Server
- Registered State Change Notification (RSCN)
- Login Services
- Name Server Zoning

Management

Interface

- Switch management using 10/100/1000 management or console ports
- CLI-based console to provide detailed out-of-band management

Mechanical specifications

- (HxWxD): 1.72 in. x 17.3 in. x 30.0 in. (4.368 x 43.9 x 76.2 cm) -1 RU
  - Height =: 1.72 in. (4.368 cm)
  - Width = 17.3 in (43.9 cm)
  - Depth = 30.0 in. (76.2 cm)
- Weight = Nexus 5010 with 2 power supplies and 1 expansion module is 35 lbs (15.875 Kg)

Environment

- Temperature
  - Operating: 32 to 104° F (0 to 40° C)
  - Non-operating: -40 to 158° F (-40 to 70° C)
- Humidity (RH), Non-condensing: 5 to 95%
- Altitude: 0 to 10,000 ft (0 to 3,000 m)
- Cooling: Airflow, front to back

Power

- AC-input voltage = 100-240 VAC
  - Rated = 200-240 Vrms
- AC-input Frequency (VinFrequency
  - Minimum = 47 Hz
  - Rated = 50-60 Hz
  - Maximum = 63 Hz
- Maximum power = 450W
- Heat dissipation = 1,536 BTU/hr

Supported management protocols

- SSHv2, Telnet, AAA, RADIUS, TACACS+, Syslog, SNMPv1, v2, and v3

- Enhanced SNMP MIB support, XML (NETCONF) support, Remote Monitoring (RMON), Advanced Encryption Standard (AES) for management traffic, unified username and passwords across CLI and SNMP
- Miscrosoft Challenge Handshake Authentication Protocol (CHAAP)
- Digital certificates for management between switch and RADIUS server
- Cisco Discovery Protocol (DCDP) v1, v2
- Role-based Access Control (RBAC)
- Switched Port Analyzer (SPAN) on physical, PortChannel, VLAN, and Fibre Channel interfaces, Enhanced Remote SPAN (ERSPAN)
- Ingress and egress packet counters per interface, Network Time Protocol (NTP)
- Power-on self-test (POST), Cisco GOLD: Ethernet and Fibre Channel
- Comprehensive bootup diagnostic tests

Management applications

- CLI
- Fabric Manager and Device Manager

Reliability, availability, and serviceability

Reliability, availability, and serviceability features include:

- Hot-swappable field replaceable power supplies, fans, and expansion modules
- N+1 power redundancy
- N+1 fan module redundancy
- Online diagnostics
- SNMP traps for alerts
- In Service Software Upgrades (ISSU) not supported

Further reading

Hardware documents can be located at http://www.cisco.com.

Cisco Nexus 4000

The Cisco Nexus 4000 Switch Module for IBM BladeCenter (also referred to as Cisco Nexus 4001I) is a Layer 2 device, which runs Cisco NX-OS.

This section contains information on this switch module, including:

For more detailed information about this Cisco switch module, refer to www.cisco.com.

Description

The Cisco Nexus 4000, shown in Figure 39 on page 85, is a 20 port, 10 G *FCoE aware* Ethernet switch module intended for use in IBM Blade Server and is fully compliant with the IEEE 802.1 Data Center Bridging (DCB) specification. This blade switch is also referred to as the Nexus 4001I switch module.

Figure 39 **Nexus 4001I switch module for IBM BladeCenter**

The term *FCoE aware* indicates that the switch is capable of performing FIP snooping and supports the creation of dynamic ACLs. It also indicates that the Nexus 4000 does not contain an FCF (Fibre Channel Forwarder) and as a result FCoE frames received from CNAs connected to the Nexus 4000 that are destined to a native FC device must be forwarded to a switch that does contain an FCF before the FC frame can be de-encapsulated and forwarded onto the SAN. Because the CNAs are not directly connected to a switch that contains an FCF, the resulting topology is actually referred to as a CEE Cloud.

Due to the nature of a CEE Cloud topology, some of the setup steps will differ from steps used in a *direct connect* environment.

Note: For more information on direct connect and CEE Cloud, refer to the "FCoE Initialization Protocol (FIP)" section in the *Fibre Channel over Ethernet TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com.

14 of the 10 G ports are used to connect to the server blades and 6 of the ports are available to connect to the Nexus 5020.

The six external interfaces can all be bundled into a Port Channel.

Management

The Nexus 4000 can be managed via Telnet.

Key features

The Cisco Nexus 4000 includes the following features:

- A total of 20 high-bandwidth, full-line-rate, nonblocking 10 Gigabit Ethernet ports
  - 14 downlinks: Used for each blade server in the IBM BCH or BCH-T chassis; use Gigabit Ethernet and 10 Gigabit Ethernet autosensing
  - 6 uplinks: Used for connectivity to upstream switches with Gigabit Ethernet and 10 Gigabit Ethernet autosensing
- Simplified blade server I/O access based on lossless 10 Gigabit Ethernet and unified fabric architecture; provides standard Ethernet, Fibre Channel over Ethernet (FCoE), and IP-based storage such as Small Computer System Interface over IP (iSCSI) and network-attached storage (NAS) through the same lossless 10 Gigabit Ethernet interface, reducing the cabling and interconnect modules needed and so using less power
- Support for IEEE 802.1 Data Center Bridging (DCB) lossless Ethernet
- Tight integration with server virtualization with the Cisco Nexus 1000V Switch
- 1.5 us latency

Manageability

Simple Network Management Protocol

The Cisco NX-OS software is compliant with Simple Network Management Protocol (SNMP) version 1, version 2, and version 3. A large number of MIBs is supported.

Role-Based Access Control

With role-based access control (RBAC), you can limit access to device operations by assigning roles to users. You can customize access and restrict it to the users who require it.

Cisco NX-OS Device Configuration Methods

You can configure devices using the CLI from a Secure Shell (SSH) session or a Telnet session. SSH provides a secure connection to the switch. You can also configure devices using the XML management

interface, which is a programmatic method based on the NETCONF protocol that complements the CLI.

Hardware characteristics

This section lists the Switch Module hardware characteristics:

- Six external 10 Gb Ethernet ports for uplink
- 14 internal XAUI ports for connection to the server blades in the chassis
- One 10/100/1000Base-T RJ45 copper management port for out-of-band management link

  This port is available on the front panel next to the console port.
- One external RS-232 serial console port

  This port is available on the front panel and uses an RJ45 connector.

Hardware features

This section describes the physical features of the Switch Module and includes the following topics:

External Interfaces

This section describes the external interfaces on the Switch Module and includes the following sections:

- "Location of Interfaces " on page 88
- "Out-of-Band Management Port " on page 88
- "External 10-Gigabit Ethernet Module Ports " on page 88
- "Serial Console Port " on page 89
- "Location of LEDs " on page 91

Location of Interfaces

Figure 40 displays the Switch Module and the hardware interfaces, which are described in following table.

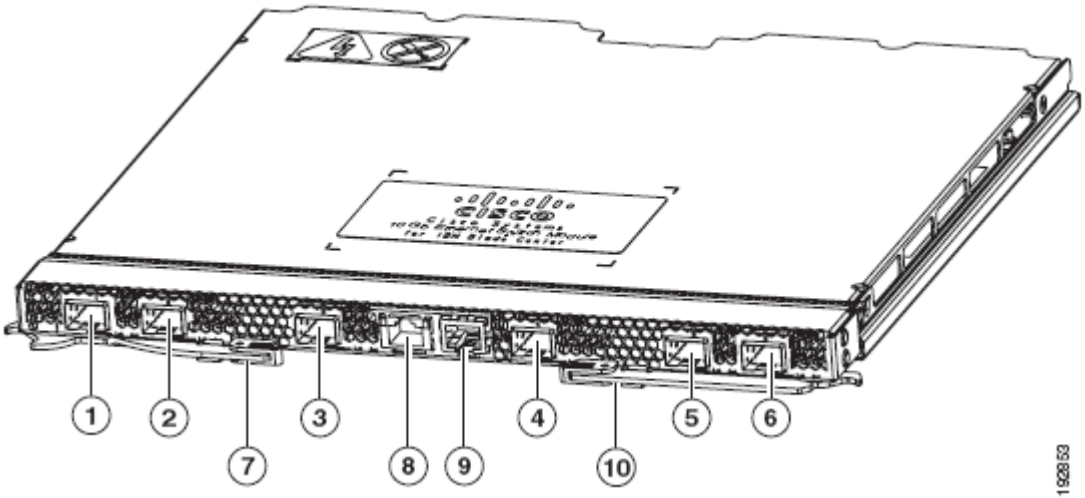


Figure 40 Switch module 40011

1-6	10 Gb Ethernet Small Form Factor Pluggable (SFP+) ports	7, 10	Release latches
8	Out-of-band management port (labeled Management)	9	Serial console port has RJ45 connector for management console (labeled Console)

Out-of-Band Management Port

The out-of-band management RJ45 port supports10/100/1000Base-T Ethernet. It can autonegotiate to operate at any line speed (10, 100, 1000 Mbps); full and half duplex modes for 10 and 100 Mbps line speed, and only full duplex at 1000 Mbps.

External 10-Gigabit Ethernet Module Ports

The Switch Module contains a switching ASIC that is capable of forwarding Ethernet and FCoE packets at wire rate speed.

Six SFP+ ports are wired for external uplink access and are located on the front panel of the Switch Module. These external uplinks support 10GBASE-SR SFP+.

The port speed for the internal Ethernet ports can be set to 1 Gb or 10 Gb (only the internal Ethernet ports can be set to auto-negotiate. The duplex setting must be full duplex.

For information on configuring the port settings, refer to the Cisco Nexus 4001I and 4005I Switch Module for IBM BladeCenter NX-OS Configuration Guide and the Cisco Nexus 4001I and 4005I Switch Module for IBM BladeCenter NX-OS Command Reference.

Serial Console Port

The Switch Module can be accessed through a serial console port located on the front panel. This is the standard Cisco RS-232 console using an RJ45 connector for the Switch Module.

You can use the console port to connect the Switch Module to a host such as a PC, workstation, or a terminal server. Use the supplied console cable to connect the switch module to a host.

The console port is an asynchronous RS-232 serial port with an RJ-45 connector. Table 3 lists the pinouts for the console port on the Switch Module.

Table 3 Serial console port pinouts

Pin	Signal
1[a]	RTS
2	DTR
3	TxD
4	GND
5	GND
6	RxD
7	DSR
8	CTS

a. Pin 1 is connected internally to pin 8.

For more information about the console port, refer to the *Cisco Nexus 4001I and 4005I Switch Module for IBM BladeCenter Getting Started Guide* and the *Cisco Nexus 4001I and 4005I Switch Module for IBM BladeCenter NX-OS Configuration Guide* located at www.cisco.com.

Internal Interfaces

This section describes the internal interfaces of the Switch Module and includes the following topics:

Internal 10-Gigabit Ethernet Module Server Ports

The Switch Module contains a switching ASIC capable of forwarding Layer-2 packets at wire rate speed.

Fourteen of the 10 Gb Ethernet ports are wired for internal access to the server blades. These downlink ports connect to the server blades through the IBM BladeCenter chassis backplane, using the KX/KX4 interface.

The port speed for the internal Ethernet ports can be set to 1 Gb, 10 Gb, or auto-negotiate. However, the duplex setting must be full duplex.

Note: The auto-negotiate speed mode works with network adapters that support IEEE802.3ap Clause 73, fixed 1G or fixed 10G. For network adapters that use the auto-negotiate speed mode, but do not support IEEE802.3ap Clause 73, the switch port speed must be set to corresponding fixed speed of either 10 Gb or 1 Gb.

Internal 100BASE-T Ethernet Management Port

The internal Ethernet management port (MGMT1) is used only for Switch Module management traffic, not for data traffic. It is connected to the IBM Advanced Management Module (aMM) through the blade enclosure backplane connector. Traffic to and from this port is isolated from the switch module ports. This port only supports autonegotiation with 100 Mb/s and full-duplex mode.

The Switch Module supports two 100Base-T Ethernet ports connected to the Management Modules through the backplane. The two Management Module Ethernet interfaces are combined into a single Ethernet interface on the switch module management circuits. Which of the two Management Module interfaces is active is determined by the chassis.

Switch Module LEDs

This section describes the LEDs on the Switch Module and includes the following topics:

Location of LEDs

You can use the switch module LEDs to monitor switch module activity. Figure 41displays the LEDs that are described in Table 4, Table 5 on page 92, and Table 6 on page 93.

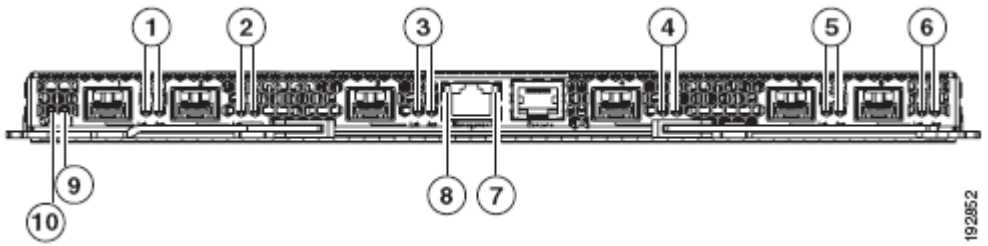


Figure 41 Switch Module LEDs and System Activity LEDs

1	10 Gb Ethernet port 15 Link and Activity LED	2	10 Gb Ethernet port 16 Link and Activity LED
3	10 Gb Ethernet port 17 Link and Activity LED	4	10 Gb Ethernet port 18 Link and Activity LED
5	10 Gb Ethernet port 19 Link and Activity LED	6	10 Gb Ethernet port 20 Link and Activity LED
7	Out-of-band management port Activity LED	8	Out-of-band management port Link LED
9	System Status Fault LED	10	System Status OK LED

Uplink 10 Gb Ethernet Port LEDs

The Switch Module port LEDs are described in Table 4. Each of the six uplink ports has two LEDs. The Activity LED blinks green or is off to indicate link activity. The Link Status LED is either solid green or off.

Table 4 Port LED indications during normal operation

Port LED Indications		Port Status
Activity LED Indication	**Link Status LED Indication**	**LED Description**
Off	Off	No link established
Off	Solid green	No activity but link established
Blinking green	Solid green	Activity (traffic) on an established link
Blinking green	Off	Activity (traffic) on an established link and port disabled (error disabled, STP blocked)

System Status LED

The system status is indicated by two LEDs. The OK LED is off when there is no power to the device, and displays as blinking or solid green when the system is active. The Fault LED is either off or displays as amber to indicate a malfunction. Table 5 describes the System Status LED conditions.

Table 5 System LED indications

System LED Indication	Description
OK LED	
Dark (off)	Power off
Solid green	System normal
Blinking green	power-on self-test (POST) in progress
Fault LED	
Dark (off)	No malfunction
Solid amber	System fault or malfunction

Management Port LEDs

The out-of-band management port has two 10/100/1000 Base-T Ethernet LEDs. The indications of the Link LED and Activity LED are described in Table 6.

Table 6 Out-of-Band Management Port LED Indications

LED Indication	Description
Link LED	
Solid green	Ethernet connection is established at the particular port with its link partner
Off	The port is not linked
Activity LED	
Blinking Green	Port is operating
Off	No activity

Supported SFP transceiver

The Switch Module supports both copper and fiber SFP+ Ethernet transceivers. The enhanced Small-Form-Factor Pluggable (SFP+) 10-Gigabit Ethernet transceiver module is a bidirectional device with a transmitter and receiver in the same physical package. It has a 20-pin connector on the electrical interface and duplex LC connector on the optical interface. The Switch Module supports the following transceiver:

Table 7 Supported SFP transceiver

Model	Description
SFP-10G-SR	10-Gigabit Ethernet—short range SFP+ module

Management options

The Switch Module offers the following management options:

- BladeCenter Advanced Management Module. The Switch Module supports the chassis management interface to the aMM in a BladeCenter chassis. For a standalone switch modules, you

can use the aMM to configure the Switch Module. See the IBM BladeCenter Advanced Management Module User's Guide for more information.

- SNMP network management. You can manage Switch Modules from an SNMP-compatible management station. The Switch Module supports a comprehensive set of Management Information Base (MIB) extensions. See the Cisco Nexus Switch Module 4001I and 4005I for IBM BladeCenter NX-OS Configuration Guide on Cisco.com and the documentation that came with your SNMP application for more information.

Product specifications

Table 8 lists the specifications for the Cisco Nexus 4000.

Table 8 Product specifications (page 1 of 2)

Description	Specification	
Performance	• 400-Gbps switching capacity • Forwarding rate of 300 million packets per second (mpps) • Low, predictable, and consistent latency of 1.5 microseconds regardless of packet size, traffic pattern, or enabled features on 10 Gigabit Ethernet interface • Line-rate traffic throughput on all ports • Configurable maximum transmission units (MTUs) of up to 9216 bytes (jumbo frames)	
Hardware tables and scalability	MAC addresses	8192
	Number of configurable VLANS	512 (configurable range 1 to 4096)
	Spanning-tree instances (sum of the VLANs per port: that is, the number of VLANs times the number of ports)	• Rapid Spanning Tree Protocol (RSTP): 3000 • Multiple Spanning Tree (MST) Protocol: 10,000
	Access control list (ACL) entries	512
	Number of EtherChannels	7
	Number of ports per EtherChannel	8
	Queues	8 hardware queues per port
	Memory	2-GB DDR2 DIMM with ECC
	Flash memory	a-GB eUSB

Table 8 Product specifications (page 2 of 2)

Description	Specification
Power consumption	12V at 5.75A (69W) (maximum)
Indicators	Total of 16 LEDs on the faceplate • 2 LEDs for uplink port status • 2 switch-status LEDs • 2 management-port-status LEDs
Dimensions (L x W x H)	10.27 x 11.57 x 0.79 in. (260.93 x 293.9 x 20 mm)
Weight	Approximately 3.94 lb (1.79 kg)
Environmental ranges	• Operating temperature: 32 to 104?‹ F (0 to 40?‹C) • Storage temperature: .13 to 158?‹ F (.25 to 70?‹C) • Operating relative humidity: 10 to 85% noncondensing • Storage relative humidity: 5 to 95% noncondensing
Predicted mean time between failure (MTBF)	Approximately 187,265 hours

Technical specifications

Technical specifications for the Switch Module in listed in Table 9 and Table 10.

Table 9 Switch module environmental and physical specifications (page 1 of 2)

Environmental Ranges	
Operating temperature	32 to 104°F (0 to 40°C)
Storage temperature	–13 to 158°F (–25 to 70°C)
Relative humidity	10 to 85% (noncondensing)
Operating altitude	Up to 10,000 ft (3049 m)
Storage altitude	Up to 15,000 ft (4573 m)
Physical Specifications	
Weight	3 lbs 15 oz (1.79 kg)

Table 9 Switch module environmental and physical specifications (page 2 of 2)

Physical Specifications	
Dimensions (H x D x W)	0.79 x 10.27 x 11.57 in. (20 x 260.93 x 293.9 cm)

Table 10 Power specifications

Power specifications	
Maximum power	69 W
Input voltage range and frequency	12 VDC +/- 10%
Input current maximum	5.75 A (= 69 W/12 V)
Total input BTU	235 BTUs per hour, 69 W

Cisco Metro 1500

The Cisco Metro 1500 platform is a true protocol and bit-rate-independent fiber-optic transport system. It supports the following protocols: SONET, ATM, Gigabit Ethernet, IP, FDDI, and all optical interfaces (OC-n).

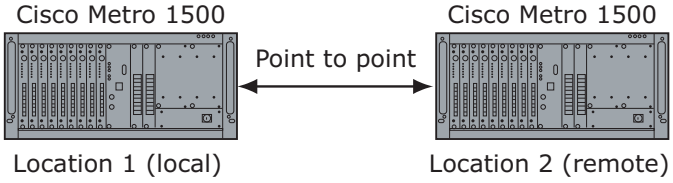
- The Cisco Metro 1500 does not have an internal backplane, and the optical connections are made using external jumpers.
- The system can support up to eight channel cards and has redundant (two) power supplies.
- Three types of channel card can be inserted into the chassis:
  - Low-Speed (LS) (data rate 10 to 200 Mb/s)
  - High-Speed (HS) (data rate 100 to 1250 Mb/s)
  - OC-48 (2.5G) (data rate 2.5 Gb/s)

DWDM Modules are *mux* and *demux* modules. The point-to-point configuration is normally connected between the mux and demux modules. If you require a protected scheme you will have to provision the boxes with RSM modules and use their connectors to run two single-mode (dark) fiber connectors. The RSM module monitors the signals and, if the primary connections fail, switches to the secondary backup connector or link.

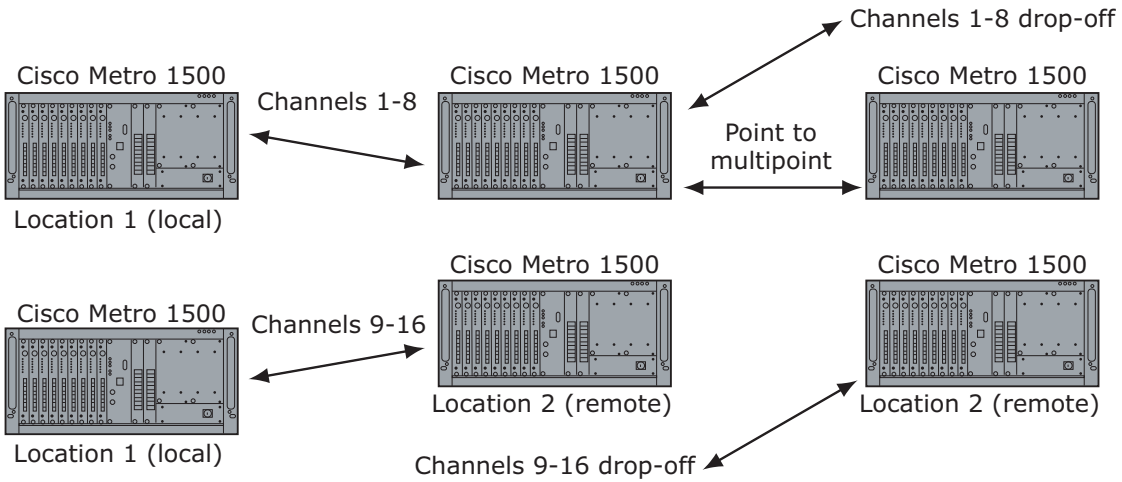
The operator should be aware that the RSM modules are a passive device and cause significant power losses to the system. The result is a significant shorter maximum distance; E-Lab Navigator contains information that can help you determine that distance.

The following configuration(s) can be implemented using the Cisco Metro 1500 system:

- **Point-to-point** — The point-to-point configuration, which is the basis for all other configurations, will include a local and remote site. The data will flow between the different sites using two links. Each link includes a transmit and receive single-mode fiber cable (dark fiber).



- **Point-to-multipoint**



Metro 1500 power budget calculations

Use the following information to calculate the power budget:

- Link loss budget for Cisco Metro 1500 input cards:

Card	Link loss budget
Standard	19 dB
Extended	24 dB
2.5 Gb/s	10 to 19 dB

- Fiber losses are calculated on the distances times the specifications of the fiber cable, in this case.2dB per km (80 km * 0.2 dB/km = 16 dB loss) and each connector has approximately 0.5 dB loss per connector.
- BSM (Band Splitter Module) has an insertion loss of 3dB. Mux insertion loss is approximately 4 dB.
- Demux insertion loss is approximately 4 dB. RSM insertion loss is approximately 3 to 5 dB. BSM insertion loss is approximately 3 dB.

No RSM, no BSM (unprotected mode) extended

Maximum link budget = 24 dB:

1. Calculate total link budget minus mux insertion loss minus demux insertion losses: 24 dB – 2(4) dB = 16 dB.
2. Divide resultant power budget by cable specification: 16 dB divided by 0.2 dB/km = 80 km (50 miles).

RSM, no BSM (protected mode) extended

Maximum link budget = 24 dB:

1. Calculate total link budget minus mux insertion loss minus demux insertion loss minus RSM insertion loss: 24 dB – 2(4) dB – 5 dB = 11 dB.
2. Divide resultant power budget by cable specification: 11 dB /0.2 dB/km = 55 km (34 miles).

Supported Metro 1500 topologies

Figure 42, next, and Figure 43 on page 100 show supported Cisco Metro 1500 topologies. (E-Lab Navigator contains distance limitations.)

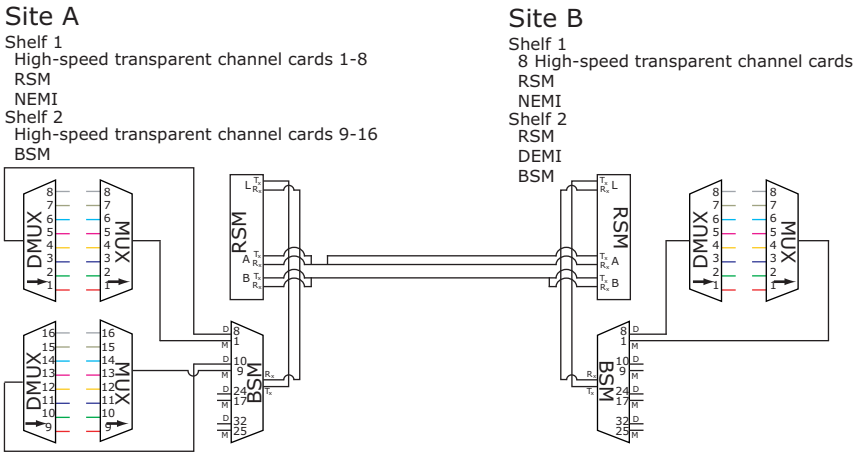


Figure 42 Point-to-point (two-site) configuration

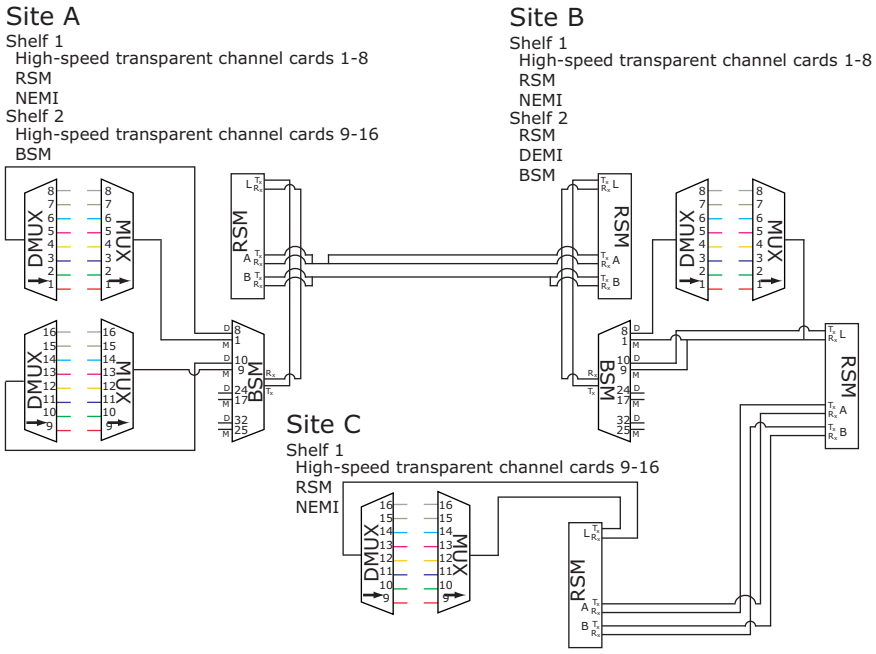


Figure 43 Multi hop (three-site) configuration

Metro 1500 diagnostics and maintenance

For configuration, power budget calculation and troubleshooting details consult the Cisco Metro 1500 technical publications.

Using the Symmetrix Fibre Channel director online utilities can complement repair and system diagnostics.

Cisco ONS 15540

The Cisco ONS 15540 platform (shown in Figure 44) is a true protocol and bit-rate-independent fiber-optic transport system. A client's 1310nm single-mode SC Fibre Channel protocol connection is converted from an electrical signal to an ITU G.692 compliant wavelength, and then optically multiplexes it with the other client signals for transmission over a fiber-optic link and demultiplexed from an optical wavelength back to an electrical signal.

The system is capable of supporting 3R (Reshape, Regeneration, Retime) mode with monitoring capabilities are Gigabit Ethernet, SONET (OC-3, OC-12, OC-48), SDH (STM-1, STM-4, STM-16), Fibre Channel (1 Gb/s), ESCON and FICON.

Up to 32 channels are supported on the ONS 15540 and 1310nm single-mode cables are accepted to the ONS 15540 unit.

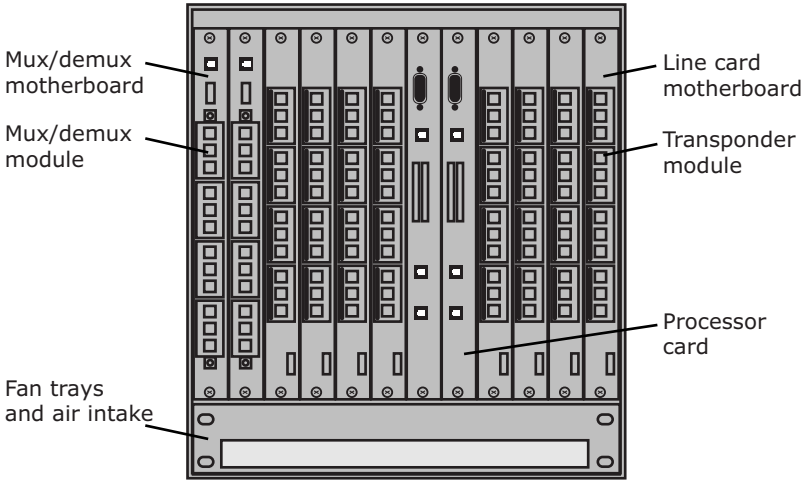


Figure 44 **Cisco 15540**

A 12-slot modular vertical chassis that receives power through redundant –48 VDC inputs and contains a redundant external AC power supply. The two left-most slots (slots 0 and 1) hold the mux/demux motherboards containing optical mux/demux modules corresponding to the east and west directions. Slots 2 through 5 and 8 through 11 hold the line card motherboards, which are populated with transponder modules. Slots 6 and 7 hold the processor cards.

The system has an optical backplane for carrying signals between the transponders and the optical mux/demux modules and an electrical backplane for system control.

Figure 45 illustrates the principle functions required for transmission of the signal between the client and transport networks, within the Cisco ONS 15540.

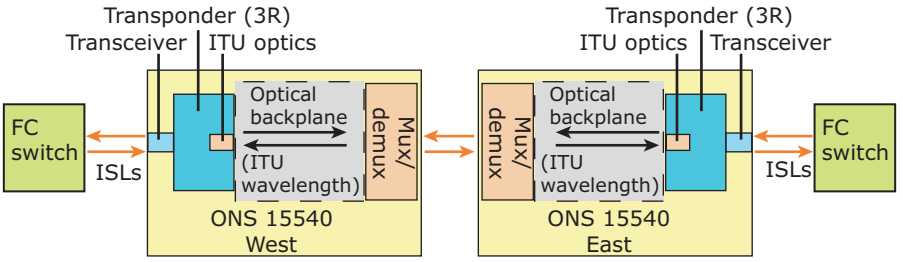


Figure 45 Client/network signal transmission in Cisco ONS 15540

From the *transmit* direction, the following functions occur. (From the *receive* direction the opposite functions occur.)

1. A transceiver receives the 1310 nm input client signal.
2. The client signal is converted to electrical; then 3R-function-signal enhancements are performed in the transponder.
3. A modulated laser diode converts the electrical signal to optical wavelength compliant to ITU laser grid.
4. Transmission of the signal is implemented over the optical backplane.
5. The optical Mux/demux module takes multiple (clients') input signals and multiplexes them into a single DWDM signal.
6. The DWDM signal is placed onto fiber for transmission on the DWDM network side.

ONS 15540 system components

The Cisco ONS 15540 has a modular architecture that allows flexibility in configuration and permits incremental upgrades of the system.

Transponder modules

The transponder modules populate the line card motherboards and have two interfaces; an external interface that connects to client equipment and an internal interface that connects to the line card motherboard.

Client-side interfaces

Client-side interfaces on the transponder module is protocol transparent and bit-rate transparent and accepts a client signal on the 1310nm wavelength through SC connections.

Both multimode (MM) and single-mode (SM) fiber are supported for client connections on specific protocols.

Encapsulation of client signals is supported on the transponder interfaces in either 3R-enhanced mode, which allows some client protocol monitoring (such as code violations and data errors) 3R mode, where the transponder is transparent to the client data stream or in regular 3R (Fast Ethernet, FDDI, 2 Gb/s Fibre Channel).

Note: For Fibre Channel switch (1 Gb/s) attachment, only 1310 nm wavelength single mode cables are supported on the ONS 15540. 850 nm multimode cables are supported only for serial (ESCON) protocols.

Transport-side interfaces

In the transponder module, the client signal is regenerated and retransmitted on an ITU-compliant wavelength across the optical backplane. The laser on each transponder module is capable of generating one of two wavelengths on the transport side. Thus, there are 16 different transponder modules (for channels 1 and 2, 3 and 4, 5 and 6, and so on, up to 31 and 32) to support the 32 channels.

Transport-software determines which wavelength each module should generate based on whether it is inserted in the upper (subslot 0 or 2) or lower (subslot 1 or 2) of a line card motherboard.

A safety protocol, LSC (laser safety control), is provided to shut the transmit laser down on the transport side when a fiber break or removed connector is detected.

The transponder modules are hot-pluggable, permitting in-service upgrades and replacement.

Line card motherboards

Line card motherboards hold the transponder modules and provide the optical connections from the transponder modules to the optical backplane. The line card motherboards are modular and are capable of being populated based on customer requirements.

One system can hold up to eight line card motherboards, each of which accepts four transponder modules.

Three types of line card motherboards are available: Splitter, East, and West:

- Splitter supports protection against fiber failure by delivering the ITU wavelengths emitted from their associated transponders over the optical backplane to the optical mux/demux modules in both the west and east slots (slots 1 and 2, respectively).
- East and West deliver the ITU wavelengths from their associated transponder modules over the optical backplane to the optical mux/demux modules in either the east or west slot.

Mux/demux motherboards

The mux/demux motherboards hold the optical mux/demux modules. Either slot 0 or slot 1 can be populated with a single mux/demux motherboard for unprotected operation, or both slots can be populated for protected operation. Each motherboard can accept up to four optical mux/demux modules depending upon the type of module used, and can be populated according to user needs.

OSC (optical supervisory channel)

There are two versions of the mux/demux motherboard with and without the OSC. Implemented with a dedicated laser and detector for a 33rd wavelength (channel 0) on the mux/demux motherboard, the OSC is a per-fiber duplex management channel for communicating between Cisco ONS 15540 systems. The OSC allows control and management traffic to be carried without the necessity of a separate Ethernet connection to each Cisco ONS 15540 in the network.

The OSC carries the following types of information:

- CDP (Cisco Discovery Protocol) packets – Used to discover neighboring devices
- IP packets – Used for SNMP and Telnet sessions between nodes
- OSCP (OSC Protocol) – Used to determine whether the OSC link is up

OSC is required for each Cisco ONS 15540 system in order for the NMS to manage it on the network. Without an OSC module, ONS 15540 system must be separately managed by Ethernet or serial connections.

Optical mux/demux modules

Mux/demux modules are responsible for optically multiplexing and demultiplexing a specific band of ITU wavelengths. In the transmit direction, the optical mux/demux modules multiplex signals transmitted by the transponder modules over the optical backplane and provide the interfaces to connect the multiplexed signal to the transport (DWDM) network. From the receive direction the optical mux/demux modules demultiplex the signals from the transport network side before passing them over the optical backplane to the transponders.

Two types of optical mux/demux modules are used in the ONS 15540, add/drop and terminal. Each module supports a range of channels called a band. In regards to add/drop mux/demux modules, a band contains 4 or 8 channels; in the case of the terminal mux/demux modules, a band contains 16 channels.

ONS 15540 channels	4-channel add/drop mux/demux module	8-channel add/drop mux/demux module	16-channel terminal mux/demux module [a]
1 through 4	Band A	Band AB	Band AD
5 through 8	Band B		
9 through 12	Band C	Band CD	
13 through 16	Band D		
17 through 20	Band E	Band EF	Band EH
21 through 24	Band F		
25 through 28	Band G	Band GH	
29 through 32	Band H		

a. A 16-channel terminal mux/demux module occupies two subslots in a mux/demux slot.

An *add/drop* mux/demux module adds a specified band of channels at a node and passes the other bands through. To support the 32-channel spectrum, there are eight different 4-channel modules and four different 8-channel modules (as shown in the table).

Processor cards

The Cisco ONS 15540 includes two processor cards for redundancy. Each processor is composed of a number of subsystems, including a CPU, a system clock, Ethernet switch for communicating between processors and with the LRC (line card redundancy controller) on the

mux/demux and line card motherboards, and a processor redundancy controller.

The active processor controls the node, and all motherboards, and a processor redundancy controller. The active processor controls the node, and all cards in the system make use of the system clock and synchronization signals from the active processor.

Available ONS 15540 topologies

The Cisco ONS 15540 supports the topologies shown in Figure 46, next, through Figure 50 on page 108. E-Lab Navigator contains information to help you determine which topologies EMC supports.

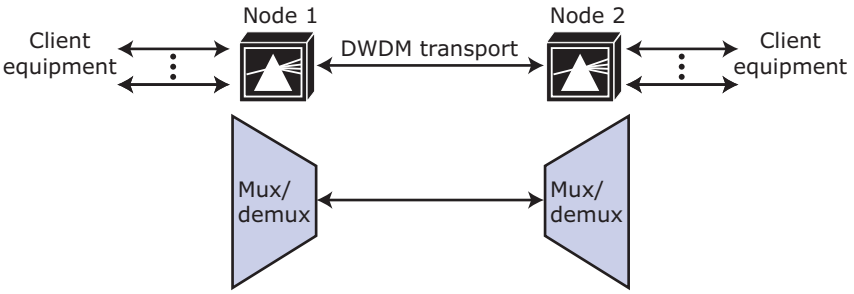


Figure 46 Unprotected point-to-point topology

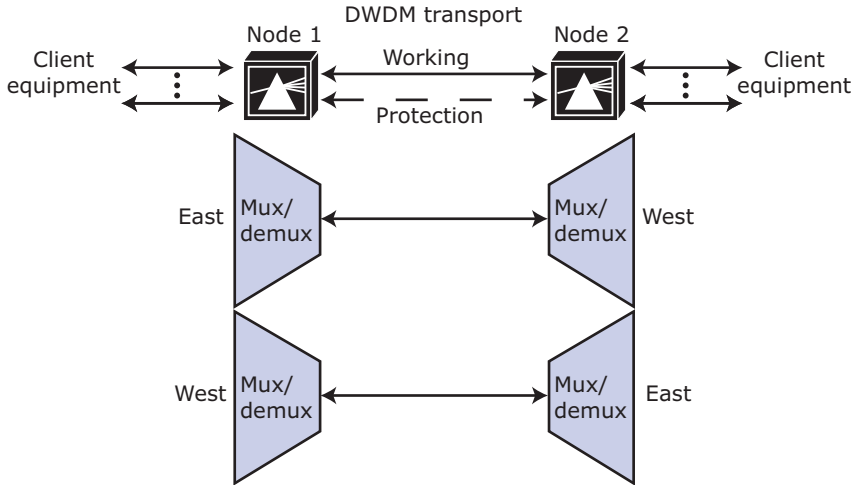


Figure 47 Protected point-to-point topology

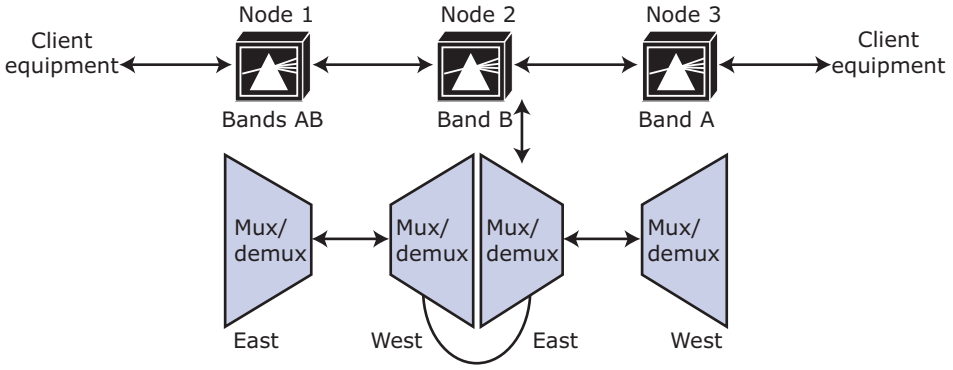


Figure 48 Bus topology

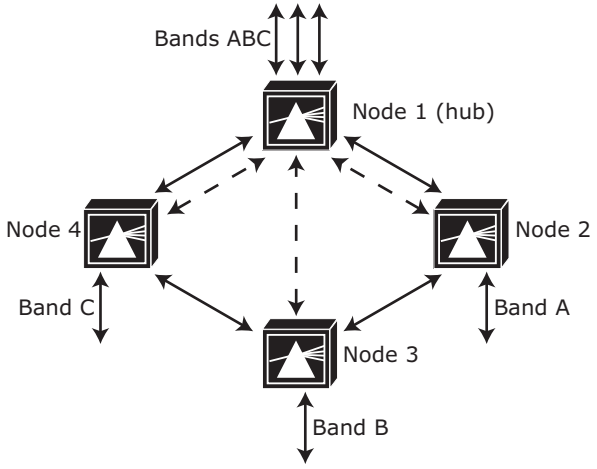


Figure 49 Hubbed-ring topology

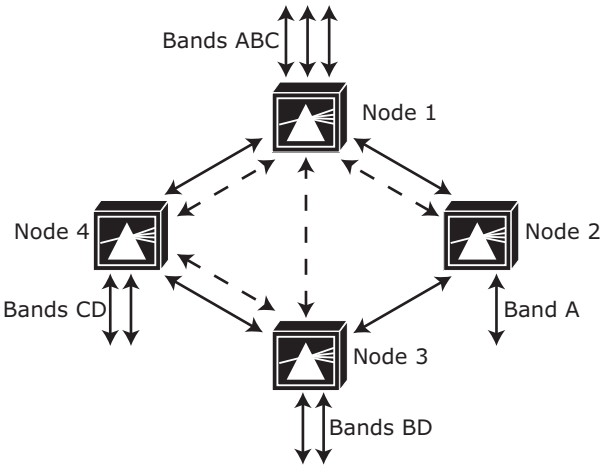


Figure 50 **Meshed ring topology**

ONS 15540 protection scheme

To survive a fiber failure, fiber-optic networks are designed with both working and protection fibers. In the event of a fiber cut or other facility failure, working traffic is switched to the protection fiber. The Cisco ONS 15540 supports such facility protection using a splitter scheme (shown under "Splitter protection considerations" on page 109) to send the output of the DWDM transmitter on two transport side interfaces.

A splitter on each line card motherboard couples the transponder's DWDM interface across the optical backplane to the internal interfaces on the optical mux/demux modules in the east and west mux/demux slots.

On the transport side, one fiber pair serves as the working connection, while the other pair provides protection. The signal is transmitted on both connections, but in the *receive* direction; an optical switch selects one signal to be the active one.

If a loss of light is detected on the working fiber, a switch to the standby signal is made under control of the LRC (line card redundancy controller).

Assuming, for example that the working signal in the diagram below is on the east interface, a failure of the signal on that fiber would

result in a switchover, and the signal on the west interface would be selected for the *receive* signal.

Splitter protection considerations

The following considerations apply when using splitter protection:

- Splitter protected line card motherboard supports splitter protection. The signal splitter introduces 4.6 dB of loss in the transmit direction. Cisco recommends using the nonsplitter protected line card motherboards (east or west version) for configurations where splitter protection is not required.
- Switchover after a failure under splitter protection is nonrevertive. After a switchover, manual intervention is required to revert to using the previously failed fiber for the working traffic once the fault has been remedied.
- The OSC plays a crucial role in splitter-based protection by allowing the protection fiber to be monitored for a cut or other interruption of service.
- LSC (laser safety control) is not available when splitter protection is used.

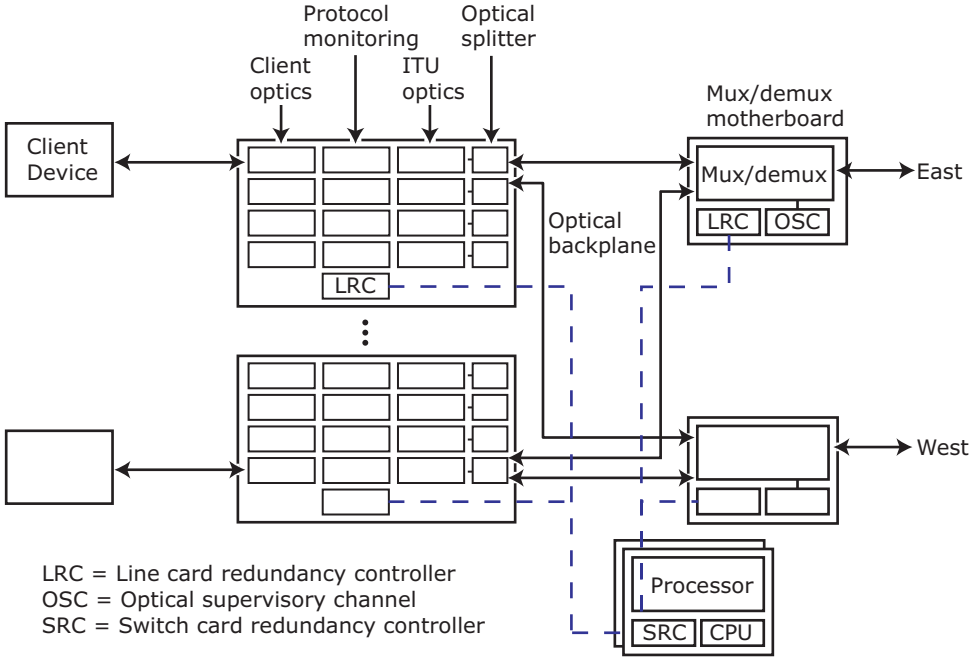


Figure 51 Cisco 15540 splitter protection diagram

ONS 15540 power budget calculations

Use the following information to calculate the power budget:

Total Loss = (Line Card Motherboard Receive Loss) + (Mux/Demux module drop loss) + (Fiber loss) + (Mux/Demux module transmit loss) + (Line Card Motherboard transmit loss)

ONS 15540 overall optical link loss budget

Transmit power and receiver range:

Channel	Transmit power (dBm)	Receiver sensitivity (dBm)
Data Channels	6	-32 to -8
OSC	6	-24 to 0

ONS 15540 diagnostics and maintenance

For configuration, power budget calculation and troubleshooting details, consult Cisco technical publications.

Additional information regarding Cisco ONS 15540 is accessible from http://www.cisco.com.

Cisco ONS 15454 MSTP

This section contains information on the Cisco ONS 15454 MSTP, Multi-Service Provisioning Platform), including:

Intended audience

This material is intended for Technical consultants, solutions architects, implementation specialists, end-users, or anyone interested in learning more about the features of the ONS 15454 Multi-Service Transport Platform (MSTP).

Description

The Cisco ONS 15454 MSTP allows a metro or regional LH DWDM system to become as intelligent and flexible as the Cisco ONS 15454 Multi-Service Provisioning Platform (MSPP), including wide service interface mix, service transparency, flexible topology, completely reconfigurable traffic pattern, and simplified operations. The Cisco ONS 15454 MSTP, with its MSPP capabilities, supports a broad range of standards-based services in a single platform. Figure 52 on page 112 shows the Cisco ONS 15454 MSTP.

Figure 52 Cisco ONS 15454 MSTP ANSI and ETSI mechanics

Key features

The key features mentioned in this section may or may not be supported by EMC. Please refer to the *EMC Support Matrix* for the latest updates on client level support.

The Cisco ONS 15454 MSTP includes the following features:

Node configurations

- Terminal
- Hub
- Line amplifier
- OADM
- 2° Reconfigure Optical Add/Drop Multiplexer (ROADM)
- Multidegree ROADM (3-8°)

Network configurations

- Linear point-to-point
- Open ring, single hub
- Open ring, multiple-hub
- Closed ring, no hub
- Mesh and multiple-ring topologies

Protocol features

- 10 GE LAN PHY
- 10 GE WAN PHY
- 10 G Fibre Channel
- OC-768 / STM-256
- OC-192 / STM-64
- OC-48 / STM-16
- OC-12 / STM-4
- OC-3 / STM-1
- 4 G Fibre Channel / FICON
- 2 G Fibre Channel / FICON
- 1 G Fibre Channel / FICON
- InterSystem Channel-3 (ISC-3) p
- InterSystem Channel-1 (ISC-1) c & p
- 1 G Ethernet
- ESCON
- Fast Ethernet
- HDTV
- D1 Video
- DV-6000
- DVB-ASI
- SDI
- Sysplex CLO & Sysplex ETR

Advanced intelligent software features

- Network topology Auto Discovery
- Point-and-click node and network setup and regulation
- Automatic network optical power management and monitoring
- Single management interface (single IP address) for all the shelves in a node
- Network-level alarm correlation for a quick and easy troubleshooting (G.798-based)
- DCN extension to provide the possibility to use any available DCN access (including DCC and GCC bytes) for management of nodes
- Automatic Node turn-up for installation and deployment without the use of Cisco Transport Planner parameters

User interface: Cisco Transport Controller (CTC)

- Integrated node and subnetwork craft GUI
- Layered graphical views: network, wavelength, node, shelf, card
- User-provisionable graphics and fonts
  - Background maps
  - Color schemes

- A-to-Z wavelength circuit routing and creation
- Network autodiscovery with provisionable subnetwork domain control
- System inventory
- PC-based client
- Familiar browser interface-Netscape Navigator or Microsoft Internet Explorer
- Complete Performance Monitoring support
  - 15-minute (32 entries) and 24-hour (two entries)
  - Optical layer
  - SONET/SDH layer
  - ITU-T G.709 layer (including FEC/E-FEC)
  - Client interface type-specific
  - Threshold-crossing alerts threshold setting

For more information on CTC, refer to "Cisco Transport Controller (CTC)" on page 147.

Alarm monitoring and reporting

- Shelf LEDs - Critical, major, minor, remote
- Card LEDs - Card failure, active/standby state, signal fail
- Cisco Transport Controller craft interface
  - Layered graphical views with real-time alarm text and coloring: network, wavelength, node, shelf, card
- Multiple technology views including DWDM and SONET/SDH with MSTP integration
- Environmental alarm contacts
- 4-alarm output contact closures (standard): critical, major, minor, remote
- Up to 48 provisionable alarm contacts in systems equipped with Alarm Interface Controller (AIC-I)

Network security features

- Four-level user control with provisionable timeout durations: superuser, provisioning, maintenance, retrieve
- Multiple usernames and logged-in users
- RADIUS

Maintenance features

- Remote software downloads and in-service, hitless activation
- Loopback
- Database backup and restore
- Lamp test

Timing and synchronization

- Two external timing-source inputs (SONET, T1 and SDH E-1, 2 MHz)
- Line timing
- Two timing-source outputs (recovered from line optics)
- Internal Stratum 3 holdover
- Synchronous status-messaging support

Additional features

- 100-Mb/s user data channel (Fast Ethernet) transported on the optical supervisory channel (OSC)
- Front only (ETSI) or front and rear access (ANSI) shelf assembly options
- A and B monitored DC power inputs

Compliance and certifications

- Network Equipment Building Standards (NEBS) Level 3 compliance
- Operations Systems Modification of Intelligent Network Elements (OSMINE) certifications
- Storage-vendor qualification and certifications
- ITU-T and CE Mark compliance
- MEF 9 and MEF 14 certification for GE and 10 GE Xponder units

System architecture

This section includes the following information:

- "Wavelength interfaces" on page 116
- "Transmission elements" on page 117
- "Distance extension cards" on page 118

Wavelength interfaces

Table 11 provides a list of services supported by the different line cards on the ONS 15454 MSTP along with the different transmission elements that make up the ONS 15454 MSTP.

Table 11 Protocol support per service card (page 1 of 2)

Modules	Supported service interfaces
2.5-Gb/s FEC Multirate Transponder	1-Gb/s Fibre Channel/FICON 2-Gb/s Fibre Channel/FICON ISC-1 ISC-3 ESCON Fast Ethernet (FE) Gigabit Ethernet (GE) T3 (Optical) OC-3/STM-1 OC-12/STM-4 OC-48/STM-16 D1-SDI Video HDTV C-Cor DV-6000 (2.38-Gb/s) ETR/CLO
2.5-Gb/s Data Muxponder	1-Gb/s Fibre Channel/FICON 2-Gb/s Fibre Channel/FICON ESCON GE
10-Gb/s EFEC Multirate Transponder	10 GE LAN 10 GE WAN OC-192/STM-64 10 Gigabit Fibre Channel
4x 2.5-Gb/s /10-Gb/s EFEC Muxponder	OC-48/STM-16
10-Gb/s EFEC Data Muxponder	1-Gb/s Fibre Channel/FICON 2-Gb/s Fibre Channel/FICON 4-Gb/s Fibre Channel/FICON ISC-1 ISC-3 GE

Table 11 Protocol support per service card (page 2 of 2)

Modules	Supported service interfaces
GE XPonder	GE
10GE XPonder	10GE LAN
MSPP-On-A-Blade	OC-3 OC-12 OC-48 GE

Transmission elements

Table 12 lists the supported modules on ONS 15454 MSTP.

Table 12 Supported modules on ONS 15454 MSTP (page 1 of 2)

Module	Unit name
Multiplexer and demultiplexer filters	
40-wavelength multiplexer, 100GHz, C band	40-MUX-C
32-wavelength multiplexer, 100-GHz, C band	32MUX-O
32-wavelength demultiplexer, 100-GHz, C band	32DMX-O
4-wavelength multiplexer/demultiplexer, 100-GHz, C band	4MD-xx.x
Optical amplifier	
Preamplifier, 50-GHz capable, C band	OPT-PRE
Booster amplifier, 50-GHz capable, C band	OPT-BST
Enhanced Booster amplifier, 50-GHz capable, C band	OPT-BST-E
Optical amplifier, 17dB gain, 50-GHz capable, C band	OPT-AMP-17C
Amplifier (can be used as Preamplifier or Booster), L band	OPT-AMP-L
Booster amplifier, 50-GHz capable, L band	OPT-BST-L
Reconfigurable optical add/drop multiplexer	
40-channel wavelength cross connect, 100-GHz, Odd, C band	40-WXC-C
Degree-4 Mesh patch panel	PP-MESH-4
Degree-8 Mesh patch panel	PP-MESH-8
40-channel wavelength selective switch, 100-GHz, Odd, C band	40-WSS-C
40-channel demultiplexer, 100-GHz, Odd, C band	40-DMX-C
40-channel wavelength selective switch, 100-GHz, Even, C band	40-WSS-CE
40-channel demultiplexer, 100-GHz, Even, C band	40-DMX-CE
32-channel wavelength selective switch, 100-GHz, C band	32-WSS
32-channel demultiplexer 100-GHz (for use with 32-WSS), C band	32-DMX
32-channel wavelength selective switch, 100-GHz, L band	32-WSS-L
32-channel demultiplexer 100-GHz (for use with 32-WSS), L band	32-DMX-L

Table 12 Supported modules on ONS 15454 MSTP (page 2 of 2)

Module	Unit name
Multi-ring/mesh upgrade unit, C band and L band	MMU
Optical band add/drop multiplexer	
1-band, 50-GHz capable, C band	AD-1B-xx.x
4-band, 50-GHz capable, C band	AD-4B-xx.x
Optical channel add/drop multiplexer	
1-channel, 100-GHz, C band	AD-1C-xx.x
2-channel, 100-GHz, C band	AD-2C-xx.x
4-channel, 100-GHz, C band	AD-4C-xx.x
Optical service channel	
Standard	OSCM
Integrated combiner and separator	OSC-CSM
Dispersion compensation	
Dispersion-compensation unit shelf assembly (2-slot)	DCU-SA
Dispersion-compensation units	DCU-<value>
Y-cable protection modules	
Shelf assembly	YCBL-LC or FL-SA
Y-cable protection module, single-mode	YCM-SM-LC or CS-SM-Y
Y-cable protection module, multimode	YCM-MM-LC or CS-MM-Y

Distance extension cards

The ONS 15454 MSTP has three cards that focus primarily on the data center for distance extension, each discussed further in this section:

- "2.5 Gb/s data muxponder" on page 118
- "8-Port enhanced data muxponder" on page 122
- "10 Gb/s multi-rate enhanced transponder" on page 126

2.5 Gb/s data muxponder

The Cisco ONS 15454 2.5 Gb/s muxponder, shown in Figure 52 on page 112, can transport up to 2 x 1-Gb/s services, 1 x 2-Gb/s services, 8 x 200 Mb/s services, or a mix of these services aggregated over a G.709 OTU-2-based, 50-GHz spaced, 50-GHz stabilized, ITU-compliant wavelength. The muxponder card architecture contains eight client interfaces that are mapped to a single line interface.

Figure 53 2.5 Gb/s Data muxponder

Each client interface supports Gigabit Ethernet, 1-Gb/s or 2-Gb/s Fibre Channel/FICON/, or ESCON using a Small Form-Factor Pluggable (SFP) optics module with LC connectors, providing the flexibility to support several protocols, data rates, or fiber types with support for qualified SFP modules (see *Cisco ONS 15454 MSTP SFP Support Matrix*). The 2.5 Gb/s data muxponder card supports a mixture of SFP types and also supports in-service insertion or removal without affecting other active ports, allowing networking flexibility and reduced pre-planning activities. The DWDM line interface provides one 2.5-Gb/s .709 OTU-2 digital wrapper, long-reach/long-haul, ITU-compliant, 50-GHz spaced optical interface using LC connectors supporting G.709 OTU-2 digital wrapper interfaces. The DWDM output line interface is tunable across 4 wavelengths across the C band. The muxponder cards are deployable in the 12 multiservice interface card slots of the Cisco ONS 15454 MSTP. The only other common card required for operation is the timing, communications, and control (TCC) card. The data muxponder card provides many carrier-class features and capabilities necessary to deliver SAN and data services, including selectable service mix, wavelength tunability, flexible protection mechanisms, flexible timing options, and management capabilities.

Figure 54 shows the data muxponder both protected and unprotected.

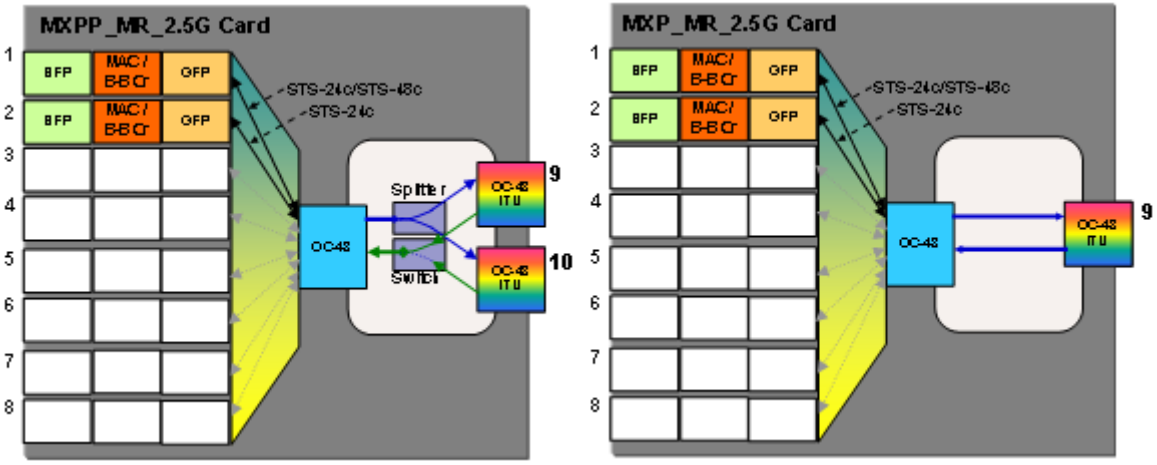


Figure 54 2.5 Gb/s data muxponder (protected and unprotected)

2.5 Gb/s data muxponder optical parameters

- Transmitter (trunk side)
  - Minimum output power: -1 dBm
  - Maximum output power: +3 dBm
  - 50-GHz wave locked
  - Four-channel wavelength tunability at 100-GHz spacing
  - Transmitter maximum return reflectance: -27 dB
  - Chromatic dispersion allowance: 5400 ps/nm, giving an optical power penalty < 2.0 dB
  - Minimum side mode suppression ratio: 30 dB
  - Transmitter is a direct modulated laser
  - Wavelength stability (drift): +/- 25 picometers (pm)
- Receiver (trunk side)

  Table 13 on page 121 lists the data muxponder receiver trunk side specifications.

Table 13 Data muxponder receiver trunk side specifications

OSNR[a]	FEC Type	Pre-FEC BER	Post-FEC BER	Input power sensitivity	Chromatic dispersion tolerance
17 dB	N/A	< 10 exp - 12	N/A	- 9 to - 23 dBm	—
17 dB	N/A	< 10 exp - 12	N/A	- 9 to - 22 dBm	+/- 1800 ps/nm
17 dB	N/A	< 10 exp - 12	N/A	- 9 to - 21 dBm	+/- 5400 ps/nm
18 dB	N/A	< 10 exp - 12	N/A	- 9 to - 23 dBm	+/- 1800 ps/nm
19 dB	N/A	< 10 exp - 12	N/A	- 9 to - 23 dBm	+/- 5400 ps/nm
21 dB	N/A	< 10 exp - 12	N/A	- 9 to - 30 dBm	—
21 dB	N/A	< 10 exp - 12	N/A	- 9 to - 29 dBm	+/- 1800 ps/nm
21 dB	N/A	< 10 exp - 12	N/A	- 9 to - 28 dBm	+/- 5400 ps/nm
22 dB	N/A	< 10 exp - 12	N/A	- 9 to - 30 dBm	+/- 1800 ps/nm
23 dB	N/A	< 10 exp - 12	N/A	- 9 to - 30 dBm	+/- 5400 ps/nm

a. OSNR defined with 0.1 nm RBW

  - Receiver sensitivity -28 dBm, BER 1 * 10 exp - 12
  - Receiver overload is equal to or exceeds -8 dBm
  - Receiver maximum reflectance of -27 dB

- Transmitter (client side)
  - Maximum transmitter output power: -1 dBm
  - Minimum transmitter output power: -6 dBm
  - Center wavelength: 1290 to 1330 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: DFB laser
- Receiver (client side)
  - Maximum receiver level: -1 dBm at BER 1 * 10 exp - 12
  - Minimum receiver level: -14 dBm at BER 1 * 10 exp - 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp - 12
  - Receiver input wavelength range: 1290 to 1605 nm

Table 14 lists the buffer credits supported per port on the 2.5G Data Muxponder.

Table 14 Buffer credits supported per port on 2.5G Data Muxponder

Fibre Channel Protocol Speed	Distance (KM)	Buffer Credit per Port
1 G FC	1600	800 B2B
2 G FC	800	800 B2B

Note: There is no concept of total B2B on the card. This is determined by the available free memory on the card.

8-Port enhanced data muxponder

The Cisco ONS 15454 8-Port 10-Gb/s data muxponder card can transport up to 8 x 1-Gb/s services, 4 x 2-Gb/s services, 2 x 4-Gb/s services, or a mix of these services aggregated over a G.709 OTU-2-based, 50-GHz spaced, 50-GHz stabilized, ITU-compliant wavelength with selectable Forward Error Correction (FEC) or Enhanced Forward Error Correction (E-FEC).

Figure 55 8-Port enhanced data muxponder

As shown in Figure 55, the muxponder card architecture contains eight client interfaces that are mapped to a single line interface. Each client interface supports Gigabit Ethernet, 1-Gb/s or 2-Gb/s Fibre

Channel/FICON/ISC, or 4-Gb/s Fibre Channel using a Small Form-Factor Pluggable (SFP) optics module with LC connectors, providing the flexibility to support several protocols, data rates, or fiber types with support for qualified SFP modules (see the *Cisco ONS 15454 MSTP SFP Support Matrix*).

The data muxponder card supports a mixture of SFP types and also supports in-service insertion or removal without affecting other active ports, allowing networking flexibility and reduced pre-planning activities. The DWDM line interface provides one 10.70923-Gb/s G.709 OTU-2 digital wrapper, long-reach/long-haul, ITU-compliant, 50-GHz spaced optical interface using LC connectors supporting G.709 OTU-2 digital wrapper interfaces. The DWDM output line interface is tunable across the full optical C or L band, dramatically reducing the inventory of spares. When operated within the outlined specifications, each card will transport the aggregated signals with a maximum bit error rate (BER) of 10E-15. The muxponder cards are deployable in the 12 multiservice interface card slots of the Cisco ONS 15454 MSTP. The only other common card required for operation is the timing, communications, and control (TCC) card. The data muxponder card provides many carrier-class features and capabilities necessary to deliver SAN and data services, including selectable service mix, wavelength tunability, flexible protection mechanisms, flexible timing options, and management capabilities.

Figure 56 shows an unprotected 8-port data muxponder.

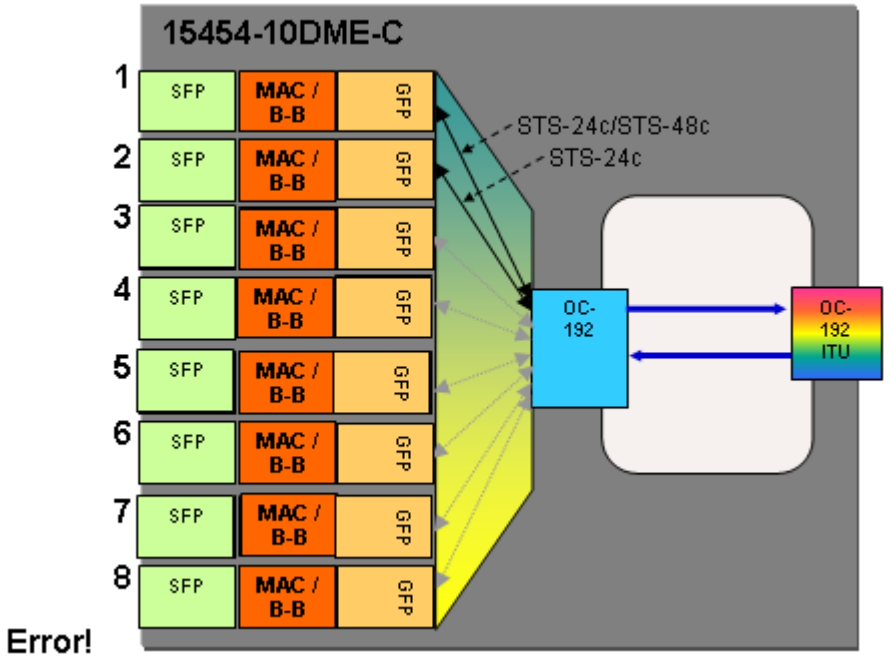


Figure 56 8-Port data muxponder (unprotected)

8-Port data muxponder optical parameters

- Transmitter (trunk side)
  - Minimum output power: +3 dBm
  - Maximum output power: +6 dBm
  - Minimum Single-Mode Suppression Ratio (SMSR): 30 dB
  - Minimum optical extinction ratio: 10 dB
  - 82 wavelength tunability at 50-GHz spacing
  - Receiver maximum return reflectance (Rx return loss): -27 dB
  - Chromatic dispersion allowance: 1200 ps/nm, giving an optical power penalty < 2.0 dB
  - Minimum side mode suppression ratio: 30 dB
  - Wavelength stability (drift): +/- 25 picometers (pm)
- Receiver (trunk side)

Table 15 lists the data muxponder receiver trunk side specifications.

Table 15 8 Gb/s data muxponder receiver trunk side specifications

FEC applications	OSNR[a]	Pre-FEC BER	Post-FEC BER	Input power sensitivity	Chromatic dispersion tolerance	Power penalty	OSNR penalty
None	23 dB	<10 exp - 12	—	-8 to -20 dBm	+/- 1200 ps/nm	2 dBm	—
	19 dB	<10 exp - 12	—	-9 to -22 dBm	+/- 1000 ps/nm	2 dBm	—
FEC	10 dB	<10 exp - 5	<10 exp - 15	-8 to -18 dBm	+/- 800 ps/nm		1.5 dB
Enhanced FEC	19 dB	<10 exp - 4	<10 exp - 15	-8 to -26 dBm	+/- 800 ps/nm	2 dBm	2 dB
	8 dB	<10 exp - 4	<10 exp - 15	-8 to -18 dBm	+/- 800 ps/nm	2 dBm	1.5 dB

a. OSNR defined with 0.5 nm RBW

  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp - 12 including dispersion
  - Receiver input wavelength range: 1529 to 1562 nm

- Transmitter (client side)
  - Maximum transmitter output power: -1 dBm
  - Minimum transmitter output power: -6 dBm
  - Center wavelength: 1290 to 1330 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: DFB laser
- Receiver (client side)
  - Maximum receiver level: -1 dBm at BER 1 * 10 exp - 12
  - Minimum receiver level: -14 dBm at BER 1 * 10 exp - 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp - 12
  - Receiver input wavelength range: 1290 to 1605 nm

Table 16 lists the buffer credits supported per port on the 8-port enhanced data muxponder.

Table 16 Buffer credits supported per port on 8-port enhanced data muxponder

Fibre Channel protocol speed	Distance (KM)	Buffer credit per port
1 G FC	1400	700 B2B
2 G FC	700	700 B2B
4 G FC	500	1000 B2B

Note: There is no concept of total B2B on the card. This is determined by the available free memory on the card. When a port on the 8-port enhanced data muxponder is configured for 4 G FC, more memory is allocated to B2B.

Figure 57 shows the 9-port buffer credit spoofing flow chart.

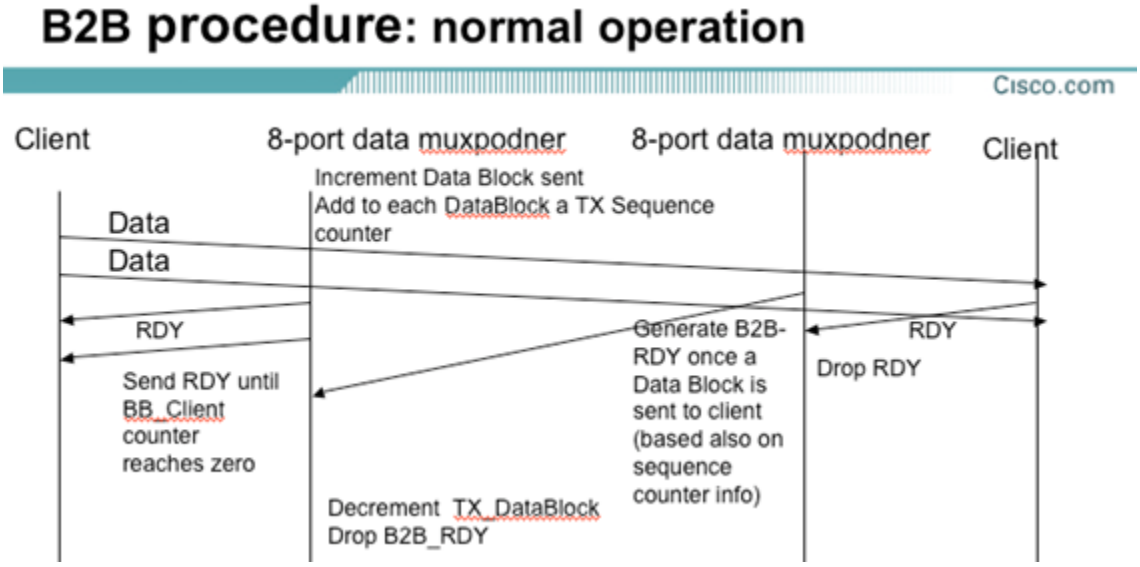


Figure 57 8-Port buffer credit spoofing flow chart

10 Gb/s multi-rate enhanced transponder

The 10-Gb/s multi-rate transponder card can transport 10 Gigabit Ethernet WAN physical layer (PHY) and LAN PHY, 10 Gigabit Fibre Channel, SONET OC-192, and SDH STM-64 services over a 100-GHz

spaced, 50-GHz stabilized, ITU-compliant wavelength. The transponder card architecture contains a single client interface that is mapped to a single line interface, as shown in Figure 58.

Figure 58 10 Gb/s Multi-rate enhanced transponder

The client interface supports 10 Gigabit Ethernet LAN PHY, 10 Gigabit Ethernet WAN PHY, 10 Gigabit Fibre Channel, SONET OC-192, and SDH STM-64 signals. The interface is based on 10 Gigabit Small Form-Factor Pluggable (XFP) Multisource Agreement (MSA). Currently available XFP optics support a short-reach/ intra-office, 1310-nanometer (nm) optical interface using LC connectors supporting fiber distances of up to 2 kilometers (km) (with or without the Y-protection option). The line interface provides one 10-Gb/s, long-reach, ITU-compliant, 100-GHz-spaced optical interface using LC connectors supporting OUT-2 G.709 digital wrapper, OC-192, STM-64, 10 Gigabit Fibre Channel, 10 Gigabit Ethernet LAN PHY, or 10 Gigabit Ethernet WAN PHY interfaces. The DWDM line interface provides one 10.70923-Gb/s G.709 OTU-2 digital wrapper, long-reach/long-haul, ITU-compliant, 50-GHz spaced optical interface using LC connectors supporting G.709 OTU-2 digital wrapper interfaces. The DWDM output line interface is tunable across the full optical C or L band, dramatically reducing the inventory of spares. When operated within the outlined

specifications, each card will transport the aggregated signals with a maximum bit error rate (BER) of 10E-15. The 10 Gb/s transponder card incorporates both a client and DWDM line interface on the same card. The 10 Gb/s transponder cards are deployable in the 12 multiservice interface card slots of the Cisco ONS 15454 platform. The only required common card is the appropriate timing, communications, and control card (TCC). The 10 Gb/s transponder card provides many carrier-class features and advanced capabilities necessary to deliver 10 Gb/s services, including the protocol transparency, wavelength tunability, flexible protection mechanisms, flow-through timing, management, and performance monitoring capabilities outlined in this section.

Figure 59 shows a block diagram of the 10 G multi-rate enhanced transponder.

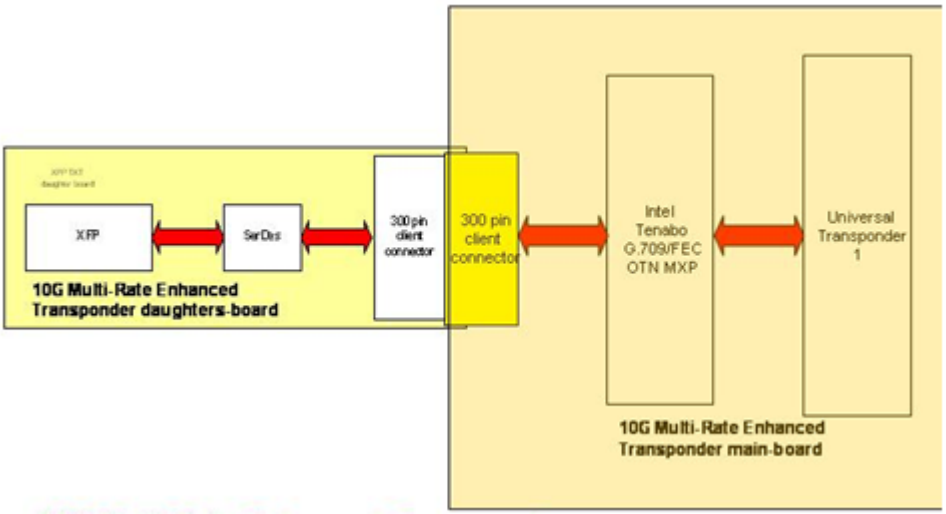


Figure 59 10 Gb/s Multi-rate enhanced transponder block diagram

10 Gb/s multi-rate enhanced transponder optical parameters

- Transmitter (trunk side)
  - Minimum output power: +3 dBm
  - Maximum output power: +6 dBm
  - Transmitter: LN external modulator transmitter
  - Wavelength stability (drift): +/- 25 picometers (pm)
- Receiver (trunk side)

Table 17 lists the 10 Gb/s multi-rate enhanced transponder receiver trunk side specifications.

Table 17 10 Gb/s multi-rate enhanced transponder receiver trunk side specifications

OSNR[a]	FEC type	Pre-FEC BER	Post-FEC BER	Input power sensitivity[b]	Chromatic dispersion tolerance
30 dB	Off	<10 exp - 12	N/A	-8 to -20 dBm	+/- 1200 ps/nm
26 dB	Off	<10 exp - 12	N/A	-8 to -20 dBm	+/- 1000 ps/nm
26 dB	Off	<10 exp - 12	N/A	-8 to -22 dBm	—
17 dB	Standard	<10 exp - 5	<10 exp - 15	-8 to -18 dBm	+/- 800 ps/nm
15.5 dB	Standard	<10 exp - 5	<10 exp - 15	-8 to -18 dBm	—
14 dB	Enhanced	<7 X 10 exp - 4	<10 exp - 15	-8 to -18 dBm	+/- 800 ps/nm
12 dB	Enhanced	<7 X 10 exp - 4	<10 exp - 15	-8 to -18 dBm	—

a. OSNR defined with 0.1 nm RBW

b. Receiver filter bandwidth greater than or equal to 180 pm (at -3 dBm)

  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp - 12 including dispersion
  - Receiver input wavelength range: 1529 to 1562 nm

- Transmitter (client side)
  - Maximum transmitter output power: -1 dBm
  - Minimum transmitter output power: -6 dBm
  - Center wavelength: 1290 to 1330 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: DFB laser
- Receiver (client side)
  - Maximum receiver level: -1 dBm at BER 1 * 10 exp - 12
  - Minimum receiver level: -14 dBm at BER 1 * 10 exp - 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp - 12
  - Receiver input wavelength range: 1290 to 1605 nm

MSTP SFP support

This section contains tables listing SFP support. For technical details, refer to "SFP technical details" on page 141.

Table 18 shows the ONS 15454 MSTP SFP matrix.

Table 18 ONS15454 MSTP SFP matrix (page 1 of 2)

ONS 15454 MSTP Boards

Product ID	100M-2.5G MR-TXP	2.5G MR DataMux	4x2,5G FEC MXP	4x2.5G EFEC TXP	10G EFEC TXP	10G MR DataMux	ADM-10G	GE-XP	10GE-XP
15454-SFP3-1-IR=	X								
ONS-SI-155-SR-MM=	X								
ONS-SI-155-L2=							X		
15454-SFP12-4-IR=	X								
ONS-SI-622-I1=							X		
15454-SFP-OC48-IR=	X		X	X					
ONS-SE-2 G-S1=	X		X	X			X		
ONS-SE-2 G-L2=	X			X			X		
ONS-SI-2 G-S1							X		
ONS-SI-2 G-I1=							X		
ONS-SI-2 G-L2=							X		
ONS-SE-Z1=							X		
ONS-SE-ZE-EL=						X		X	
15454-SFP-GE+-LX=	X	X				X			
15454-SFP-GEFC-SX=	X	X				X			
ONS-SE-G2F-SX=	X	X				X	X	X	
ONS-SE-G2F-LX=	X	X				X	X	X	
ONS-SE-GE-ZX=	X	X							
ONS-SI-GE-ZX=						X[a]	X	X	

Table 18 ONS15454 MSTP SFP matrix (page 2 of 2)

ONS 15454 MSTP Boards

Product ID	100M-2.5G MR-TXP	2.5G MR DataMux	4x2,5G FEC MXP	4x2.5G EFEC TXP	10G EFEC TXP	10G MR DataMux	ADM-10G	GE-XP	10GE-XP
15454-SFP-200=	X								
ONS-SE-200-MM=	X	X							
ONS-SE-4 G-MM=						X			
ONS-SE-4 G-SM=						X			
ONS-SC-2 G-xx.x=[b]	X			X			X	X	
ONS-SC-Z3-xxxx=[c]	X	X		X			X	X	
ONS-XC-10G-S1=					X		X	X	X
ONS-XC-10G-I2=[d]					X			X	X
ONS-XC-10G-L2=					X [e]				
ONS-XC-10G-xx.x=[f]							X	X	X

a. Supported with SW release 7.0.x but not in 8.0. Support in Release 8.5.

b. DWDM SFPs, xx.x from 30.3 to 60.6. Supporting GE, 1 G FC, 2 G FC and OC48 pending board rate support. Only P/N version 02 is qualified on 15454 MSTP.

c. CWDM SFPs, xxxx from 1470 to 1610. Supporting GE, 1 G FC, 2 G FC and OC48 pending board rate support.

d. Only P/N version 02 is qualified on 15454 MSTP.

e. ONS-XC-10G-L2. 10G TXP when equipped with LR2 XFP need to be placed on High Speed slot for power dissipation constraint if using FTA-3 or FTA-48V. If it is used CC-FTA there is no restriction.

f. DWDM XFPs, xx.x from 30.3 to 61.4.

SONET/SDH SFPs SFPs fully compliant with SONET and SDH standards. Details are shown in Table 19.

Table 19 SONET/SDH SFPs (page 1 of 2)

Product ID	Product description	Part number	Applicable standard	Temperature range (°C)
15454-SFP3-1-IR=	SFP - OC-3/D1-SDI - 1310nm IR - SM - LC	10-1828-01	GR253 OC3 IR1 G.957 S-1.1	0 to +70
15454-SFP12-4-IR=	SFP - OC-12 - 1310nm IR - SM - LC	10-1976-01	GR253 OC12 IR1 G.957 S-4.1	0 to +70
15454-SFP-OC48-IR=	SFP - OC-48- 1310nm IR - SM - LC	10-1975-01	GR253 OC48 IR1 G.957 S-16.1	0 to +70
ONS-SE-2 G-S1=	SFP - OC48/STM16 - 1310 SR - SM LC	10-2017-01	GR253 OC48 SR G.957 I-16	-10 to +85
ONS-SE-2 G-L2=	OC48/STM16, LR2, 1550nm, Small Form Pluggable (SFP), EXT	10-2013-01	GR253 OC48 LR2 G.957 L-16.2	-10 to +85
ONS-SI-155-SR-MM=	SFP - OC3, SR, 1310 NM, MULTI MODE, I-TEMP	10-2279-01	GR253	-40 to +85
ONS-SI-155-I1=	SFP - OC3/STM1 IR1/S-1.1 1310 SFP, ITEMP	10-1938-02	GR253 OC3 IR1 G.957 S-1.1	-40 to +85
ONS-SI-155-L1=	SFP -OC3/STM1 LR, L-1.1, 1310 nm,, ITEMP	10-1957-02	GR253 OC3 LR1 G.957 L-1.1	-40 to +85
ONS-SI-155-L2=	SFP -OC3/STM1 LR-2, L-1.2, 1550 nm, ITEMP	10-1937-02	GR253 OC3 LR2 G.957 L-1.2	-40 to +85
ONS-SI-622-SR-MM=	SFP - OC12, SR, 1310 NM, MULTI MODE, I-TEMP	10-2280-01	GR253	-40 to +85
ONS-SI-622-I1=	SFP -OC12/STM4 and OC3/STM1 IR, S-4.1, S-1.1, 1310 nm, ITEMP	10-1956-02	GR253 OC3/OC12 IR1 G.957 S-4.1/S-1.1	-40 to +85
ONS-SI-622-L1=	SFP -OC12/STM4 LR, L-4.1, 1310 nm, ITEMP	10-1958-02	GR253 OC12 LR1 G.957 L-4.1	-40 to +85

Table 19 SONET/SDH SFPs (page 2 of 2)

Product ID	Product description	Part number	Applicable standard	Temperature range (°C)
ONS-SI-622-L2=	SFP -OC12/STM4 LR, L-4.2, 1550 nm, ITEMP	10-1936-02	GR253 OC12 LR2 G.957 L-4.2	-40 to +85
ONS-SI-2 G-S1	SFP - OC48/STM16, SR, 1310nm, ITEMP, LC	10-1992-02	GR253 OC48 SR G.957 I-16	-40 to +85
ONS-SI-2 G-I1=	SFP - OC48/STM16, IR, 1310nm, ITEMP, LC	10-1993-02	GR253 OC48 IR1 G.957 S-16.1	-40 to +85
ONS-SI-2 G-L1=	SFP - OC48/STM16, LR1, 1310nm, ITEMP, LC	10-2102-02	GR253 OC48 LR1 G.957 L-16.1	-40 to +85
ONS-SI-2 G-L2=	SFP - OC48/STM16, LR2, 1550nm, ITEMP, LC	10-1990-02	GR253 OC48 LR2 G.957 L-16.2	-40 to +85

Data SFPs DATA SFPs able to transmit GbE, FC, FICON, and ESCON signal format. Details are shown in Table 20.

Table 20 Data SFPs (page 1 of 3)

Product ID	Product description	Part number	Applicable standard	Temperature range (°C)
ONS-SE-100-LX10=	SFP - 100Mbps Long Reach - 1310nm - SM - LC, EXT-TEMP	10-2213-01	100Base LX IEEE-802.3	-10 to +85
ONS-SI-100-LX10=	SFP - 100Mbps Long Reach - 1310nm - SM - LC, ITEMP	10-2294-01	100Base LX IEEE-802.3	-40 to +85
ONS-SE-100-FX=	SFP - 100Mbps Short Reach - 1310nm - MM - LC, EXT-TEMP	10-2212-01	100Base FX IEEE-802.3	-10 to +85
ONS-SI-100-FX=	SFP - 100Mbps Short Reach - 1310nm - MM - LC, ITEMP	10-2350-01	100Base FX IEEE-802.3	-40 to +85
ONS-SE-100-BX10U=	SFP -10/100 BX-U, EXT	10-2353-01	100Base BX-U IEEE-802.3	-10 to +85
ONS-SE-100-BX10D=	SFP -10/100 BX-D, EXT	10-2352-01	100Base BX-D IEEE-802.3	-10 to +85

Table 20 Data SFPs (page 2 of 3)

Product ID	Product description	Part number	Applicable standard	Temperature range (°C)
15327-SFP-LC-SX=	1000 Base SX LC, SFP	30-1301-01	1000Base SX IEEE-802.3	0 to +70
15327-SFP-LC-LX=	1000 Base LX LC, SFP	30-1299-01	1000Base SX IEEE-802.3	0 to +70
15454-SFP-LC-SX=	1000 Base SX LC, SFP	30-1301-01	1000Base SX IEEE-802.3	0 to +70
15454-SFP-LC-LX=	1000 Base LX LC, SFP	30-1299-01	1000Base LX IEEE-802.3	0 to +70
ONS-SC-GE-SX=[a]	1000Base SX SFP - 850nm - LC - C Temp	10-2301-01	1000Base SX IEEE-802.3	0 to +70
ONS-SI-GE-SX=	SFP - 1000BASE-SX Gigabit Ethernet, 850nm, MM, I-TEMP	10-2295-01	1000Base SX IEEE-802.3	-40 to +85
ONS-SC-GE-LX=[b]	1000Base LX SFP - 1310nm - LC - C Temp	10-2298-01	1000Base LX IEEE-802.3	0 to +70
ONS-SI-GE-LX=	SFP - 1000BASE-LX Gigabit Ethernet, 1310, SM, I-TEMP	10-2300-01	1000Base SX IEEE-802.3	-40 to +85
15454-SFP-GE+-LX= EOS	SFP - GE/1 G-FC/2 G-FC - 1310nm - MM - LC	10-1832-03	1000Base LX IEEE-802.3, 100-M5-SN-I 200-M5-SN-I	-10 to +85
15454-SFP-GEFC-SX= EOS	SFP-GE/1G-FC/2G-FC-850nm-MM-LC	10-1833-02	1000Base SX IEEE-802.3, 100-M5-SN-I 100-M6-SN-I 200-M5-SN-I 200-M6-SN-I	-10 to +85
ONS-SE-G2F-SX=	SFP - GE/1 G-FC/2 G-FC - 850nm - MM – LC - EXT TEMP	10-2272-01	1000Base SX IEEE-802.3, 100-M5-SN-I 100-M6-SN-I 200-M5-SN-I 200-M6-SN-I	-10 to +85

Table 20 Data SFPs (page 3 of 3)

Product ID	Product description	Part number	Applicable standard	Temperature range (°C)
ONS-SE-G2F-LX=	SFP - GE/1 G-FC/2 G-FC/HDTV - 1310nm - SM – LC - EXT TEMP	10-2273-02	1000Base LX IEEE-802.3, 100-SM-LC-L 200-SM-LC-L	-10 to +85
ONS-SI-GE-ZX=	SFP - 1000BASE-ZX Gigabit Ethernet, 1550, SM, I-Temp	10-2296-01	1000Base ZX IEEE-802.3	-40 to +85
ONS-SE-GE-ZX=	SFP - 1000BASE-ZX Gigabit Ethernet, 1550, SM, Ext-Temp	10-2354-01	1000Base ZX IEEE-802.3	-10 to +85
15454-SFP-200=	SFP-ESCON - 1310nm - MM - LC	10-1750-01	ESCON	0 to +70
ONS-SE-200-MM=	SFP-ESCON - 1310nm - MM – LC - EXT TEMP	10-2248-01	ESCON	-10 to +85
ONS-SE-4 G-MM=	4 G FC SFP, 850nm, LC, MM - EXT TEMP	10-2259-01	400-M5-SN-I and 400-M6-SN-I	-10 to +85
ONS-SE-4 G-SM=	4 G FC SFP, 1310nm, LC, SM - EXT TEMP	10-2252-01	400-SM-LC-L	-10 to +85

a. This SFP will replace the old 15327-SFP-LC-SX= and 15454-SFP-LC-SX= that have initiated EoL process.

b. This SFP will replace the old 15327-SFP-LC-LX= and 15454-SFP-LC-LX= that have initiated EoL process

DWDM SFPs DWDM ITU-T compliant SFPs. Details are shown in Table 21.

Table 21 DWDM SFPs (page 1 of 3)

Product ID	Product description	Part number	Applicable standard	Temperature range (°C)
ONS-SC-2 G-28.7=	OC-48/STM16, SFP, 1528.77, 100 GHz, LC	10-2307-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-30.3=	OC-48/STM16, SFP, 1530.33, 100 GHz, LC	10-2155-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-31.1=	OC-48/STM16, SFP, 1531.12, 100 GHz, LC	10-2156-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-31.9=	OC-48/STM16, SFP, 1531.90, 100 GHz, LC	10-2157-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-32.6=	OC-48/STM16, SFP, 1532.68, 100 GHz, LC	10-2158-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-33.4=	OC-48/STM16, SFP, 1533.47, 100 GHz, LC	10-2306-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-34.2=	OC-48/STM16, SFP, 1534.25, 100 GHz, LC	10-2159-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-35.0=	OC-48/STM16, SFP, 1535.04, 100 GHz, LC	10-2160-02	ITU G694, GR2918	0 to +70

Table 21 DWDM SFPs (page 2 of 3)

Product ID	Product description	Part number	Applicable standard	Temperature range (°C)
ONS-SC-2 G-35.8=	OC-48/STM16, SFP, 1535.82, 100 GHz, LC	10-2161-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-36.6=	OC-48/STM16, SFP, 1536.61, 100 GHz, LC	10-2162-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-38.1=	OC-48/STM16, SFP, 1538.19, 100 GHz, LC	10-2163-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-38.9=	OC-48/STM16, SFP, 1538.98, 100 GHz, LC	10-2164-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-39.7=	OC-48/STM16, SFP, 1539.77, 100 GHz, LC	10-2165-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-40.5=	OC-48/STM16, SFP, 1540.56, 100 GHz, LC	10-2185-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-41.3=	OC-48/STM16, SFP, 1541.35, 100 GHz, LC	10-2305-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-42.1=	OC-48/STM16, SFP, 1542.14, 100 GHz, LC	10-2166-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-42.9=	OC-48/STM16, SFP, 1542.94, 100 GHz, LC	10-2167-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-43.7=	OC-48/STM16, SFP, 1543.73, 100 GHz, LC	10-2168-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-44.5=	OC-48/STM16, SFP, 1544.53, 100 GHz, LC	10-2169-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-46.1=	OC-48/STM16, SFP, 1546.12, 100 GHz, LC	10-2170-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-46.9=	OC-48/STM16, SFP, 1546.92, 100 GHz, LC	10-2171-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-47.7=	OC-48/STM16, SFP, 1547.72, 100 GHz, LC	10-2172-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-48.5=	OC-48/STM16, SFP, 1548.51, 100 GHz, LC	10-2173-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-49.3=	OC-48/STM16, SFP, 1549.32, 100 GHz, LC	10-2304-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-50.1=	OC-48/STM16, SFP, 1550.12, 100 GHz, LC	10-2186-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-50.9=	OC-48/STM16, SFP, 1550.92, 100 GHz, LC	10-2174-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-51.7=	OC-48/STM16, SFP, 1551.72, 100 GHz, LC	10-2175-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-52.5=	OC-48/STM16, SFP, 1552.52, 100 GHz, LC	10-2176-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-54.1=	OC-48/STM16, SFP, 1554.13, 100 GHz, LC	10-2177-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-54.9=	OC-48/STM16, SFP, 1554.94, 100 GHz, LC	10-2178-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-55.7=	OC-48/STM16, SFP, 1555.75, 100 GHz, LC	10-2179-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-56.5=	OC-48/STM16, SFP, 1556.55, 100 GHz, LC	10-2180-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-57.3=	OC-48/STM16, SFP, 1557.36, 100 GHz, LC	10-2308-02	ITU G694, GR2918	0 to +70

Table 21 DWDM SFPs (page 3 of 3)

Product ID	Product description	Part number	Applicable standard	Temperature range (°C)
ONS-SC-2 G-58.1=	OC-48/STM16, SFP, 1558.17, 100 GHz, LC	10-2181-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-58.9=	OC-48/STM16, SFP, 1558.98, 100 GHz, LC	10-2182-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-59.7=	OC-48/STM16, SFP, 1559.79, 100 GHz, LC	10-2183-02	ITU G694, GR2918	0 to +70
ONS-SC-2 G-60.6=	OC-48/STM16, SFP, 1560.61, 100 GHz, LC	10-2184-02	ITU G694, GR2918	0 to +70

CWDM SFPs CWDM ITU-T compliant SFPs. Details are shown in Table 22.

Table 22 CWDM SFPs (page 1 of 2)

Product ID	Product description	Part number	Applicable standard	Temperature range (°C)
ONS-SE-155-1470=	SFP - OC3/STM1, CWDM, 1470 nm, EXT	10-1996-01	ITU-T G.694.2	-10 to +85
ONS-SE-155-1490=	SFP - OC3/STM1, CWDM, 1490 nm, EXT	10-1998-01	ITU-T G.694.2	-10 to +85
ONS-SE-155-1510=	SFP - OC3/STM1, CWDM, 1510 nm, EXT	10-1999-01	ITU-T G.694.2	-10 to +85
ONS-SE-155-1530=	SFP - OC3/STM1, CWDM, 1530 nm, EXT	10-2000-01	ITU-T G.694.2	-10 to +85
ONS-SE-155-1550=	SFP - OC3/STM1, CWDM, 1550 nm, EXT	10-2001-01	ITU-T G.694.2	-10 to +85
ONS-SE-155-1570=	SFP - OC3/STM1, CWDM, 1570 nm, EXT	10-2002-01	ITU-T G.694.2	-10 to +85
ONS-SE-155-1590=	SFP - OC3/STM1, CWDM, 1590 nm, EXT	10-2003-01	ITU-T G.694.2	-10 to +85
ONS-SE-155-1610=	SFP - OC3/STM1, CWDM, 1610 nm, EXT	10-1997-01	ITU-T G.694.2	-10 to +85
ONS-SE-622-1470=	SFP - OC12/STM4, CWDM, 1470 nm, EXT	10-2004-01	ITU-T G.694.2	-10 to +85
ONS-SE-622-1490=	SFP - OC12/STM4, CWDM, 1490 nm, EXT	10-2005-01	ITU-T G.694.2	-10 to +85
ONS-SE-622-1510=	SFP - OC12/STM4, CWDM, 1510 nm, EXT	10-2006-01	ITU-T G.694.2	-10 to +85
ONS-SE-622-1530=	SFP - OC12/STM4, CWDM, 1530 nm, EXT	10-2007-01	ITU-T G.694.2	-10 to +85
ONS-SE-622-1550=	SFP - OC12/STM4, CWDM, 1550 nm, EXT	10-2008-01	ITU-T G.694.2	-10 to +85
ONS-SE-622-1570=	SFP - OC12/STM4, CWDM, 1570 nm, EXT	10-2009-01	ITU-T G.694.2	-10 to +85
ONS-SE-622-1590=	SFP - OC12/STM4, CWDM, 1590 nm, EXT	10-2010-01	ITU-T G.694.2	-10 to +85
ONS-SE-622-1610=	SFP - OC12/STM4, CWDM, 1610 nm, EXT	10-2011-01	ITU-T G.694.2	-10 to +85
ONS-SC-Z3-1470=	SFP - OC48/STM16/GE, CWDM, 1470 nm	10-2285-01	ITU-T G.694.2	0 to +70

Table 22 CWDM SFPs (page 2 of 2)

Product ID	Product description	Part number	Applicable standard	Temperature range (°C)
ONS-SC-Z3-1490=	SFP - OC48/STM16/GE, CWDM, 1490 nm	10-2286-01	ITU-T G.694.2	0 to +70
ONS-SC-Z3-1510=	SFP - OC48/STM16/GE, CWDM, 1510 nm	10-2287-01	ITU-T G.694.2	0 to +70
ONS-SC-Z3-1530=	SFP - OC48/STM16/GE, CWDM, 1530 nm	10-2288-01	ITU-T G.694.2	0 to +70
ONS-SC-Z3-1550=	SFP - OC48/STM16/GE, CWDM, 1550 nm	10-2289-01	ITU-T G.694.2	0 to +70
ONS-SC-Z3-1570=	SFP - OC48/STM16/GE, CWDM, 1570 nm	10-2290-01	ITU-T G.694.2	0 to +70
ONS-SC-Z3-1590=	SFP - OC48/STM16/GE, CWDM, 1590 nm	10-2291-01	ITU-T G.694.2	0 to +70
ONS-SC-Z3-1610=	SFP - OC48/STM16/GE, CWDM, 1610 nm	10-2292-01	ITU-T G.694.2	0 to +70

Grey XFPs Grey XFPs. Details are shown in Table 23.

Table 23 Grey XFPs

Product ID	Product description	Part number	Applicable standard	Temperature range (°C)
ONS-XC-10G-S1=	XFP - OC192/STM64/10GE - 1310 SR - SM LC	10-2012-02	ITU G694 I-64.1 GR253 SR-1 10GE BASE LR 1200-SM-LL-L	0 to +70
ONS-XC-10G-I2=	XFP - OC192/STM64/10GE - 1550 IR2 - SM LC	10-2193-02	ITU G694 S-64.2b GR253 IR-2	0 to +70
ONS-XC-10G-L2=	XFP - OC192/STM64 - 1550 LR2 - SM LC	10-2194-02	ITU G959.1 P1L1-2D2 GR253 LR-2	0 to +70

DWDM XFPs DWDM XFPs. Details are shown in Table 24.

Table 24 DWDM XFPs (page 1 of 2)

Product ID	Product description	Part number	Applicable standard	Temperature range (°C)
ONS-XC-10G-30.3=	OC-192/STM64/10GE, XFP, 1530.33, 100 GHz, LC	10-2347-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-31.1=	OC-192/STM64/10GE, XFP, 1531.12, 100 GHz, LC	10-2346-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-31.9=	OC-192/STM64/10GE, XFP, 1531.90, 100 GHz, LC	10-2344-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-32.6=	OC-192/STM64/10GE, XFP, 1532.68, 100 GHz, LC	10-2345-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-33.4=	OC-192/STM64/10GE, XFP, 1533.47, 100 GHz, LC	10-2343-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-34.2=	OC-192/STM64/10GE, XFP, 1534.25, 100 GHz, LC	10-2342-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-35.0=	OC-192/STM64/10GE, XFP, 1535.04, 100 GHz, LC	10-2341-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-35.8=	OC-192/STM64/10GE, XFP, 1535.82, 100 GHz, LC	10-2340-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-36.6=	OC-192/STM64/10GE, XFP, 1530.33, 100 GHz, LC	10-2347-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-37.4=	OC-192/STM64/10GE, XFP, 1531.12, 100 GHz, LC	10-2346-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-38.1=	OC-192/STM64/10GE, XFP, 1531.90, 100 GHz, LC	10-2344-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-38.9=	OC-192/STM64/10GE, XFP, 1532.68, 100 GHz, LC	10-2345-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-39.7=	OC-192/STM64/10GE, XFP, 1533.47, 100 GHz, LC	10-2343-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-40.5=	OC-192/STM64/10GE, XFP, 1534.25, 100 GHz, LC	10-2342-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-41.3=	OC-192/STM64/10GE, XFP, 1535.04, 100 GHz, LC	10-2341-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-42.1=	OC-192/STM64/10GE, XFP, 1535.82, 100 GHz, LC	10-2340-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-42.9=	OC-192/STM64/10GE, XFP, 1536.61, 100 GHz, LC	10-2339-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-43.7=	OC-192/STM64/10GE, XFP, 1537.40, 100 GHz, LC	10-2338-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-44.5=	OC-192/STM64/10GE, XFP, 1538.19, 100 GHz, LC	10-2337-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-45.3=	OC-192/STM64/10GE, XFP, 1538.98, 100 GHz, LC	10-2336-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-46.1=	OC-192/STM64/10GE, XFP, 1539.77, 100 GHz, LC	10-2335-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-46.9=	OC-192/STM64/10GE, XFP, 1540.56, 100 GHz, LC	10-2348-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-47.7=	OC-192/STM64/10GE, XFP, 1541.35, 100 GHz, LC	10-2334-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-48.5=	OC-192/STM64/10GE, XFP, 1542.14, 100 GHz, LC	10-2333-01	ITU G694, GR2918	0 to +70

Table 24 DWDM XFPs (page 2 of 2)

Product ID	Product description	Part number	Applicable standard	Temperature range (°C)
ONS-XC-10G-49.3=	OC-192/STM64/10GE, XFP, 1542.94, 100 GHz, LC	10-2332-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-50.1=	OC-192/STM64/10GE, XFP, 1543.73, 100 GHz, LC	10-2331-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-50.9=	OC-192/STM64/10GE, XFP, 1544.53, 100 GHz, LC	10-2330-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-51.7=	OC-192/STM64/10GE, XFP, 1545.32, 100 GHz, LC	10-2329-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-52.5=	OC-192/STM64/10GE, XFP, 1546.12, 100 GHz, LC	10-2328-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-53.3=	OC-192/STM64/10GE, XFP, 1546.92, 100 GHz, LC	10-2327-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-54.1=	OC-192/STM64/10GE, XFP, 1547.72, 100 GHz, LC	10-2326-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-54.9=	OC-192/STM64/10GE, XFP, 1548.51, 100 GHz, LC	10-2325-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-55.7=	OC-192/STM64/10GE, XFP, 1549.32, 100 GHz, LC	10-2324-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-56.5=	OC-192/STM64/10GE, XFP, 1550.12, 100 GHz, LC	10-2323-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-57.3=	OC-192/STM64/10GE, XFP, 1550.92, 100 GHz, LC	10-2322-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-58.1=	OC-192/STM64/10GE, XFP, 1551.72, 100 GHz, LC	10-2321-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-58.9=	OC-192/STM64/10GE, XFP, 1552.52, 100 GHz, LC	10-2320-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-59.7=	OC-192/STM64/10GE, XFP, 1553.33, 100 GHz, LC	10-2319-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-60.6=	OC-192/STM64/10GE, XFP, 1554.13, 100 GHz, LC	10-2318-01	ITU G694, GR2918	0 to +70
ONS-XC-10G-61.4=	OC-192/STM64/10GE, XFP, 1554.94, 100 GHz, LC	10-2317-01	ITU G694, GR2918	0 to +70

SFP technical details

This section contains tables listing SFP technical details.

SONET/SDH SFPs

The SFPs are compatible with the SONET/SDH standards, and support the digital diagnostic functions specified in the SFF-8742 Multi-Source Agreement (MSA).

Table 25 lists the optical parameters for the Cisco ONS SONET/SDH SFPs.

Table 25 SONET/SDH SFPs optical specification

Product ID	Operating wavelength range (nm)	Transmit power range (dBm)	Receiver power range (dBm)	Maximum dispersion (ps/nm)
15454-SFP3-1-IR= ONS-SI-155-I1=	1261-1360	-15 to -8	-28 to -8	96 (@155.52Mb/s)
ONS-SI-155-L1=	1263-1360	-5 to 0	-34 to -10	NA
ONS-SI-155-L2=	1480-1580	-5 to 0	-34 to -10	NA
ONS-SI-155-SR-MM=	1270-1380	-20 to -14	-30 to -14	NA
ONS-SI-622-SR-MM=	1270-1380	-20 to -14 (50 mm) -24 to -14 (62.5 mm)	-26 to -14	NA
15454-SFP12-4-IR= ONS-SI-622-I1=	1293-1334	-15 to -8	-28 to -8	46 (@ 622.08Mb/s)
ONS-SI-622-L1=	1280-1335	-3 to +2	-28 to -8	NA
ONS-SI-622-L2=	1480-1580	-3 to +2	-28 to -8	NA
ONS-SE-2 G-S1= ONS-SI-2 G-S1=	1266-1360	-10 to -3	-18 to -3	12
ONS-SI-2 G-I1= 15454-SFP-OC48-IR=	1260-1360	-5 to 0	-18 to 0	NA
ONS-SI-2 G-L1=	1280-1335	-3 to +2	-27 to -9	NA
ONS-SE-2 G-L2= ONS-SI-2 G-L2=	1500-1580	-3 to +2	-28 to -9	1200-1600[a]

a. The indicated dispersion range corresponds to the approximate worst-case dispersion for 80 km G.652/G.654 fiber over the wavelength range 1500-1580 nm.

GBIC / DATA SFPs

The ONG Pluggables GBIC / Data SFPs are compatible with the IEEE 802.3, SBCON Single-Byte Command Code Sets CONnection architecture (SBCON) Rev2.3 [ESCON], ANSI INCITS 352-2002 Information technology - Fibre Channel – Physical Interfaces (FC-PI) Rev. 13[1xFC & 2xFC] and support the digital diagnostic functions specified in the SFF-8742 Multi-Source Agreement (MSA).

Table 26 on page 143 through Table 28 on page 144 list the optical parameters for the Cisco ONS Data SFPs.

Table 26 Ethernet pluggables optical specification

Product ID	Operating wavelength range (nm)	Transmit power range (dBm)	Receiver power range (dBm)	Maximum dispersion (ps/nm)
ONS-SE-100-LX10=	1260-1360	-15 to -8	-28 to -8	NA
ONS-SE-100-FX=	1270-1380	-20 to -14[a]	-31 to -14	NA
15327-SFP-LC-SX= 15454-SFP-LC-SX= ONS-SC-GE-SX= ONS-SI-GE-SX= 15454-SFP-GEFC-SX= ONS-SE-G2F-SX= ONS-GC-GE-SX=	770-860	-9.5 to 0	-17 to 0[b]	NA
15327-SFP-LC-LX= 15454-SFP-LC-LX/LH= 15454-SFP-GE+-LX= ONS-SC-GE-LX= ONS-SI-GE-LX= ONS-SE-G2F-LX= ONS-GC-GE-LX=	1270-1355	-9.5 to -3	-19 to -3[c]	NA
ONS-GC-GE-ZX= ONS-SI-GE-ZX= ONS-SE-GE-ZX=	1500-1580	0 to +5	-23 to -3	1200-1600[d]

a. 62.5/125 µm, NA = 0.275 Fiber.

b. Minimum Stressed Sensitivity (10-12): -12.5(62.5um) and -13.5(50um) dBm.

c. Minimum Stressed Sensitivity (10-12): -14.4 dBm.

d. The indicated dispersion range corresponds to the approximate worst-case dispersion for 80 km G.652/G.654 fiber over the wavelength range 1500-1580 nm.

Table 27 ESCON SFPs optical specification

Product ID	Operating wavelength range (nm)	Transmit power range (dBm)	Receiver power range (dBm)	Maximum dispersion (ps/nm)
15454-SFP-200= ONS-SE-200-MM=	1280-1380	-20.5 to -15	-14 to -29[a]	NA

a. Based on any valid 8B/10B code pattern measured at, or extrapolated to, 10E-15 BER measured at center of eye.

Table 28 FC/FICON pluggables optical specification

Product ID	operating wavelength range (nm)	Transmit power range (dBm)	Receiver sensitivity (dBm)	Operating distance (m)
1 G FC/FICON (1062.5 Kb/s)				
15454-SFP-GEFC-SX= ONS-SE-G2F-SX=	770-860	-10 to -3.5	-22	0.5 to 500m (50/125?mm fiber) 0.5 to 300m (62.5/125??m fiber)
ONS-GX-2FC-MMI=	770-860	-10 to -2.5	-22	0.5 to 500m (50/125??m fiber) 0.5 to 300m (62.5/125??m fiber)
15454-SFP-GE+-LX= ONS-SE-G2F-LX=	1270-1360	-10 to -3.5	-22	2 to 10,000
ONS-GX-2FC-SML=	1270-1355	-9 to -3	-23.5	2 to 10,000
2 G FC/FICON (2125 Kbps)				
15454-SFP-GEFC-SX= ONS-SE-G2F-SX=	830-860	-10 to -3.5	-20	0.5 to 300
ONS-GX-2FC-MMI=	820-860	-9.5 to -5	-15	0.5 to 300
15454-SFP-GE+-LX= ONS-SE-G2F-LX=	1270-1360	-10 to -3.5	-21	2 to 10,000
ONS-GX-2FC-SML=	1270-1355	-9 to -3	-23.5	2 to 10,000
4 G FC/FICON (4250 Kb/s)				
ONS-SE-4 G-MM=	830-860	-9 to -3.5	-15	0 to 70 (50/125??m fiber) 0 to 150 (62.5/125??m fiber)
ONS-SE-4 G-SM=	1270-1355	-8.4 to -3	29??W OMA[a]	2 to 10,000

a. Specified OMA at 4.25 Gb/s is equivalent to an average power of -17.3 dBm at an ER of 9 dB.

XWDM SFPs ONG is offering a full set of CWDM SFPs for 155Mbps and 622Mbps and DWDM SFPs for 2.5 Gb/s application. Table 29 through Table 31 on page 145 list SFPs optical parameters.

Table 29 CWDM SFPs optical specification

Product ID	Receiver wavelength range (nm)	Spectral width (nm)	Transmit power range (dBm)	Receiver power range (dBm)
ONS-SE-155-xxxx=	1460-1620	1	0 to +5	-34 to -3 (BER 10^{-10})
ONS-SE-622-xxxx=	1460-1620	1	0 to +5	-28 to -3 (BER 10^{-10})
ONS-SC-Z3-xxxx=	1460-1620	1	0 to +4	-28 to -9 (BER 10^{-10})

xxxx from 1470 to 1610.

Table 30 DWDM SFPs optical specification

Product ID	Receiver wavelength range (nm)	Transmitter stability (pm)	Spectral width (pm)	Transmit power range (dBm)
ONS-SC-2 G-xx.x=	1260-1620[a]	-100 to +100 (100GHz Spacing)	200	0 to +4

a. Receiver Sensitivity specified over 1528-1561nm only, with 2dB degradation permitted outside of this range.

xx.x from 30.3 to 60.6

Table 31 DWDM SFPs optical performances

Power limited performances			
Input power range	dBm	-9 to -28	At BER=10e-12 with SONET framed PRBS23 at OSNR of 21dB, 0.1nm BW
Dispersion Tolerance	ps/nm	-800 to +2400	Power Penalty=3dB, OSNR=21dB@0.1nmBW (Noise Penalty=0dB)
Noise limited performances			
Input power range	dBm	-9 to -22	At BER=10e-12 with SONET framed PRBS23. at OSNR of 16dB at 0.1nm bandwidth.
Dispersion Tolerance	ps/nm	-800 to +2400	Noise Penalty=3dB, OSNR=19dB@0.1nmBW (Power Penalty=0dB)

Grey XFPs Grey XFPs for 10 Gb/s application. Table 32 lists optical parameters.

Table 32 XFPs optical specification

Product ID	Transmitter wavelength range (nm)	Transmit power range (dBm)	Receiver wavelength range (nm)	CD robustness (ps)	Receiver power range (dBm)
ONS-XC-10G-S1=	1260-1335	-6 to -1[a] 8.2 to +0.5 [b]	1260-1565	6.6	-11 to -1[a] -14.4 to +0.5[b, c]
ONS-XC-10G-I2=	1530-1565	-1 to +2	1260-1565	800	-14 to +2
ONS-XC-10G-L2=	1530-1565	0 to +4	1260-1565	1600	-24 to -7

a. SONET/SDH Application.

b. 10 GE/10 G FC Application.

c. Stressed receiver sensitivity (max) in OMA is -10.3 dBm.

DWDM XFPs DWDM XFPs for 10 Gb/s application. Table 33 lists optical parameters.

Table 33 DWDM XFPs optical specification

Product ID	Receiver wavelength range (nm)	Transmitter stability (pm)	Spectral width (pm)	Transmit power range (dBm)
ONS-XC-10G-xx.x=	1260-1607[11]	-100 to +100 (100GHz Spacing)	200	-1 to +3

xx.x from 30.3 to 61.4

Table 34 DWDM XFPs optical performances (page 1 of 2)

Short Wavelength performances			
Input power range	dBm	-7 to -20	At BER=10e-12 (@1310nm ±20nm) applicable at 9.9G, 10.3 G only
Long Wavelength performances C band NO-FEC applications power limited			
Input power range	dBm	-7 to -23	At BER=10e-12 applicable at 9.9G, 10.3 G only 23dB OSNR
Input power range		-7 to -20	At BER=10e-12 (-500 to +1600 ps/nm) applicable at 9.9G, 10.3 G only – 23dB OSNR
Long Wavelength performances C band NO-FEC applications noise limited			
Input power range	dBm	-7 to -18	At BER=10e-12 applicable at 9.9G, 10.3 G only 17dB OSNR

Table 34 DWDM XFPs optical performances (page 2 of 2)

Input power range	dBm	-7 to -18	At BER=10e-12 (-500 to +1600 ps/nm) applicable at 9.9G, 10.3 G only – 20dB OSNR
Long Wavelength performances C band FEC applications noise limited			
Input power range	dBm	-7 to -18	At BER PREFEC <10e-5 applicable at 10.7G, 11.1 G only -- 11dB OSNR
Input power range	dBm	-7 to -18	At BER PREFEC <10e-5 (-500 to +1100 ps/nm) applicable at 10.7G, 11.1 G only – 12dB OSNR
Long Wavelength performances C band E-FEC applications power limited			
Input power range	dBm	-7 to -27	At BER PREFEC <7*10e-4 applicable at 10.7G, 11.1 G only – 23dB OSNR
Input power range	dBm	-7 to -24	At BER PREFEC <7*10e-4 (-500 to +1300 ps/nm) applicable at 10.7G, 11.1 G only – 23dB OSNR
Long Wavelength performances C band E-FEC applications noise limited			
Input power range	dBm	-7 to -18	At BER PREFEC <7*10e-4 applicable at 10.7G, 11.1 G only – 8dB OSNR
Input power range	dBm	-7 to -18	At BER PREFEC <7*10e-4 (-500 to +1100 ps/nm) applicable at 10.7G, 11.1 G only – 9dB OSNR

MSTP management

The ONS 15454 MSTP has several options in which it can be managed:

- Cisco Transport Controller (CTC), discussed briefly in this section
- Cisco Transport Manager (CTM), discussed briefly in this section
- SNMP v1, v2
- TL1
- Corba

The ONS 15454 MSTP has one software load which distributes the appropriate firmware to the individual line cards. If cases that new firmware is available for a particular line card an administrator is required to activate the new firmware if the new firmware is service disruptive.

Cisco Transport Controller (CTC)

Cisco Transport Controller (CTC) is a provisioning and administration tool located on the TCC2 card and is activated when a web browser is directed to the IP address of the ONS 15454 MSTP.

CTC is a Java application that is uses Corba to communicate with the node to retrieve/provision/monitor a network of MSTP nodes.

Cisco Transport Manager (CTM)

Cisco Transport Manager (CTM) is an intelligent element management system (EMS) that efficiently manages the entire Cisco ONS Family of products as well as the Cisco Carrier Routing System (CRS-1), Cisco XR 12000 Series Router, Cisco 7609, Cisco MGX 8880 Media Gateway, and voice-enabled Cisco MGX 8850 and MGX 8830 Multiservice Switches.

Cisco Transport Manager supports configuration, fault, performance, and security management and serves as a foundation for integration into a larger OSS environment. High availability, self-healing processes, and comprehensive management across different types of Cisco devices give service providers and large enterprises a resilient, adaptable, and integrated carrier-class EMS solution.

Cisco Transport Manager is a powerful GUI-based management system that makes advanced management capabilities such as A-to-Z circuit provisioning easy to learn and use. Its explorer-style navigation and extensive use of wizards, tool tips, legends, and online help allow operators to perform tasks quickly and efficiently. Many otherwise tedious, time-consuming, and error-prone tasks can be fully streamlined using these intuitive tools.

Cisco Transport Manager is designed for continuous operation. High-availability deployment configurations are available to provide local and geographic redundancy options. Cisco Transport Manager can cope with heavy load scenarios such as high circuit-transaction rates, performance-monitoring data collection, alarm storms, and numerous simultaneous clients. Cisco Transport Manager plays a crucial role in the high availability of the network itself. The Cisco Transport Manager fault-management and performance-management capabilities help to ensure that network problems are discovered quickly and accurately so that often they can be addressed even before a customer's service is noticeably affected.

MSTP further reading

For further reading on the ONS 15454 MSTP the following link has white papers, data sheets, case studies, etc., on the platform.

http://www.cisco.com/en/US/products/hw/optical/ps2006/tsd_products_support_series_home.html

Finisar FLX-2000 Link Extender

This chapter contains information on the Finisar FLX-2000 link extender.

Note: For information on EMC-qualified third-party products, refer to the *EMC Select* document on Powerlink.

Introduction

The Symmetrix Fibre Channel fabric implementation supports the Finisar Model FLX-2000-1062-40, a 40 km optical extender.

As illustrated in Figure 60, the function of the FLX-2000 is to relay or convert a Fibre Channel multi-mode signal from the source and translate the input to a single-mode long-haul signal. Another FLX-2000 then translates the single-mode signal back into a multi-mode signal into the target device.

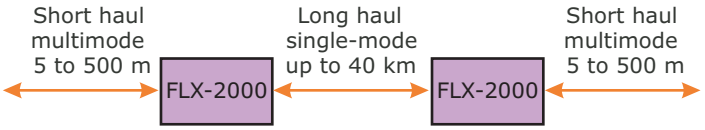


Figure 60 FLX-2000 function

Configuration guidelines

The following are some guidelines and limitations for using extenders in a switched Fibre Channel environment with Symmetrix Fibre Channel storage.

Host connection

The FLX-2000 extender can be used between a host Fibre Channel connection and a Connectrix Fibre Channel switch port connection.

Symmetrix connection

The FLX-2000 extender can be used between a Symmetrix Fibre Channel director (FA) port and a Connectrix Fibre Channel switch port connection.

Switch connections

Multiple extender connections into a Connectrix (a requirement for high-availability environments) require multiple FLX extenders, since each FLX-2000 supports only one through-connection.

Buffer-to-Buffer Credit calculation

In order to achieve maximum utilization of the Fibre Channel link, it is highly advisable that both ports, connected on either side of the long-haul setup provided by the extender, be capable of high BB_Credit counts.

Use the following formula to calculate the approximate BB_Credit required for the specific long haul application:

(Required BB_Credit) = (One way distance in Km) / 2

Cable requirements

A long-haul connection requires a long-haul fiber connector, ST/PC single mode, zero dispersion at 1310 nm, 9/125mm, maximum attenuation 0.4 dB/Km@1310 nm.

Power budget

Power measurements must be taken in order to insure long-haul link integrity. Maximum losses in long-haul medium (cable and connectors) must not exceed 23 dBm:

- Minimum transmission power is -3 dB.
- Minimum receiver sensitivity is -26 dB.

Note: Consult single-mode cable manufacturer specifications.

For reference, *dBm* is a logarithmic power ratio of a power source relative to 1 mW (milliwatt):

dB = 10 x LOG (P1/P2)
dBm = 10 x LOG (P/1E-3)

where:

p2 = 1 mW
1E-3 = 0.001 W

Examples:

0 dBm = 1 mW
-20 dBm = 0.01 mW

Firmware

The FLX-2000 firmware must be revision 3.0 or later.

Symmetrix microcode

The Symmetrix microcode must be 5265.38.24 or later.

Diagnostics and maintenance

Repair and system diagnostics can be performed through the FLX control console, as described in the FLX user manual.

6

SONET

This chapter provides a basic overview of SONET.

Note: For information on EMC-qualified third-party products, refer to the *EMC Select* document on Powerlink.

SONET overview

SONET (Synchronous Optical NETwork) is a telecommunications standard developed by the Exchange Carriers Standards Association for ANSI. SONET defines a technology for carrying different capacity signals through a synchronous optical network. The standard defines a byte-interleaved multiplexed transport occupying the physical layer of the OSI model. Synchronization is provided by one principal network element with a very stable clock (Stratum 3), which is sourced on its outgoing OC-N signal. This clock is then used by other network elements for their clock (loop timing).

SONET is useful in a SAN for consolidating multiple low-frequency channels (Client ESCON and 1 Gb Fibre Channel) into a single higher-speed connection. This can reduce DWDM wavelength requirements in an existing SAN infrastructure. It can also allow a distance solution to be provided from any SONET service carrier, saving the expense of running private optical cable over long distances.

The basic SONET building block is an STS-1 (Synchronous Transport Signal), composed of the transport overhead plus a synchronous payload envelope (SPE), totaling 810 bytes. The 27-byte transport overhead is used for operations, administration, maintenance, and provisioning. The remaining bytes make up the SPE, of which an additional nine bytes are path overhead. It is arranged as depicted in Figure 61. Columns 1, 2, and 3 are the transport overhead.

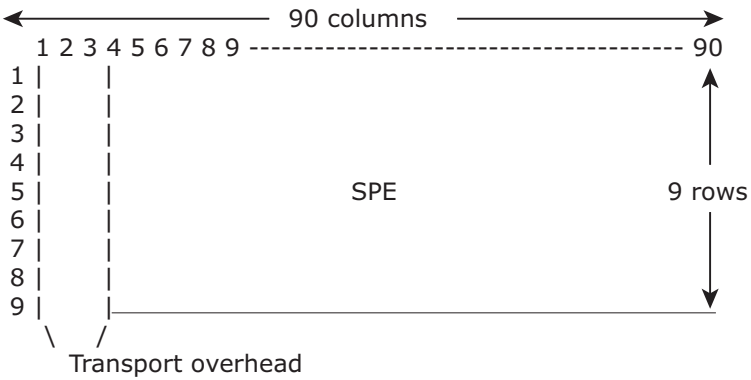


Figure 61 STS-1 organization

An STS-1 operates at 51.84 Mb/s, so multiple STS-1s are required to provide the necessary bandwidth for ESCON, Fibre Channel and Ethernet, as shown in Table 35. Multiply the rate by 95 % to obtain the usable bandwidth in an STS-1 (reduction due to overhead bytes).

Table 35 STS-1s and optical carrier rates

STS	Optical Carrier	Optical Carrier Rate
STS-1	OC-1	51.84 MB/s
STS-3	OC-3	155.52 MB/s
STS-12	OC-12	622.08 MB/s
STS-48	OC-48	2488.32 MB/s
STS-192	OC-192	9953.28 MB/s

As Table 35 shows, one OC-48 can carry roughly 2.5 channels of 1 Gb/s traffic. To achieve higher data rates for client connections, multiple STS-1s are byte-interleaved to create an STS-N. SONET defines this as byte-interleaving three STS-1s into an STS-3, and subsequently interleaving STS-3s.

By definition, each STS is still visible and available for ADD/DROP multiplexing in SONET, although most SAN requirements can be met with less complex point-to-point connections. The addition of DWDM can even further consolidate multiple SONET connections (OC-48), while also providing distance extension.

How STS-1s are interleaved to create an STS-12

Figure 62 shows how STS-1s are interleaved to create an STS-12.

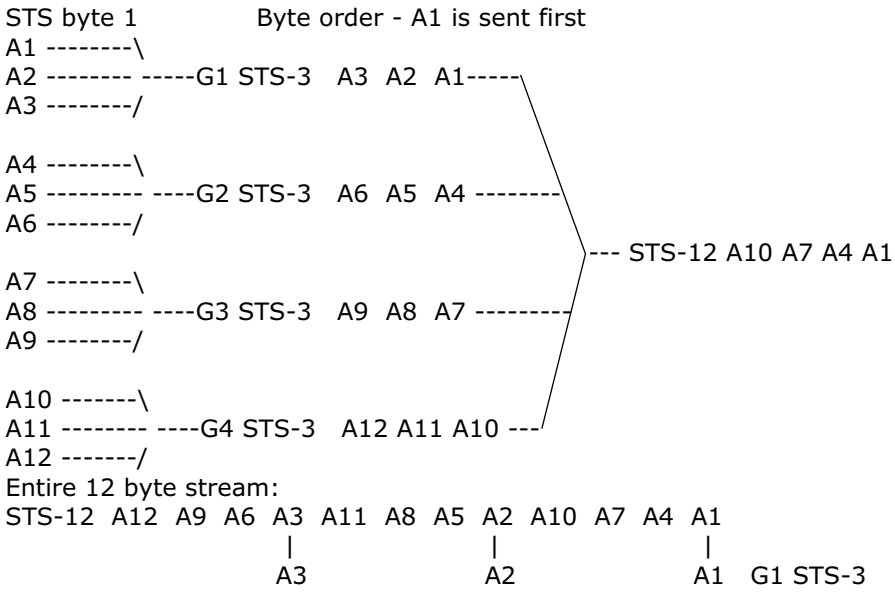


Figure 62 STS-12 organization

7

Lucent OptiStar EdgeSwitch

This chapter contains data on the Lucent OptiStar EdgeSwitch.

Note: For information on EMC-qualified third-party products, refer to the *EMC Select* document on Powerlink.

Overview

Figure 63 shows a OptiStar switches over a SONET network.

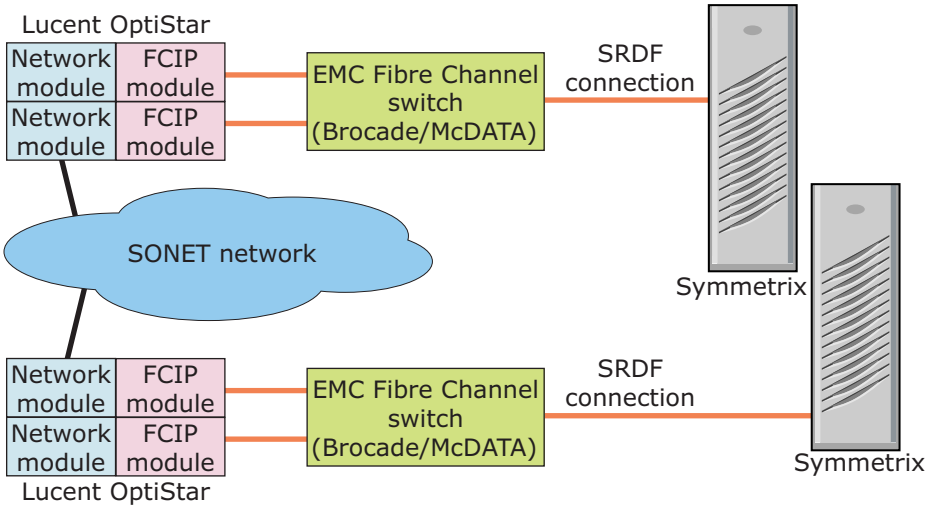


Figure 63 OptiStar switches over SONET network

Supportable configurations

Minimum requirements for this setup include the following:

- The OptiStar switches will be used as part of a DR (disaster recovery) SAN only.
- SRDF is the only supported configuration.
- No direct-attach or remote Host I/O will be supported in this configuration.
- Ideally, the total aggregated throughput of SRDF links should not exceed the OptiStar EdgeSwitch Network module's bandwidth.

The OptiStar switch will be supported in the following network characteristics (refer to Lucent technical notes):

- 0% packet loss.
- Guaranteed bandwidth; however, the minimum contiguous bandwidth should not be less than 622 Mb/s (an OC-12 link).

As a result of these limitations, the OptiStar will fit best in a leased bandwidth network such as SONET or DWDM.

The DR SAN will be composed of one OptiStar EdgeSwitch plus a Brocade or Brocade M Series switch at the local site, and the same number and type of switches at the remote site.

Note: E-Lab Navigator describes the latest supported configurations.

Symmetrix setup

Symmetrix SRDF ports should be configured as standard Fibre Channel SRDF ports. The Lucent switch, similar to any Fibre Channel switch, provides Fibre Channel switching services (such as zoning, RSCN, and name services) to the SRDF ports connected to the Brocade or Brocade M Series switch.

SRDF can be set up to run in any one of the following modes:

- Semi-synchronous Adaptive Copy Disk mode
- Semi-synchronous Adaptive Copy Write Pending mode
- Synchronous mode

8

Blade Servers

This chapter contains data on blade servers.

Note: For information on EMC-qualified third-party products, refer to the *EMC Select* document on Powerlink.

Blade server switch modules

Note: For more information on blade servers, refer to "Blade servers" on page 187.

The Brocade switch modules in this section integrate Brocade technology into the respective blade server architecture.

The Brocade M Series modules in this section are actually QLogic switch modules with Brocade M Series firmware.

Table 36 lists switch features for Brocade and Brocade M Series switches.

Table 36 Switch features (page 1 of 2)

	ASIC family	No. of Internal ports	No. of External ports	Line speed per port (in Gb/s)	ISL Trunking performance	
					Max no. of ports per trunk	Max. speed per ISL trunk (in Gb/s)
Brocade B Series						
DELL SW3014	Bloom 2	10	4	2/1	4	8
DELL SW4016	Golden Eye	10	4	4/2/1	4	16
HP A7535A [SW4012]	Golden Eye	8	4	4/2/1	4	16
IBM 26K5601	Bloom 2	14	2	2/1	N.A	N.A
IBM 90P0165	Bloom 2	14	2	2/1	N.A	N.A
IBM 32R1812 [SW4020]	Golden Eye	14	6	4/2/1	3	12
IBM 32R1813 [SW4020]	Golden Eye	7	3	4/2/1	3	12

Table 36 Switch features (page 2 of 2)

	ASIC family	No. of Internal ports	No. of External ports	Line speed per port (in Gb/s)	ISL Trunking performance	
					Max no. of ports per trunk	Max. speed per ISL trunk (in Gb/s)
HP AE370A [SW4024]	Golden Eye	8	4	4/2/1	4	16
HP AE371A [SW4024]	Golden Eye	16	8	4/2/1	4	16
HP AE372A [SW4024]	Golden Eye	16	8	4/2/1	4	16
Brocade M Series:						
DELL SW4314	Agate	10	4	2/1	4	8
DELL SW4416	Agate	10	4	4/2/1	4	16
HP A8001A	Agate	8	2	4/2/1	4	16
IBM 32R1790	Agate	14	6	2/1	4	8
IBM 32R1905	Agate-2	7	3	4/2/1	4	16
IBM 32R1833	Agate-2	14	6	4/2/1	4	16
Cisco MDS Series:						
HP MDS9124e	Atlantis	16	8	4/2/1	Standard port channeling supported	
IBM 39Y9284	Atlantis	7	3	4/2/1	Standard port channeling supported	
IBM 39Y9280	Atlantis	14	6	4/2/1	Standard port channeling supported	

DELL SW3014 Brocade 4-port 1/2 Gb FC switch module

The SW3014 includes the Brocade Fabric Operating System (Fabric OS) and is compatible with the entire SilkWorm product family. It is designed to work solely within switch module bay 3 or 4 of a Dell Poweredge 1855 chassis.

ASIC family

Bloom 2

Key features

Connectivity feature includes:

- 14 ports
  - 10 internal fabric ports
  - 4 external 2 Gb / 1 Gb auto-sensing auto-links: Ports numbered 10-13
- At the time of this publication, EMC supports connectivity to a maximum of 24 domains for this kind of a switch module. In general, these switch modules have a domain ID range from 1-239.

Note: For an actual count of the maximum number of domains supported by this switch module, please refer to the E-Lab Navigator.

Fabric services include:

- Simple name server
  - Registered State Change Notification (RSCN)
  - Alias Server (multicast)
  - Brocade Zoning
  - Fabric Watch
  - Extended Fabrics
  - ISL Trunking
  - Performance Monitoring
  - Secure Fabric OS
- ISL Trunking to other B Series switches:
  - Up to four ports per trunk, doing up to 8 Gb/s per ISL trunk.
- Class 2, Class 3, and Class F (interswitch frames) Fibre Channel protocol support.

Performance

- 2.125 Gb/s line speed, full duplex per Fibre Channel port.

Management

- Centralized configuration and management of fabric using client/server architecture (Web Tools) and CLI.
- Management software:
  - Telnet
  - SNMP
  - Web Tools
  - EMC Fabric Manager
  - I nteractive and non-interactive (nondisruptive) firmware upgrades.
- RJ-45 connector
  - Supports 10/100 Mb Ethernet connections.

Mechanical specifications

Mechanical specifications include:

- Width = 127 mm (5 in)
- Height = 35 mm (1.375 in)
- Depth = 247.7 mm (9.75 in)

DELL SW4016 Brocade 4-port 1/2/4 Gb FC switch module

The SW3014 includes the Brocade Fabric Operating System (Fabric OS) and is compatible with the entire SilkWorm product family. It is designed to work solely within switch module bay 3 or 4 of a Dell Poweredge 1855 chassis.

ASIC family

Golden Eye

Key features

Connectivity feature includes:

- 14 ports
  - 10 internal fabric ports
  - 4 external 4 Gb/2 Gb/1 Gb auto-sensing auto-links: Ports numbered 10-13
- At the time of this publication, EMC supports connectivity to a maximum of 24 domains for this kind of a switch module. In general, these switch modules have a domain ID range from 1-239.

Note: For an actual count of the maximum number of domains supported by this switch module, please refer to the E-Lab Navigator.

Fabric services include:

- Simple name server
  - Registered State Change Notification (RSCN)
  - Alias Server (multicast)
  - Brocade Zoning
  - Fabric Watch
  - Extended Fabrics
  - ISL Trunking
  - Performance Monitoring
  - Secure Fabric OS
- ISL Trunking to other B Series switches:
  - Up to four ports per trunk, doing up to 16 Gb/s per ISL trunk.
- Class 2, Class 3, and Class F (interswitch frames) Fibre Channel protocol support.

Performance

- 4.25 Gb/s line speed, full duplex per Fibre Channel port.

Management

- Centralized configuration and management of fabric using client/server architecture (Web Tools) and CLI.
- Management software:
  - Telnet
  - SNMP
  - Web Tools
  - EMC Fabric Manager
- Interactive and non-interactive (nondisruptive) firmware upgrades.
- RJ-45 connector
  - Supports 10/100 Mb Ethernet connections.

Mechanical specifications

Mechanical specifications include:

- Width = 127 mm (5 in)

- Height = 35 mm (1.375 in)
- Depth = 247.7 mm (9.75 in)

HP A7535A Brocade 4-port 1/2/4 Gb FC switch module

The HP A7535A switch module plugs into the back of the HP Blade System chassis thus resulting in a zero footprint Fibre Channel connection solution like any other switch module.

ASIC family

Golden Eye

Key features

Connectivity feature includes:

- 12 ports
  - 8 internal fabric ports
  - 4 external 2 Gb/1 Gb auto-sensing auto-links: Ports numbered 8-11)
- At the time of this publication, EMC supports connectivity to a maximum of 24 domains for this kind of a switch module. In general, these switch modules have a domain ID range from 1-239.

Note: For an actual count of the maximum number of domains supported by this switch module, please refer to the E-Lab Navigator.

Fabric services include:

- Simple name server
  - Registered State Change Notification (RSCN)
  - Alias Server (multicast)
  - Brocade Zoning
  - Fabric Watch
  - Extended Fabrics
  - ISL Trunking
  - Performance Monitoring
  - Secure Fabric OS
- ISL Trunking to other B Series switches. Up to four ports per trunk, doing up to 16 Gb/s per ISL trunk.
- Class 2, Class 3, and Class F (interswitch frames) Fibre Channel protocol support.

Performance

- 4.25 Gb/s line speed, full duplex per Fibre Channel port.

Management

- Centralized configuration and management of fabric using client/server architecture (Web Tools) and CLI.
- Management software:
  - Telnet
  - SNMP
  - Web Tools
  - EMC Fabric Manager
- Nondisruptive firmware upgrades.
- RJ-45 connector
  - Supports 10/100 Mb Ethernet connections.

Mechanical specifications

Mechanical specifications include:

- Width = 86.6 mm (3.41 in)
- Height = 38.7 mm (1.525 in)
- Depth = 114.12 mm (4.493 in)

IBM PN 26K5601 Brocade 2-port entry-level switch module

This switch is ideal for smaller Brocade Storage Area Networks still providing the option to expand and grow as needed. Integration of SAN switching capabilities reduces complexity and increases SAN manageability.

ASIC family

Bloom 2

Key features

Connectivity feature includes:

- 16 ports
  - 14 internal fabric ports
  - 2 external 2 Gb/1 Gb auto-sensing auto-links: Ports 0 and 15
- Switch module supports connectivity to a maximum of 2 domains per fabric. Thus, this switch is ideal for smaller Brocade Storage Area Networks.

Fabric services include:

- Simple name server
  - Registered State Change Notification (RSCN)

- Alias Server (multicast)
- Brocade Zoning
- Fabric Watch
- Extended Fabrics
- ISL Trunking
- Performance Monitoring
- Secure Fabric OS

- ISL Trunking option is not available since the two external ports are not consecutive ports.
- Class 2, Class 3, and Class F (interswitch frames) Fibre Channel protocol support.

Performance

- 2.125 Gb/s line speed, full duplex per Fibre Channel port.

Management

- Centralized configuration and management of fabric using client/server architecture (Web Tools) and CLI.
- Management software:
  - Telnet
  - SNMP
  - Web Tools
  - EMC Fabric Manager
- Nondisruptive firmware upgrades.
- Support for 10/100 Mb Ethernet connections for out-of-band management.

Mechanical specifications

Mechanical Specifications include:

- Width = 260 mm (10.2 in)
- Height = 112 mm (4.4 in)
- Depth = 29 mm (1.14 in)

IBM PN 90P0165 Brocade 2-port enterprise-level switch module

This switch is ideal for larger Brocade Storage Area Networks. Integration of SAN switching capabilities reduces complexity and increases SAN manageability.

ASIC family

Bloom 2

Key features

Connectivity feature includes:

- 16 ports
  - 14 internal fabric ports
  - 2 external 2 Gb/1 Gb auto-sensing auto-links: Ports 0 and 15
- At the time of this publication, EMC supports connectivity to a maximum of 24 domains for this kind of a switch module. In general, these switch modules have a domain ID range from 1-239.

Note: For an actual count of the maximum number of domains supported by this switch module, please refer to the E-Lab Navigator.

Fabric services include:

- Simple name server
  - Registered State Change Notification (RSCN)
  - Alias Server (multicast)
  - Brocade Zoning
  - Fabric Watch
  - Extended Fabrics
  - ISL Trunking
  - Performance Monitoring
  - Secure Fabric OS
- ISL Trunking option is not available since the two external ports are not consecutive ports.
- Class 2, Class 3, and Class F (interswitch frames) Fibre Channel protocol support.

Performance

- 2.125 Gb/s line speed, full duplex per Fibre Channel port.

Management

- Centralized configuration and management of fabric using client/server architecture (Web Tools) and CLI.
- Management software:
  - Telnet
  - SNMP
  - Web Tools

  - EMC Fabric Manager
- Nondisruptive firmware upgrades.
- Support for 10/100 Mb Ethernet connections for out-of-band management.

Mechanical specifications

Mechanical specifications include:

- Width = 260 mm (10.2 in)
- Height = 112 mm (4.4 in)
- Depth = 29 mm (1.14 in)

IBM PN 32R1812 Brocade 6-port SAN switch module

This switch module enables high end-to-end performance with 1, 2, and 4 Gb/s SAN solutions for the data center.

ASIC family Golden Eye

Key features Connectivity feature includes:

- 20 ports
  - 14 internal fabric ports
  - 6 external 4 Gb/2 Gb/1 Gb auto-sensing auto-links: Ports 14-19
- At the time of this publication, EMC supports connectivity to a maximum of 24 domains for this kind of a switch module. In general, these switch modules have a domain ID range from 1-239.

Note: For an actual count of the maximum number of domains supported by this switch module, please refer to the E-Lab Navigator.

Fabric services include:

- Simple name server
  - Registered State Change Notification (RSCN)
  - Alias Server (multicast)
  - Brocade Zoning
  - Fabric Watch
  - Extended Fabrics

- ISL Trunking
- Performance Monitoring
- Secure Fabric OS

- ISL Trunking to other B Series switches. In this case, up to four ports per trunk, doing up to 16 Gb/s per ISL trunk.
- Class 2, Class 3, and Class F (interswitch frames) Fibre Channel protocol support.

Performance

- 4.25 Gb/s line speed, full duplex per Fibre Channel port.

Management

- Centralized configuration and management of fabric using client/server architecture (Web Tools) and CLI.
- Management software:
  - Telnet
  - SNMP
  - Web Tools
  - EMC Fabric Manager
- Nondisruptive firmware upgrades.
- Support for 10/100 Mb Ethernet connections for out-of-band management.

Mechanical specifications

Mechanical specifications include:

- Width = 260 mm (10.2 in)
- Height = 112 mm (4.4 in)
- Depth = 29 mm (1.14 in)

IBM PN 32R1813 Brocade 3-port SAN switch module

This switch module is physically similar to the IBM PN 32R1812, however it has just 10 functional ports. It enables high end-to-end performance with 1, 2, and 4 Gb/s SAN solutions for the data center.

ASIC family

Golden Eye

Key features

Connectivity feature includes:

- 10 ports
  - Seven internal fabric ports

- Three external 4 Gb/2 Gb/1 Gb auto-sensing auto-links: Ports 14-16

Note: Hence, in this case, the switch module has access to only 7 blades. If access to more blades is required the 20-port IBM brocade PN 32R1812 must be used.

- At the time of this publication, EMC supports connectivity to a maximum of 24 domains for this kind of a switch module. In general, these switch modules have a domain ID range from 1-239.

  For an actual count of the maximum number of domains supported by this switch module, please refer to the E-Lab Navigator.

Fabric services include:

- Simple name server
  - Registered State Change Notification (RSCN)
  - Alias Server (multicast)
  - Brocade Zoning
  - Fabric Watch
  - Extended Fabrics
  - ISL Trunking
  - Performance Monitoring
  - Secure Fabric OS
- ISL Trunking to other B Series switches: In this case, up to four ports per trunk, doing up to 16 Gb/s per ISL trunk.
- Class 2, Class 3, and Class F (interswitch frames) Fibre Channel protocol support.

Performance

- 4.25 Gb/s line speed, full duplex per Fibre Channel port.

Management

- Centralized configuration and management of fabric using client/server architecture (Web Tools) and CLI.
- Management software:
  - Telnet
  - SNMP
  - Web Tools

  - EMC Fabric Manager
- Nondisruptive firmware upgrades.
- Support for 10/100 Mb Ethernet connections for out-of-band management.

Mechanical specifications

Mechanical specifications include:

- Width = 260 mm (10.2 in)
- Height = 112 mm (4.4 in)
- Depth = 29 mm (1.14 in)

DELL SW4314 Brocade M Series 6-port SAN switch module

The SW4314 can be integrated into the Dell Blade server enclosure and provides native switch support and interoperability in existing Brocade M Series fabrics as well as standard Fibre Channel interoperability in Open Mode.

ASIC family Agate

Key features Connectivity feature includes:

- 14 ports
  - 4 external ports
  - 10 internal ports (2 Gb/s), 1/2 Gb auto sensing
- Brocade M Series Fabric Mode

  The Brocade M Series 4314 may be configured to operate in either open standards or Brocade M Series mode to enable non-disruptive connectivity of the Brocade M Series 4314 to existing or planned Brocade M Series-based fabrics.
- ISL trunking is supported on these modules. Up to 4 ports can be used for an ISL trunk. They need not be sequential ports.

Fabric services include:

- Fabric Monitoring
- Zoning

- FDMI: Fabric Device Management Interface, a Storage Networking Industry Association (SNIA) standard that defines the sharing of information between SAN devices, including HBAs and switches
- FC Security: Complies with T11 FC-GS4 security standards
- Access using SSH / SSL
- Fabric Device Management Interface (FDMI), a Storage Networking Industry Association (SNIA) standard that defines the sharing of information between SAN devices, including HBAs and switches. Some of the features include WWN, firmware, and drive revision level data interchange
- RADIUS is an out-of-band security method that can be used to authenticate devices that are logging into the SAN\ fabric
- Fibre Channel service classes: Class 2 and Class 3

Performance

2.125 Gb/s non-blocking throughput on all external.

Management

Non-Disruptive firmware upgrade.

Out of band:

- EFCM
- EMC Connectrix Manager
- Brocade M Series Embedded Web Server - Embedded Web GUI served up as applet from the switch
- SNMP
- Telnet
- EMC VisualSAN

In band:

- GS-3 management server

Mechanical specifications

Mechanical specifications include:

- Width = 260 mm (10.2 in)
- Height = 112 mm (4.4 in)
- Depth = 29 mm (1.14 in)

DELL SW4416 Brocade M Series 6-port 1/2/4 Gb FC switch module

The SW4316 can be integrated into the Dell Blade server enclosure and provides native switch support and interoperability in existing Brocade M Series fabrics as well as standard Fibre Channel interoperability in Open Mode.

ASIC family Agate-2

Key features Connectivity features include:

- 16 ports
  - 10 internal ports: Ports numbers 0-9.
  - 6 external auto-sensing ports: Ports numbered 10-15.
- At the time of publication, EMC supports connectivity to a maximum of 24 domains for this kind of a switch module. In general, these switch modules have a domain ID range from 1-239.

  Note: For an actual count of the maximum number of domains supported by this switch module, please refer to the E-Lab Navigator.

- Interoperability:

  The Brocade M Series 4314 may be configured to operate in either open standards or Brocade M Series mode to enable seamless, non-disruptive connectivity of the Brocade M Series 4314 to existing or planned Brocade M Series-based fabrics.

- ISL trunking is supported on these modules. Up to 4 ports can be used for an ISL trunk and they need not be sequential ports.

Fabric services include:

- FC Security
  - Complies with T11 FC-GS4 security standards.
- Fabric Device Management Interface (FDMI) is a Storage Networking Industry Association (SNIA) standard that defines the sharing of information between SAN devices, including HBAs and Switches. Some of the features include WWN, firmware and drive revision level data interchange.
- RADIUS is an out-of-band security method that can be used to authenticate devices that are logging into the SAN fabric.

- Fibre Channel service classes: Class 2, Class 3, and Class F.

Performance

4.25 Gb/s non-blocking throughput on all external ports.

Management

- Telnet
- Secure Shell (SSH)
- Switch Management
- Inband Management
- Secure Socket Layer (SSL)
- Embedded GUI
- Simple Network Management Protocol (SNMP)
- Network Time Protocol (NTP)
- Common Information Model (CIM)
- File Transfer Protocol (FTP)
- Management Server (MS)
- Command Line Interface
- Brocade M Series Element Manager1 through EFCM
- Non-Disruptive Code Load and Activation

Mechanical specifications

Mechanical specifications include:

- Width = 127 mm (5 in)
- Height = 35 mm (1.375 in)
- Depth = 247.7 (9.75 in)

IBM PN 32R1790 Brocade M Series 6-port SAN switch module

This 6-port Brocade M Series Fibre Channel (FC) switch enables 2 Gb SAN solutions. It provides easy integration of the IBM Blade center into Brocade M Series environments.

ASIC family

Agate

Key features

Connectivity feature includes:

- 20 ports:
  - 14 internal 2 Gb/s ports

- 6 external 1/2 Gb/s auto-sensing ports

- At the time of publication, EMC supports connectivity to a maximum of 24 domains for this kind of a switch module. In general, these switch modules have a domain ID range from 1-239.

  Note: For an actual count of the maximum number of domains supported by this switch module, please refer to the E-Lab Navigator.

- Interoperability:

  The I/O module supports Native Brocade M Series Mode Interoperability.

Fabric services include:

- Security:

  The I/O module provides fabric security and interswitch link security. Fabric security controls management access to the fabric. When fabric security is enabled on all switches in the fabric, you must provide a username and password to access the fabric. Security is enabled by default.

- Registered State Change Notification (RSCN):

  The I/O module supports RSCN as described in FC-FLA. RSCN enables an agent to register for change events in the fabric and attached devices.

- Error detection: The I/O module supports the following error detection methods
  - Cyclic redundancy check (CRC)
  - 8-byte and 10-byte conversion
  - Parity
  - Long frame and short frame
  - D_ID mismatch
  - S_ID mismatch

- Frame bundling:

  The I/O module provides the following frame bundling methods: - No frame bundling - Intermix frames from different sources at will. - Soft lockdown - Soft lockdown causes the I/O module to wait for either the sequence to be completed or a gap in the frame traffic to occur before servicing requests from a different port.

- Configurable Fabric Address Notification (FAN):

  A FAN, as described in FC-FLA, is sent out by the fabric after an initialization event (usually a loop initialization port) to each attached NL_Port. The purpose of the FAN is to inform the attached NL_Ports of the fabric node name, port name, and fabric address.

- Simple name server implementation:

  The simple name server is implemented as described in Fibre Channel Generic Services (FC-GS-3). The simple name server requests and responses are based on the Common Transport Interface (CTI) as described in FC-GS-3. Name server database objects are defined as follows:

  - Native Port Identifier (P_ID)
  - Port Name (PN)
  - Node Name (NN)
  - Class of Service (CoS)
  - Internet protocol (IP) Address (IP_A)
  - Initial Process Associator (IPA)
  - FC-4 Types (Type) and Port Type (PT)
  - Symbolic Port Name (SPN)
  - Symbolic Node Name (SNN)

Performance

2.125 Gb/s non-blocking throughput on all external ports.

Management

- Simple Network Management Protocol (SNMP)/Management Information Base (MIB) IBM Confidential Version 1.1
- Telnet/Command Line Interface (CLI)
- Web Browser Management Interface
- Standalone Switch Management Application
- API Interface
- IBM Director Deployment Wizard Plug-in
- Support for Non-Disruptive Code Load Activation (NDCLA)

Mechanical specifications

Mechanical specifications include:

- Height: 112mm (4.4 inches)

- Width: 260mm (10.2 inches)
- Depth: 29mm (1.14 inches)

IBM PN 32R1833 Brocade M Series 6-port SAN switch module

The 6-port Brocade M Series Fibre Channel (FC) switch enables 4 Gb SAN solutions. It is ideal for the small to medium sized storage area networks and provides easy integration of BladeCenter into Brocade M Series environments.

ASIC family Agate-2

Key features Connectivity feature includes:

- 20 ports:
  - 14 internal 2/4 Gb/s ports
  - 6 external 1/2/4 Gb/s auto-sensing ports.
- Supports 239 domains.
- Interoperability:

  The I/O module supports Native Brocade M Series Mode Interoperability.
- ISL trunking is supported on these modules. Up to 4 ports can be used for an ISL trunk and they need not be sequential ports.

Fabric services include:

- Security:

  The I/O module provides fabric security and interswitch link security.
- Registered State Change Notification (RSCN):

  The I/O module supports RSCN as described in FC-FLA. RSCN enables an agent to register for change events in the fabric and attached devices.
- Error detection: The I/O module supports the following error detection methods.
  - Cyclic redundancy check (CRC)
  - 8-byte and 10-byte conversion
  - Parity
  - Long frame and short frame
  - D_ID mismatch

- S_ID mismatch

- Frame bundling: The I/O module provides the following frame bundling methods:
  - No frame bundling
    Intermix frames from different sources at will.
  - Soft lockdown
    Soft lockdown causes the I/O module to wait for either the sequence to be completed or a gap in the frame traffic to occur before servicing requests from a different port.
- Configurable Fabric Address Notification (FAN):

  A FAN, as described in FC-FLA, is sent out by the fabric after an initialization event (usually a loop initialization port) to each attached NL_Port. The purpose of the FAN is to inform the attached NL_Ports of the fabric node name, port name, and fabric address.
- Simple name server implementation:

  The simple name server is implemented as described in Fibre Channel Generic Services (FC-GS-3). The simple name server requests and responses are based on the Common Transport Interface (CTI) as described in FC-GS-3. Name server database objects are defined as follows:
  - Native Port Identifier (P_ID)
  - Port Name (PN)
  - Node Name (NN)
  - Class of Service (CoS)
  - Internet protocol (IP) Address (IP_A)
  - Initial Process Associator (IPA)
  - FC-4 Types (Type) and Port Type (PT)
  - Symbolic Port Name (SPN)
  - Symbolic Node Name (SNN)

Performance

4.25 Gb/s

Management

- Simple Network Management Protocol (SNMP)/Management Information Base (MIB) IBM Confidential Version 1.1
- Telnet/Command Line Interface (CLI)

- Web Browser Management Interface
- Connectrix Manager
- API Interface
- IBM Director Deployment Wizard Plug-in
- Non-disruptive firmware upgrades

Mechanical specifications

Mechanical specifications include:

- Depth 1.14 in
- Height 4.4 in
- Width 10.2 in

IBM PN 32R1905 Brocade M Series 3-port SAN switch module

This 3-port Brocade M Series Fibre Channel (FC) switch enables 4 Gb SAN solutions. It is ideal for the small to medium-sized storage area networks and provides easy integration of BladeCenter into Brocade M Series environments.

ASIC family Agate-2

Key features Connectivity feature includes:

- 10 ports:
  - 7 internal 2/4 Gb/s ports
  - 3 external 1/2/4 Gb/s auto-sensing ports.
- Supports 239 domains.
- Interoperability:

  The I/O module supports Native Brocade M Series Mode Interoperability.
- ISL trunking is supported on these modules. Up to 4 ports can be used for an ISL trunk and they need not be sequential ports.

Fabric services include:

- Security: The I/O module provides fabric security and interswitch link security.

- Registered State Change Notification (RSCN):

  The I/O module supports RSCN as described in FC-FLA. RSCN enables an agent to register for change events in the fabric and attached devices.

- Error detection: The I/O module supports the following error detection methods:
  - Cyclic redundancy check (CRC)
  - 8-byte and 10-byte conversion
  - Parity
  - Long frame and short frame
  - D_ID mismatch
  - S_ID mismatch

- Frame bundling:

  The I/O module provides the following frame bundling methods: - No frame bundling - Intermix frames from different sources at will. - Soft lockdown - Soft lockdown causes the I/O module to wait for either the sequence to be completed or a gap in the frame traffic to occur before servicing requests from a different port.

- Configurable Fabric Address Notification (FAN):

  A FAN, as described in FC-FLA, is sent out by the fabric after an initialization event (usually a loop initialization port) to each attached NL_Port. The purpose of the FAN is to inform the attached NL_Ports of the fabric node name, port name, and fabric address.

- Simple name server implementation:

  The simple name server is implemented as described in Fibre Channel Generic Services (FC-GS-3). The simple name server requests and responses are based on the Common Transport Interface (CTI) as described in FC-GS-3. Name server database objects are defined as follows:
  - Native Port Identifier (P_ID)
  - Port Name (PN)
  - Node Name (NN)
  - Class of Service (CoS)
  - Internet protocol (IP) Address (IP_A)
  - Initial Process Associator (IPA)

- FC-4 Types (Type) and Port Type (PT)
- Symbolic Port Name (SPN)
- Symbolic Node Name (SNN)

Performance 4.25 Gb/s

Management

- Simple Network Management Protocol (SNMP)/Management Information Base (MIB) IBM Confidential Version 1.1
- Telnet/Command Line Interface (CLI)
- Web Browser Management Interface
- Connectrix Manager
- API Interface
- IBM Director Deployment Wizard Plug-in
- Non-disruptive firmware upgrades

Mechanical specifications

Mechanical specifications include:

- Depth 1.14 in
- Height 4.4 in
- Width 10.2 in

Blade servers

A blade server is a server chassis housing a number of individual minimally-packaged computer motherboard *blades*, each including one or more processors, computer memory, computer storage, integrated network controllers, an optional Fibre Channel host bus adapter (HBA) and other input/output (IO) ports, but sharing a common power supply and air-cooling resources. The motivation behind the evolution of blade servers is to allow more processing power in less rack space, simplifying cabling and reducing power consumption.

A blade typically comes with one or two local drives. For additional storage, blade servers can connect to a storage pool facilitated by a Fibre Channel or iSCSI- based storage area network (SAN) or by network attached storage (NAS).

The advantages of blades do not lie merely in housing several servers in a single chassis, but also from the consolidation of associated resources (like storage and network equipment) into a smaller architecture that can be managed through a single interface.

Blade server architecture

This section reviews the generic blade server architecture.

Blade server chassis

The individual blades in a blade server chassis are typically hot-swappable. One of the greatest advantages of blade servers is that they allow the use of a single reliable heavy-duty DC power supply, rather than many small and unreliable power supplies. However, since a single power supply is a single point of failure, manufacturers recommend using a minimum of two power supplies per enclosure.

Blade servers use custom-designed blade boards, rather than commodity PC motherboards, so can be designed to have significantly more efficient air-cooling airflow than a rack of servers.

The server blades connect to vendor-implemented internal buses on a shared backplane or multiplan in the chassis. The internal buses serve to provide connectivity between the blades to all of the common functions it requires, such as KVM (Keyboard-Video-Mouse) console access, IP networking, and FC interconnect for storage.

The blades draw DC power using the backplane from shared power-supply modules in the chassis. The cooling function is also consolidated in the chassis through dual-redundant fan modules.

Figure 64 shows a simple model of a blade server with all its components.

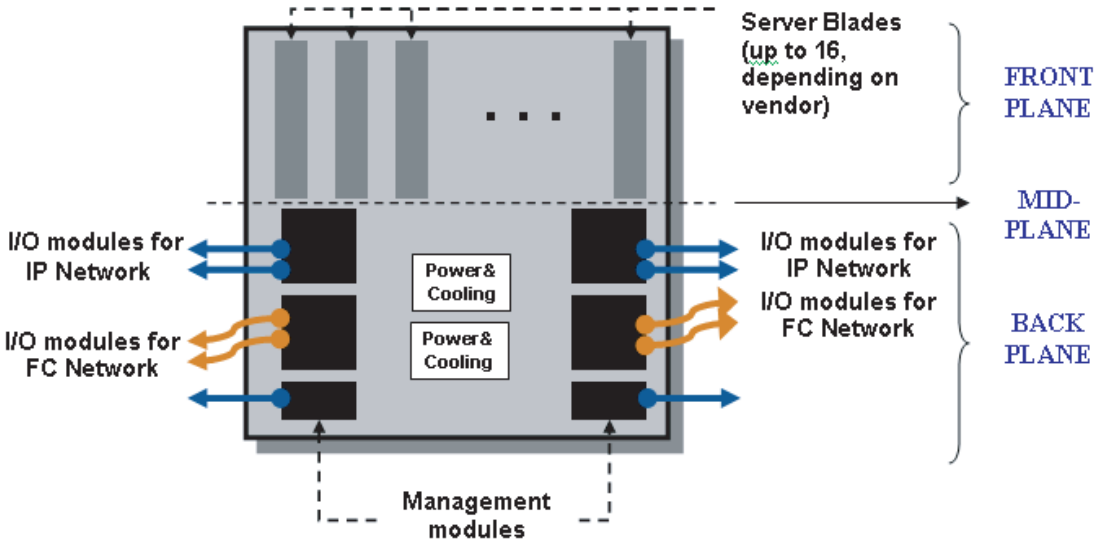


Figure 64 Basic blade server architecture

Figure 65 shows the front panel of a Dell blade server with 10 server blades.

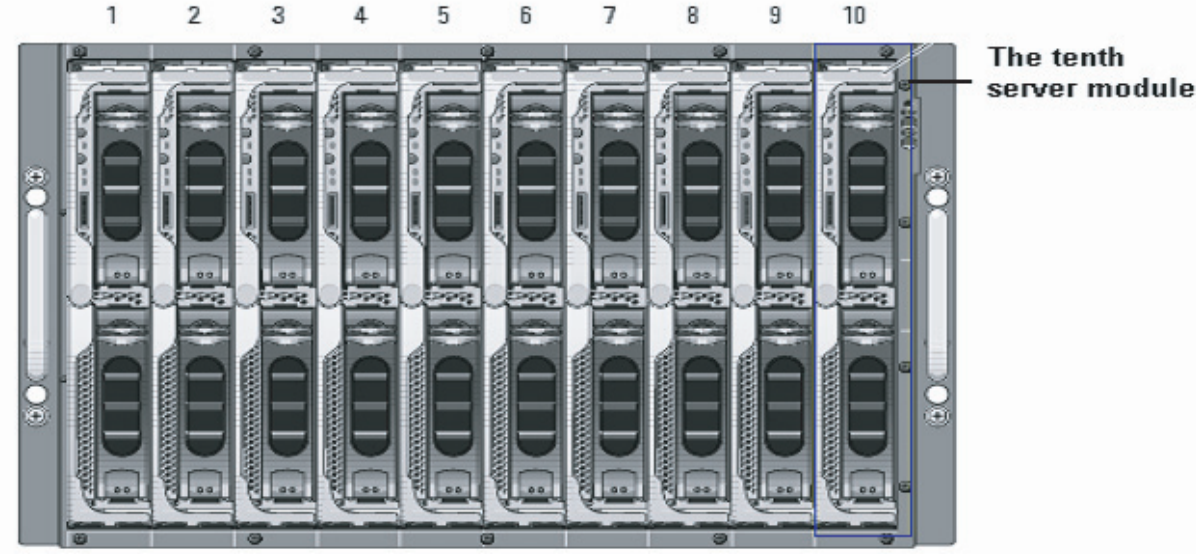


Figure 65 Front plane of a Dell blade server with 10 server blades

Figure 66 on page 190 shows the back plane of a Dell blade server showing the power supply modules, the Fan modules, I/O bays for the Ethernet and FC switch modules, and the Management module (DRAC/MC module).

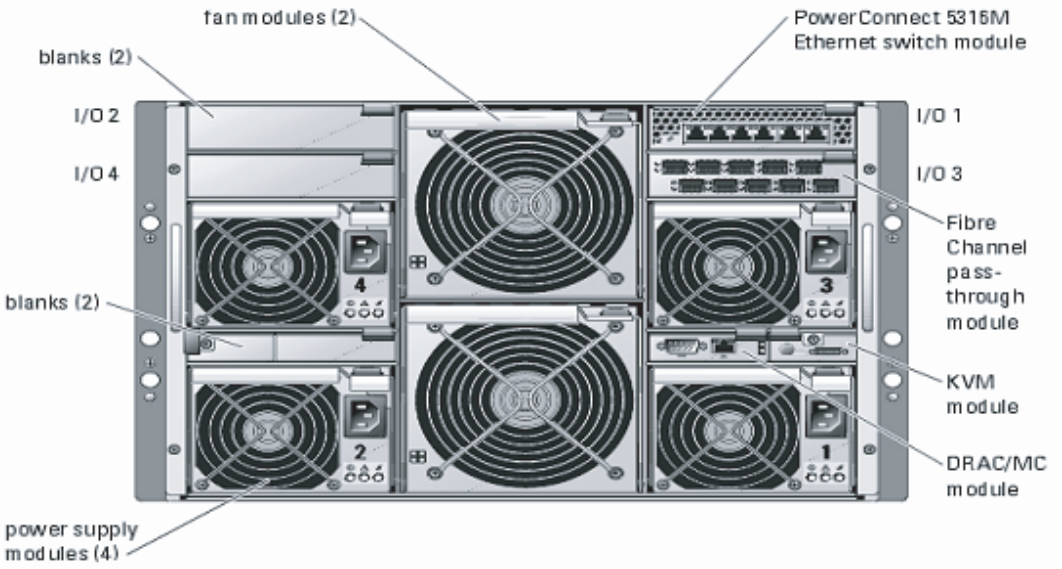


Figure 66 Back plane of a Dell blade server with 10 server blades

Server blades

At the time of this publication, a single chassis accommodates up to 16 processor blades, depending on vendor model. Processor blades available today mostly use Intel or AMD processors (i86 architecture).

Blades can accommodate up to two internal disk drives (either ATA or SCSI). Typically the operating system is installed on two local drives that are hardware-mirrored. It is possible to use a diskless blade if deploying boot over SAN.

A mezzanine card, also referred to as a *daughter card*, may be installed as an option inside the server blade. This card typically goes into a PCI-X or PCI-Express slot in the server and provides two internal ports. Each port connects through internal bus to one of a suitable I/O module pair. A given mezzanine card has the ability to provide either a GigE networking functionality, Infiniband, or FC Connectivity, in which case it is equivalent to an FC HBA.

Figure 67 is an example of a server blade showing a highlighted view of some ports, indicators, and buttons generally seen on a blade.

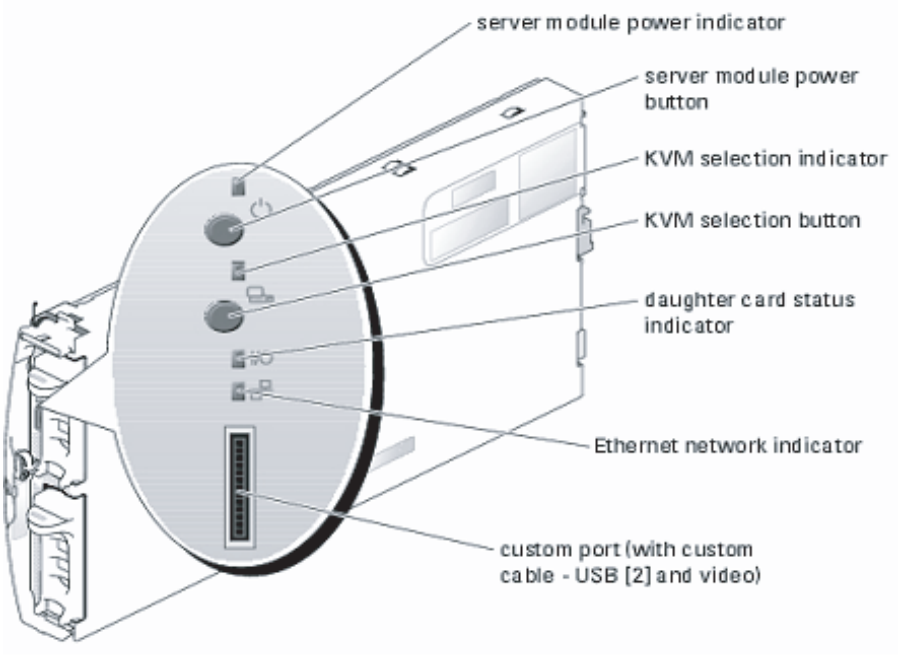


Figure 67 Server blade example

Table 37 on page 192 explains the functionality or indicator codes of the different buttons and indicators which are common to most of the EMC supported blade servers. Please note that the ones that are specific to the example in the figure have not been listed as a part of this publication.

Table 37 Indicator codes for blade servers (page 1 of 2)

Indicator	Icon	Activity indicator	Indicator code
Server module power indicator		Off	Power is not available to the server module, the server module is not turned on, or the server module is installed incorrectly.
		Green	The module is turned on.
		Green blinking fast	The module power is on and there is a fault with the server module.
		Amber	The module power is off, but the system power is on.
		Amber blinking fast	The module power is off and there is a fault with the server module.
Server module power button	N/A	None	Turns server module power off and on. • If you turn off the module using the power button and the module is running an ACPI-compliant operating system, the module can perform an orderly shutdown before the power is turned off. • If the module is not running an ACPI-compliant operating system, power is turned off immediately after the power button is pressed. • Press and hold the button to turn off the server module immediately. The button is enabled in the System Setup program. When disabled, you can only use the button to turn on the server module.
KVM selection indicator		Off	The server module is not selected by the KVM.
		Green	The server module is selected for the KVM.
		Amber blinking	The server module is not selected by the KVM and a power fault exists.
		Green/amber blinking	The server module is selected for the KVM and a power fault exists.
KVM selection button	N/A	None	Selects the server module for use with the KVM located on the back of the system.
Daughter card status indicator	I/O	Off	Power is off or the signal is lost.
		Green	Power is on or signal is online.
		Green blinking	A firmware error exists.

Table 37 Indicator codes for blade servers (page 2 of 2)

Indicator	Icon	Activity indicator	Indicator code
Network indicators	 Off Indicates that the server module does not have a link to the Ethernet switch or Pass-Thru module.	Off	Indicates that the server module does not have a link to the Ethernet switch or Pass-Thru module.
		Green on	Indicates that the server module has a valid link to the network switch module.
		Green blinking	Indicates network activity between the server module and the network switch module. **Note:** External network activity is not reported by this indicator.

Management and KVM modules

A management module provides a common console (KVM: keyboard-video-mouse) access to each of the individual blades. It also allows for chassis connection to the external network. In some designs, IP configuration for server blades and for installed I/O modules must be done using chassis utilities, which can be accessed through the management module. They are usually installed as a dual-redundant pair. There are vendor-specific applications for chassis management.

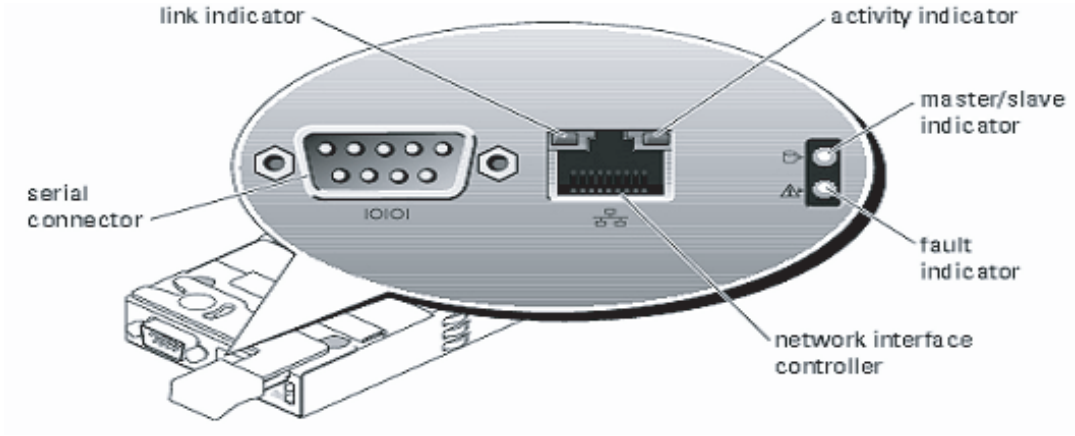


Figure 68 Management module example

Note: Some of the indicators shown in Figure 68 on page 193 are specific to the example in the figure and do not apply to all management modules in general. Thus, their functionality and indicator codes have not been listed as a part of this publication.

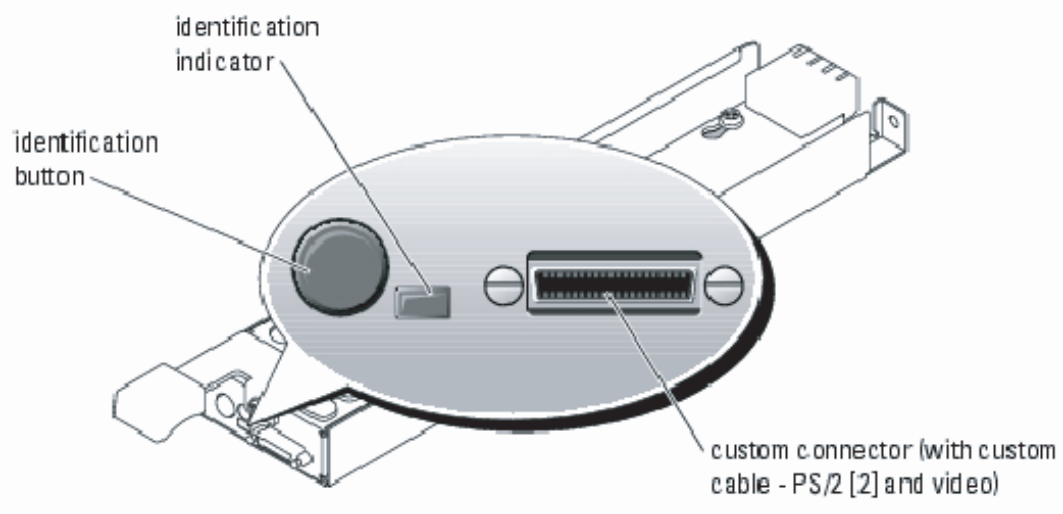


Figure 69 KVM module example

Table 38 explains the functionality or indicator codes of the different buttons and indicators which are common to most of the EMC management modules. Please note that the ones that are specific to the example in Figure 69 have not been listed as a part of this publication.

Table 38 Indicator codes for management modules

Indicator	Icon	Activity indicator	Indicator code
Identification button	**ID**	None	Press to activate the front and back identification indicators. To turn off the identification feature, press the button again.
Identification indicator		Off	System has not been selected for identification.
		Amber	System is selected for identification.
		Amber blinking	System is being identified.

I/O modules

The main functionality of I/O modules is to provide external port connectivity to the blade servers. I/O modules are always installed in pairs, in specific I/O bays within the chassis.

To provide dual-pathed FC SAN connectivity to servers, the following components must be installed:

- At least one mezannine card / FC Host Bus Adapter card (HBA) in each blade server to be connected must be installed.
- A pair of FC SAN switch modules can be installed. At the time of publication, these embedded FC SAN switch modules are manufactured mainly by Brocade and QLogic. They have different modes of operation depending on the external fabric components they are connected to, and have specific switch firmware revisions that can be supported depending on the manufacturer and blade server vendor. The EMC-supported FC SAN switch modules have been listed with their details in "Blade servers supported by EMC" on page 200.
- Alternatively, one can also install a pair of supported optical pass-thru modules (Figure 70 on page 196) which provides the external fabric components with direct access to server blades. Basically, the embedded optical pass through modules enable daughter cards to access external switches without the need to place the FC SAN switch modules into the blade server switch bays.

As can be seen, the optical pass-thru modules are comparatively much more flexible than the FC SAN switch modules and can be used to hook up the blade server modules to any external standalone switch in a fabric, independent of the firmware and mode running on that switch. The only factors that would affect this connectivity are the type of HBA (manufacturer, driver revisions etc.) or the operating system on the server blade.

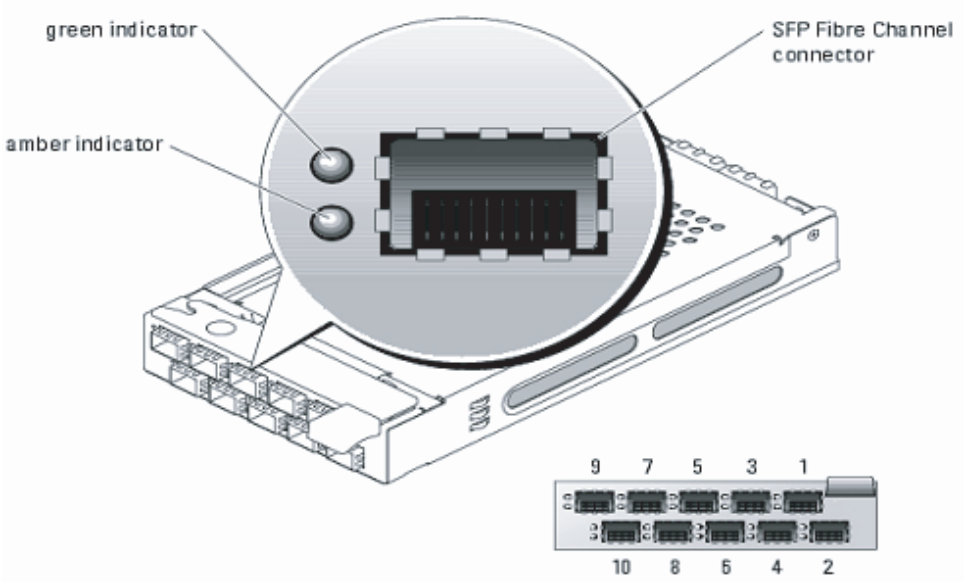


Figure 70 **Pass-thru example**

Table 39 explains the functionality or indicator codes of the different buttons and indicators which are common to most of the EMC supported I/O modules. Please note that the ones that are specific to the example in Figure 70 have not been listed as a part of this publication.

Table 39 **Indicator codes for I/O modules**

Indicator type	Activity indicator	Indicator code
Fibre Channel indicator (green/amber)	Off	Power is off to the system.
	Green/amber	System has power.
	Green/off	Fibre Channel connection is online.
	Off/amber	The port is connected to a valid link partner on the network.
	Off/flashing (twice per second)	Connection has lost synchronization.

Figure 71 depicts the FC connectivity mechanism. Each mezzanine card provides two I/O ports that connect internally (through buses on the chassis backplane or midplane) to internal ports on the FC switch modules. Correspondingly, each switch module typically provides for one internal port per blade server.

Figure 71 also shows a pair of switch modules with just two external FC ports each. The FC Switch Modules (FCSMs) usually have 2, 4, or 6 external ports depending on the blade server vendor and switch module model.

As shown in Figure 71, a minimum of two fibre-optic cables are needed from the FC switch module on each side of the blade server chassis, to provide a dual-path connectivity to all the server blades in that chassis. Thus, Fabric A and Fabric B can access all the server blades through the respective FC switch modules to which they are connected.

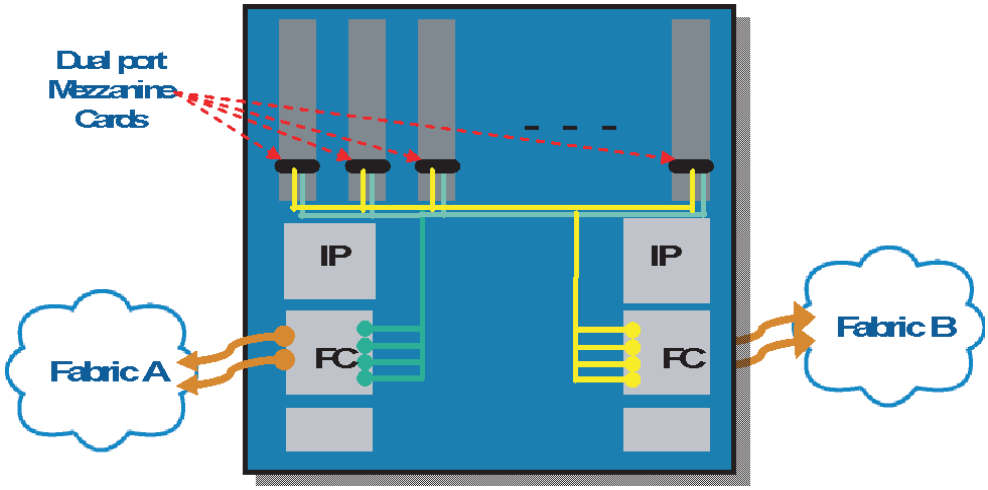


Figure 71 FC blade server – Switch module connectivity mechanism

Ethernet pass-thru modules

An Ethernet pass-thru module (shown in Figure 72 on page 198) provides connectivity between the server modules and an external Ethernet device. The Ethernet pass-thru modules generally have a certain number of uplinks and downlinks.

- The number of downlinks depends on the maximum number of server blades the chassis can accommodate, and hence the number of embedded Ethernet controllers. The downlinks

operate at 1000 Mb only, in most cases. The downlinks are internal ethernet network connections and in most cases operate at 1000 Mb only.

- The uplinks connect to the external Ethernet network and operate at 10/100/1000 Mb.

Since each server blade or server module is equipped with at least one ethernet card, or rather two onboard Gigabit Ethernet ports, it is potentially ready for iSCSI.

The Ethernet modules generally go in I/O bays 1 and 2 in most blade server chasses.

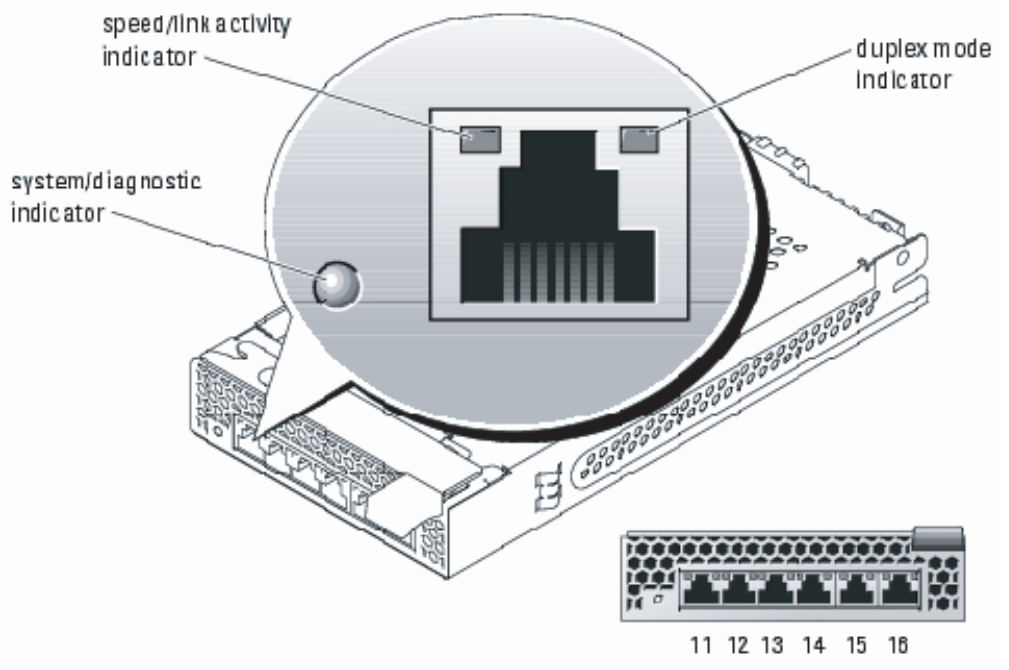


Figure 72 Ethernet switch module example

Power supplies/cooling

There are generally four hot-pluggable, redundant power supplies in a chassis, depending on the power requirement of the blade servers and other operational modules. In most cases, two to three power supplies provide power to the system, while the additional power systems provide redundancy. Figure 73 on page 199 shows an example of a power module.

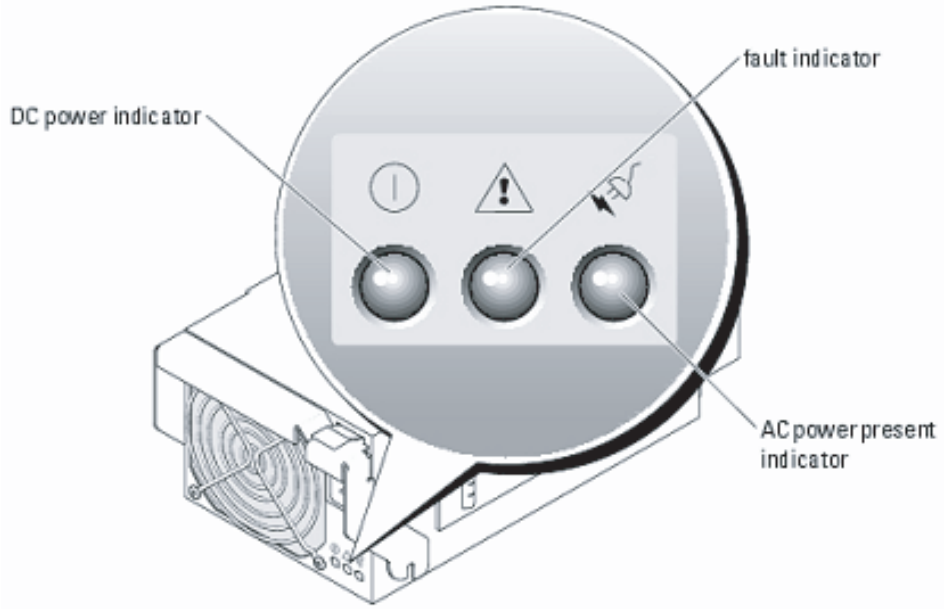


Figure 73 **Power module example**

In addition to providing power to the system, these power supply modules assist in cooling the system. If a power supply fails, it is advisable to keep the power supply module in the chassis because the fans continue to cool the chassis. Similarly, every chassis usually has two exclusive hot-pluggable system fan modules. Each fan module further has two replaceable fans.

Figure 74 shows an example of a fan module.

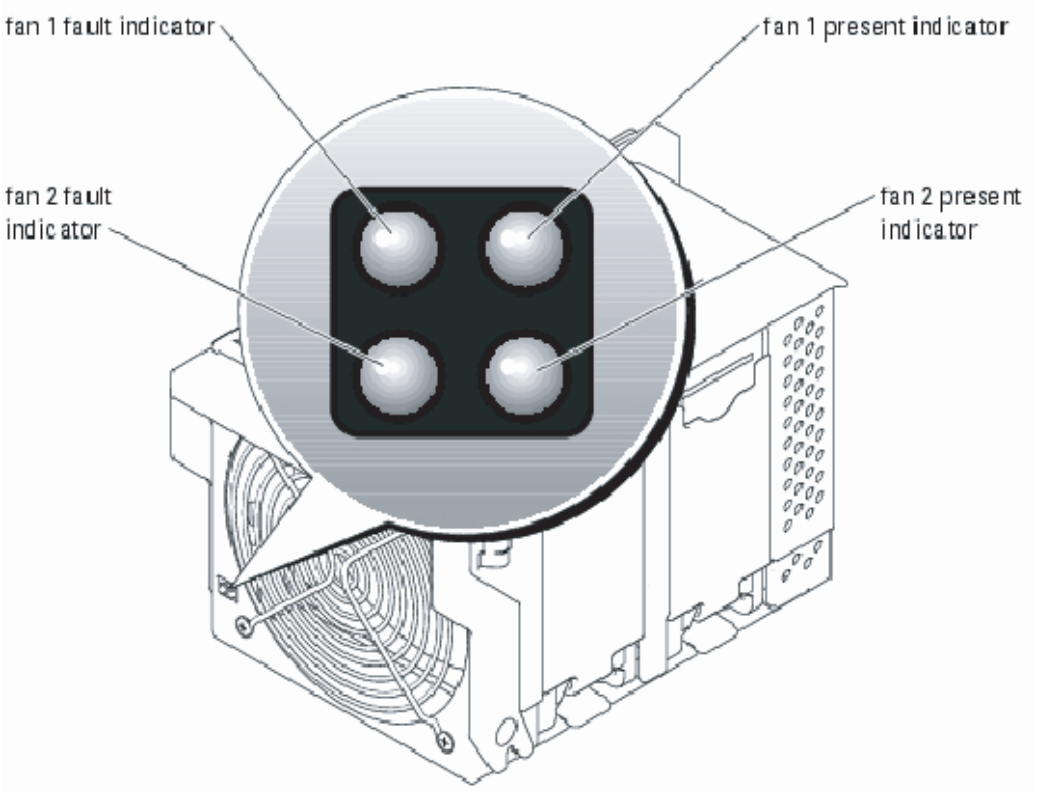


Figure 74 Fan module example

Blade servers supported by EMC

EMC qualifies blade servers manufactured by the following vendors

- Dell
- HP
- IBM
- Intel, and models based on the Intel architecture manufactured by
  - Fujitsu Siemens
  - Digital Henge
  - Lang Chao

Dell, HP, and IBM blade servers

Technical specifications for EMC-supported Dell, HP, and IMBM servers are listed in the Table 40, Table 41, and Table 42.

Table 40 Processor information

Dell blade servers	HP blade servers	IBM blade servers
The Dell blade server (Dell Glacier) or the Poweredge 1855 chassis is a 7U-high cabinet, which supports up to 10 server blades. Each blade server can house up to two Intel Xeon processors.	The HP blade server is a 6U-high cabinet, which supports anywhere from 2 to 16 server blades. There are different types of server blades, which can house 2 to 4 Intel or AMD processors, depending on the type of server blades.	The IBM blade server is a 7U-high cabinet. There are two families of chasses: • The standard BladeCenter can house 14 server blades. • The BladeCenter T can house 8 server blades. Also, there are different type of server blades that can house 2 to 4 Intel or AMD processors,depending on the type of server blades.

The operating systems that EMC supports on these blade servers are Windows, Linux flavors (RHEL and SuSE), and VMWare.

Table 41 Mezzanine cards

Dell blade servers	HP blade servers	IBM blade servers
All supported mezzanine cards can be installed in a PCI-X slot on the blade server.	The BL20 (G2 and G3), BL25, BL30, BL35 and BL45 blades do not provide a PCI-X slot for mezzanine cards. The dual-ported FC mezzanine cards are installed directly on the motherboard. The cards requiring Qlogic firmware and drivers are the HPQ Dual-port Fibre Channel Adapters for HP Proliant BL20p(G2)/20p(G3)/25p/45p/30p/35p Emulex mezzanine cards are also available and supported for some blades, e.g., the Emulex-based BL25/30/35/45p Fibre Channel Mezzanine HBA, model 394588-B21.	All supported mezzanine cards install in a PCI-X slot on the blade server. The EMC-qualified card models are as follows: • IBM Emulex LP1005DC FC Expansion Card • IBM HS20 4 Gb SFF FC Expansion Card: ***model 26R0890*** • IBM HS20 4 Gb Standard FC Expansion Card: ***model 26R0884*** • IBM HS20 FC Expansion Card: ***model 13N2203*** • IBM HS20 FC Expansion Card: ***model 26K4841*** • IBM HS20 FC Expansion Card: ***model 48P7061***

Check the E-Lab Navigator for currently-qualified blade/mezzanine combinations, host operating system, and card driver versions.

Table 42 FC switch modules

Dell blade servers	HP blade servers	IBM blade servers
EMC supports the following FC switch modules for the Dell Poweredge 1855: • 4-port 2 Gb Brocade FC switch module **(SW3014)** • 4-port 4 G b Brocade FC switch module **(SW4016)** • 4-port 2 Gb Brocade M Series FC switch module **(SW4314)** • Optical Pass-thru module **(J6780)** • 4-port 4 Gb Brocade M Series FC switch module **(SW4416)**	EMC supports the following FC switch modules for the HP blade server: • 4-port 4 Gb Brocade FC switch module **(Power Pack model A7535A)** • 2-port 4 Gb Brocade FC switch module **(A8001)**	EMC supports the following FC switch modules for the IBM blade server: • 2-port 2 Gb Brocade Entry level FC SAN switch module **(26K5601)** • 2-port 2 Gb Brocade Enterprise level FC SAN switch module **(90P0165)** • 3-port 4 Gb Brocade FC SAN switch module **(32R1813)** • 6-port 4 Gb Brocade FC SAN switch module **(32R1812)** • 6-port 2 Gb Brocade M Series FC SAN switch module **(32R1790)** • 2-port 4 Gb Qlogic FC SAN switch module **(48P7062)** • 6-port 4 Gb Qlogic FC SAN switch module **(26K6477)** • 3-port 4 Gb Brocade M Series FC SAN switch module (**32R1905**) • 6-port 4 Gb Brocade M Series FC SAN switch module (**32R1833**)

Important: Each of these switch modules behave like standalone edge switches in a deployed core-edge configuration.

Intel blade server

The architecture of the Intel blade server, is similar to the IBM Blade server. It is a 7U-high cabinet and can house 14 server blades. The Intel FC switch modules SBCEBFCESW and SBCEBFCSW listed in the E-Lab Navigator are the entry and enterprise versions of the Brocade switch modules. These are similar in characteristics to the IBM Brocade SAN switch modules 26K5601 (refer to "IBM PN 26K5601 Brocade 2-port entry-level switch module" on page 170) and the 90P0165 (refer to "IBM PN 90P0165 Brocade 2-port enterprise-level switch module" on page 171). The switch modules from other vendors, such as Fujitsu Siemens, Digital Henge, and the Lang Chao are based on the Intel Blade servers.

Modes supported on the switch modules

The Brocade switch modules for blade servers behave and can be managed like any other Brocade standalone edge switch. Hence, they can operate in either of the two Brocade modes: native mode (interopmode 0) and interoperable mode (interopmode 1).

EMC supports all the switches mentioned in Table 42 on page 202 for native mode support with most of the Brocade switch families and for interoperable mode support with standalone Brocade M Series and Cisco switches. A detailed listing of the supported firmware revisions and other specifics used to manage the fabric comprising of the switch modules, is in the E-Lab Navigator.

Table 43 gives a brief overview about the various interoperable configurations supported for the Brocade switch modules. The table also highlights the mode in which the switch/switch module operates, and the fabric management application that EMC recommends for the specific configuration.

Table 43 Supported Interoperable configurations

Switch module	Interoperable stand-alone switch	Fabric management application
Vendor: Brocade Mode: interopmode 0	Vendor: Brocade Mode: interopmode 0	Brocade Fabric Manager
Vendor: Brocade Mode: interopmode 1	Vendor: Brocade M Series Mode: Open Fabric Mode	EMC Connectrix Manager
Vendor: Brocade Mode: interopmode 1	Vendor: Cisco Mode: interop-1	EMC Connectrix Manager or Cisco Fabric Manger
Vendor: Brocade M Series Mode: Brocade M Series mode	Vendor: Brocade M Series Mode: Brocade M Series mode	SANsurfer switch manager for individual switch management and EFCM for the Fabric Management
Vendor: Brocade M Series Mode: Standard mode	Vendor: Brocade M Series Mode: Open Fabric mode	SANsurfer switch manager for individual switch management and EFCM for the Fabric Management

Further reading

The following documentation is available for additional product information:

- IBM blade server related information can be found at:

  www.ibm.com/systems/bladecenter/

- HP blade server related information can be found at:

  h71028.www7.hp.com/enterprise/ cache/80316-0-0-0-121

- A good reference for HP Brocade switch module related information can be found at:

h18006.www1.hp.com/products/quickspecs/12231_div/12231_div.html

- Dell blade server (Poweredge 1855) related information can be found at:

http://www1.us.dell.com/content/products/productdetails.aspx/pedge_1855?c=us&cs=555&l=en&s=biz

- http://www.brocade.com
- http://www.Brocade M Series.com
- http://www.qlogic.com

9

NPIV Gateways

This chapter contains information on NPIV gateways:

Note: For information on EMC-qualified third-party products, refer to the *EMC Select* document on Powerlink.

NPIV gateways

NPIV Gateway modules are embedded blade server Fibre Channel modules that utilize the N_Port ID Virtualization (NPIV) protocol to directly connect the server blades to a SAN fabric. In NPIV gateway mode, all the external ports on the blade server module come up as N_Ports.

In an NPIV Gateway based setup, multiple blade server HBA ports have the ability to connect to the external fabric through a reduced number of physical (external) N_Ports. Since the blade servers directly connect to the fabric, the NPIV gateway eliminates switch/domain count considerations (improving SAN scalability).

The external ports on the NPIV Gateway modules that are used for connectivity to an external FC switch are N_Ports, as shown in Figure 75. This eliminates switch interoperability concerns between the gateway module and the FC switch. The gateway module is equivalent to a pass-thru module with a many-to-one mapping between its internal and external ports, unlike an optical pass-thru module where there is a one-to-one mapping.

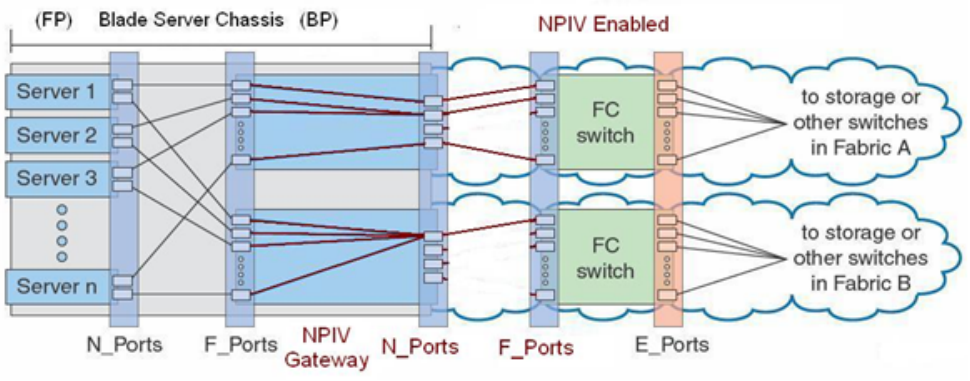


Figure 75 NPIV Gateway external N_Ports

Advantages

The advantages of using NPIV gateways include:

- No interoperability modes

  There is no need to set up any interopmodes while connecting an NPIV gateway module to an FC switch that belongs to different vendors. The FC switch that the NPIV gateway is being connected to must have NPIV *enabled, as shown in* Figure 75 on page 206. NPIV is enabled by default on most current switches.

- Increased scalability

  NPIV gateways can be added without worrying about fabric domain count restrictions.

- Easier management

  Limited time is invested to manage the NPIV gateways. Once the internal-to-external port mapping is completed on the gateway module, the presence of the NPIV gateway is equivalent to the presence of a pass-thru module, therefore needs no extra management.

Supported NPIV gateway modules

The currently tested and supported NPIV gateway modules are as follows:

- Brocade Access gateway (AG)

  The Brocade Access Gateway is a Brocade FOS (software-enabled) feature for Brocade blade server SAN switches that can transform an existing Brocade Fibre Channel switch module into an NPIV gateway module.

  For more details on the supported features and functionality of the AG module, refer to "Brocade Access Gateway" on page 220. There are also some case studies which describe the currently supported AG based configurations.

  An online reference that provides more information about the Brocade AG module is located at:

`http://www.brocadejapan.com/products/software/docs/Access_Gateway_DS_00.pdf`

- **HP Virtual Connect Fibre Channel (VC-FC) module**

  The HP VC-FC module is a separate piece of hardware that can be purchased from HP with the HP c-class blade server chassis. The HP VC-FC module requires an HP Virtual Connect Ethernet module installed in the system for management and administration.

  More details on the HP VC-FC module are available on the following link:

http://hpstoragerules.com/sponsors/QLogic/documents/techdocs/QuickSpecs%20HP%20VCFC%20Module.pdf

- **IBM Intelligent Pass-Thru module or the IBM Transparent switch module**

  The IBM Intelligent Pass-Thru module is actually a QLogic ASIC-based Fibre Channel switch module with a software command that can transform it into an NPIV gateway.

  More information on the QLogic Intelligent Pass-Thru module is available in the following IBM Red Paper:

http://www.redbooks.ibm.com/abstracts/redp4342.html

- **Cisco NPV module**

  The Cisco NPV mode is a Cisco SAN OS (software enabled) feature for Cisco blade server SAN switches that can transform an existing Cisco Fibre Channel switch module into an NPIV gateway module.

  Further information on how to configure NPV mode and the supported features with NPV is available at:

http://www.cisco.com/en/US/products/ps5989/products_configuration_guide_chapter09186a00808a0bce.html

Basic features of NPIV Gateways

This section first reviews three of the basic features of an NPIV gateway module, providing a context for the "Frequently asked questions (FAQ)" on page 210 and the "Comparison chart" on page 218.

N_Port failover policy

When one N_Port (external port on an NPIV gateway switch module) fails, all the internal F_Ports mapped to this N_Port are mapped to an N_Port that is enabled and attached to the same fabric. The N_Port

failover feature allows host/server ports to automatically remap to an online N_Port if the N_Port they are connected to goes offline. By default, the failover policy is enabled for all N_Ports. The F_Ports get evenly distributed among the N_Ports that are online and going out to the same switch or fabric at that time unless, and until, a preferred N_Port that should be used for the failover is specified by the user or is available by default.

The following sequence describes how an N_Port failover event occurs:

1. An N_Port goes offline.
2. All F_Ports mapped to that N_Port are disabled.

   This logs out all N_Ports that are utilizing those F_Ports.
3. With the N_Port failover policy enabled, the disabled F_Ports are remapped to an online N_Port.
4. The F_Port is re-enabled on the new N_Port.
5. The host establishes a new connection with the fabric.

Note: The delay between the disable and re-enable of F_Ports is of the order of 5-10ms. In this case, the S_IDs assigned to the N_Ports get modified and there is a minimal disruption to I/O. If the host cannot handle the S_ID change, the I/O stops and user intervention or a host reboot is required. This would only impact HP-UX and AIX. (Refer to EMC Knowledgebase article emc115725 for more information.) This also applies to the N_Port failback, described next.

N_Port failback

When the active N_Port that failed comes online again, all the internal F_Ports previously mapped to this N_Port (before it failed) are automatically re-mapped to it. In NPIV Gateways that support N_Port failback, this feature is enabled by default.

The following sequence describes how an N_Port failback event occurs:

1. With the failback feature enabled, when an N_Port comes back online, the F_Ports that were originally mapped to it are disabled.
2. The F_Port is rerouted to the primary mapped N_Port and then re-enabled.
3. The host establishes a new connection with the fabric.

Blade server chassis slot-wise persistent WWN allocation

Some of the NPIV gateway modules are capable of allocating a fixed or persistent WWN to the HBA ports on a server blade that is slid in a specific blade server slot. If this server blade is swapped with another server blade, the HBA ports on this new server blade will now get the WWNs that were allocated to the server blade HBA ports that were swapped out from this slot. Therefore, any server blade HBA ports in a particular slot get a set of fixed WWNs allocated to it by the gateway module. If this feature is enabled, a user has the following benefits:

- No SAN re-configuration or fabric re-zoning is required when a new blade server attaches to the blade switch port.
- Provides flexibility for the server administrator by eliminating need for coordinating change management with networking team.
- Reduces the downtime when replacing failed blade servers.

Frequently asked questions (FAQ)

This section compares some of the basic functionality details for the previous NPIV gateways by answering some frequently asked questions based on the deployment of a specific gateway module. The responses highlight the caveats, warnings, and/or issues that a user should be aware of.

Question: Is N_Port failover a supported feature? If not, are there plans to support it?

Answer: **Brocade AG:** N_Port failover is a supported feature on the Access Gateway modules. A preferred failover port can be specified by the user. This, however, becomes the only port to which the host or server port (that was mapped to the primary N_Port that went offline) can failover. F_Port trunking is a new Brocade FOS v6.1.x feature that aggregates the bandwidth of the ports within the trunk group. It is configured on the FC switch connected to the Gateway module, thus it is termed as an F_Port trunk. On the AG, an N_Port trunk is formed. The N_Port failover preferably takes place within the N_Port trunk until all the members of the trunk go offline. That is when the general failover policy comes into play.

Note: The PID assigned by the FC switch during the re-login through the gateway N_Port stays unchanged when the N_Ports are a part of a trunk; therefore, any I/O running before the failover does not stop and the failover is completely transparent to the host.

HP VC-FC: A VC-FC module pair can be installed in the HP c-class chassis interconnect bays 3 and 4 or interconnect bays 5 and 6. In order to enable failover, the HP VC-FC module pairs need to be installed in all of these interconnect bays. The modules in interconnect bays 5 and 6 are treated as backup modules for the modules in interconnect bays 3 and 4. They have links emerging from their ports corresponding to the links emerging from the same port numbers on the modules in bays 3 and 4. Thus, they provide a secondary path to the same fabric or switch. Similar F_Port to N_Port mappings (internal to the gateway module) must be made by the user on the modules in bays 3 and 5, and the modules in 4 and 6, respectively. If an external N_Port on a VC-FC module in bay 3 or 4 fails, the c-class server blade port internally connects to the F_Port on the backup modules 5 or 6 and, as per the mapping created, accesses the outside SAN through the corresponding N_Ports emerging from bays 5 or 6, respectively. To summarize, the N_Port failover takes place from an N_Port on modules 3 or 4 to the corresponding N_Port on bays 5 or 6.

The failover described above was the only N_Port failover mechanism present with HP VC FC's Static Login Distribution. With VC firmware v1.3x and later, Dynamic Login Distribution is available, which allows N_Port failover across the same module.

For more details and specifics regarding Static versus Dynamic Login Distribution and the failover, refer to the *HP Virtual Connect Fibre Channel Networking Scenarios Cookbook* at http://bizsupport1.austin.hp.com/bc/docs/support/SupportManual/c01702940/c01702940.pdf.

IBM intelligent Pass-Thru module: N_Port failover is supported for Intelligent Pass-Thru modules. The N_Ports can be configured as primary or backup for a particular F_Port mapping. Therefore, if the N_Port configured as primary fails, all the F_Ports mapped to this primary port now get mapped to the N_Port configured as a backup port for this primary port. Multiple ports can be configured as backup.

Cisco NPV module: N_Port failover is supported within the NPV module. The failover can occur within the same VSAN only. If "NPV

traffic management" (introduced with SAN OS v3.3.1c) is configured, the N_Port can failover only to the ports configured by the user.

Question: In a multi-fabric environment, is N_Port failover supported/not supported?

Answer: **Brocade AG:** For multi-fabric configurations "portgroups" need to be created by the user. A *portgroup* is a collection of external N_Ports that are going out to the same fabric. N_Port failover is restricted to occur within the same portgroup; therefore it is supported in a multi-fabric setup.

In Figure 76 on page 212, there are two fabrics, A and B. Ports N1, N2 going out to Fabric A are part of one portgroup, while ports N3, N4 going out to Fabric B are part of a different portgroup. These portgroups have to be created by the user.

Figure 76 **Part I: Access Gateway module attached to two fabrics**

In Part II, as shown in Figure 77 on page 213, when port N1 gets disabled, all the internal F_Ports get mapped to port N2, which is in the same portgroup, and *not* to ports N3 or N4, which are in a different portgroup. The same concept applies to ports N3 and N4 when port N4 goes down.

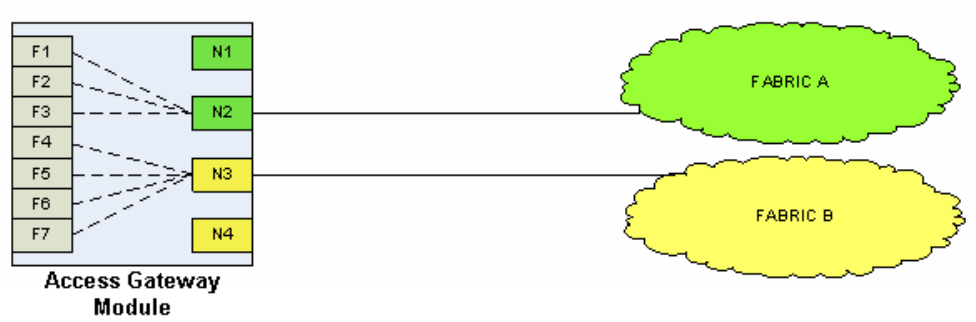


Figure 77 **Part II: N_Port failover in an Access Gateway module attached to two fabrics (after N1 and N4 go offline)**

There is no auto-detect feature to recognize all the ports connected to the same fabric. If the user does not create a portgroup for new fabric connectivity, and just uses the default *portgroup 0* that all the AG N_Ports are a part of, an N_Port failover can occur between N_Ports connected to different fabrics, causing issues when it comes to device discovery.

IMPORTANT

The user must remember to create *portgroups* when connecting to multiple fabrics.

HP VC-FC: The VC-FC module can be connected to multiple SAN fabrics. A user must configure the uplink ports going to the SAN fabric for Dynamic Login Distribution. This allows for failover within a fabric. In fact, the user can granularly control connections to the VC FC uplink ports and to SAN fabrics.

For more details and specifics regarding Static versus Dynamic Login Distribution and the failover, refer to the *HP Virtual Connect Fibre Channel Networking Scenarios Cookbook* at http://bizsupport1.austin.hp.com/bc/docs/support/SupportManual/c01702940/c01702940.pdf.

IBM intelligent Pass-Thru module: A user must configure the primary and secondary backup port within the same fabric before connecting to multiple fabrics. Failover is restricted within same fabric.

This is explained with the help of Figure 78, next, Figure 79 on page 214, and Figure 80 on page 215, showing the Intelligent Pass-Thru module in three parts.

Part I, shown in Figure 78, shows the original F_Port to N_Port mapping within the gateway module given all N_Ports are connected to the same Fabric A. In this case N3 is a backup port for N1 and vice-versa (marked as p1, p2 respectively), while N4 is a backup port for N2 and vice-versa (marked as P1, P2).

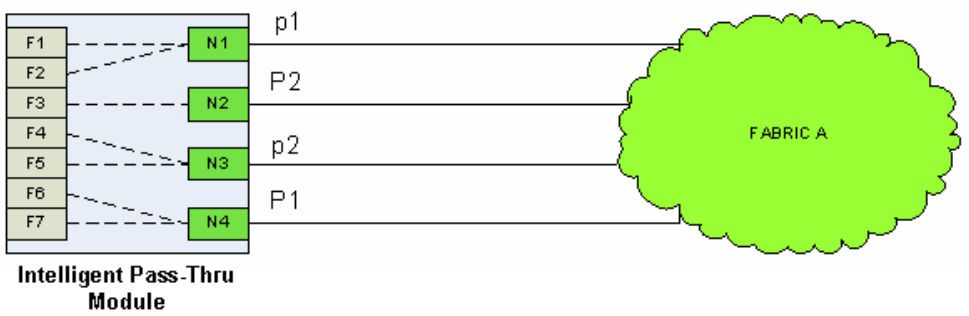


Figure 78 Part I: Intelligent Pass-Thru module attached to single fabric A

In Part II, shown in Figure 79, when N3 goes down, all the internal F_Ports mapped to N3 now failover to the backup port N1. When N2 goes down all the internal F_Ports mapped to N2 failover to N4.

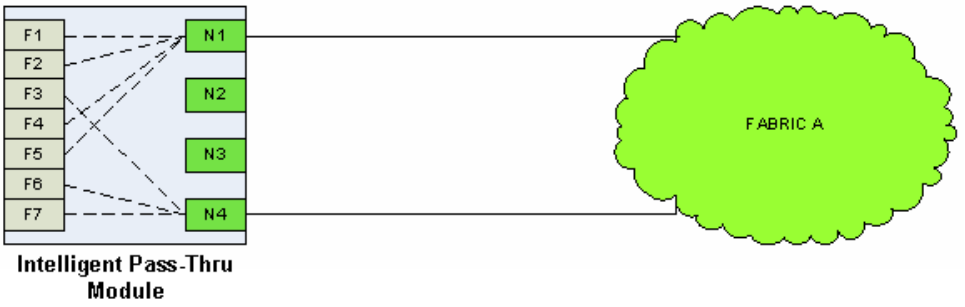


Figure 79 Part II: N_Port failover in an Intelligent Pass-Thru module attached to single fabric A (after N2 and N3 go offline)

Now consider that the Intelligent Pass-Thru module is connected to another fabric, and say F1, F2, F3 are zoned to targets in Fabric A while F4, F5, F6, F7 are zoned to targets in Fabric B. In this case, looking back at Part I and the default internal F_Port to N_Port

mapping, ports N1 and N2 (mapped to F1, F2, F3) need to be connected to Fabric A, while ports N3 and N4 (mapped to F3, F4, F5, F6, F7) will be connected to Fabric B. Therefore, N1 and N2 must now be configured as primary and secondary backup port, while N3 and N4 must be configured as the primary and secondary backup port, respectively.

Part III, shown in Figure 80, shows how the internal mapping gets affected if ports N2 and N3 go down. All ports mapped to N2 now failover to N1 while ports mapped to N3 now failover to N4.

Figure 80 **Part III: N_Port failover in an Intelligent Pass-Thru module attached to fabrics A and B (after N2 and N3 go offline and the primary and backup port settings have changed)**

Cisco NPV module: Connectivity to multiple fabrics (with a separate VSAN for each fabric) is supported for the NPV module.

Question: Is preferred port failover supported/not supported?

Answer: **Brocade AG:** Failover to a preferred port is supported for AG. The user can specify an N_Port to which a given F_Port can failover. However, that becomes the only N_Port to which the F_Port can failover. If the preferred N_Port is disabled, the F_Port that is mapped to the initial N_Port that failed loses connectivity to the fabric all together.

HP VC-FC: In an HP VC-FC setup, the VCM Management application/VC software utility allows the user to granularly control the internal F_Port to N_Port failover, but the user cannot really setup a preferred failover port.

IBM intelligent Pass-Thru module: This is a supported feature and failover can occur to any N_Port configured as a backup.

Cisco NPV module: This is not applicable as mapping is automatic. Traffic management is a feature, introduced with SAN OS v3.3.1c, allows the user to map the internal F_Ports to the external N_Ports, but there is no prioritization on the external link usage. Once the mapping is done, the internal ports can use only the assigned external links.

Question: If preferred port is not available, can the F_Ports failover to any other available N_Port?

Answer: **Brocade AG:** If an F_Port fails over to a preferred port set by the user, and the preferred port is disabled, the F_Port does not fail over to any other available N_Port connected to the same fabric. Even if the preference setting is deleted at the point where the failover does not occur, the F_Ports mapped to a disabled N_Port still do not fail over. A cold failover is required, where the Access Gateway switch needs to be disabled and re-enabled so that the F_Ports can now map to an appropriate enabled N_Port connection to the same fabric.

HP VC-FC: There is no preferred port setting available for the HP VC-FC modules, but F_Port to N_Port failover is supported.

IBM intelligent Pass-Thru module: If the primary port is not available, backup ports will be used. F_Ports will not failover to other ports if they are not configured as backup.

Cisco NPV module: Not applicable as the mapping is automatic.

Question: What happens if the F_Ports are mapped to a disabled N_Port by the user?

Answer: **Brocade AG:** Nothing can prevent a user from mapping an internal F_Port to a disabled external N_Port. The F_Port does not fail over to any other available N_Port going out to the same fabric. A cold failover is required, where the Access Gateway switch needs to be disabled and re-enabled so that the F_Ports can then map to an appropriate enabled N_Port going out to the same fabric.

HP VC-FC: A user can map an F_Port to a disabled N_Port. Based on whether the VC-FC is set up for Static or Dynamic Login Distribution, the F_Port will look out for an available N_Port/uplink going out to the same fabric. For more details and specifics about F_Port to N_Port mapping or failover control, refer to the *HP Virtual Connect Fibre Channel Networking Scenarios Cookbook* at http://bizsupport1.austin.hp.com/bc/docs/support/SupportManual/c01702940/c01702940.pdf.

IBM intelligent Pass-Thru module: F_Ports will failover to backup port. If there are no backup ports, the F_Ports will have no way to connect to an external switch.

Cisco NPV module: Not applicable. This is not user-configurable. Logins are distributed across available external links.

Question: Is N_Port failback a supported feature? If not, are there plans to support it?

Answer: **Brocade AG:** N_Port failback is a supported feature on the Access Gateway modules.

HP VC-FC: N_Port failback is not a supported feature on the VC-FC modules.

IBM intelligent Pass-Thru module: This is a supported feature. The F_Ports fail back to the primary N_Port.

Cisco NPV module: This is not supported since there is no prioritization of the external ports. Once an F_Port fails over to another N_Port, it will not automatically failback to the previous N_Port. A load balancing feature will be introduced at a later time, which will allow distributing all the logins across all active N_Ports.

Question: In a multi fabric setup, if the N_Port that failed is now attached to a different fabric, the failback should not occur. Is this verified?

Answer: **Brocade AG:** N_Port failback is supported and users need to create portgroups for each different fabric as previously discussed. Since failback occurs only within the same portgroup, the failback will not occur if the original N_Port that failed before the failover is now added to a different portgroup.

HP VC-FC: Multi-fabric connectivity is not supported on the HP VC-FC modules.

IBM intelligent Pass-Thru module: In this case, the failback does occur. The ports failback to the primary N_Port even if it is connected to a different fabric.

Cisco NPV module: Failback is not currently supported.

Question: **Does this NPIV Gateway support persistent WWN addressing?**

Answer: **Brocade AG:** The Access Gateway is currently not capable of allocating persistent WWNs to the HBA ports that are connected to the F_Ports on the gateway module. If the HBA connected to the

F_Ports changes, appropriate zoning and configuration changes must be made to map these changed WWNs to the desired target ports.

HP VC-FC: The management interface for the VC-FC modules (i.e., the VC Manager), can be used to allocate persistent WWNs to the HP c-class server blade HBA ports, based on the blade server chassis slot they reside in. If this blade is swapped with another blade, the HBA ports on the new blades now gets allocated the WWNs that were being used by the blade that was swapped out.

IBM intelligent Pass-Thru module: This module is currently not capable of allocating persistent WWNs to the HBA ports that are connected to the F_Ports on the pass-thru module.

Cisco NPV module: The FlexAttach is a feature introduced with Cisco SAN OS v3.3.x wherein a Cisco NPV module is capable of allocating a set of fixed WWNs to the ports attached to the internal F_Ports on a Cisco Fibre Channel switch module.

Comparison chart

Table 44 compares features and functions from the answers provided in the previous section, "Frequently asked questions (FAQ)" on page 210.

Table 44 Comparison chart (page 1 of 2)

	Brocade Access Gateway	HP Virtual Connect (FC & Ethernet)	IBM Transparent Switch	Cisco NPV
Software enabled?	Yes	No	Yes	Yes
N_Port failover?	Yes (To a preferred N_Port in same portgroup or to a specific group of ports within a portgroup configured for N_port trunking)	Yes (Mechanism differs based on whether the login distribution is Static/Dynamic)	Yes (To preferred N_Ports: Primary & secondary)	Yes (To N_Port in same VSAN or to a specific group of ports within a VSAN configured for traffic management)

Table 44 Comparison chart (page 2 of 2)

	Brocade Access Gateway	HP Virtual Connect (FC & Ethernet)	IBM Transparent Switch	Cisco NPV
Multi-fabric support?	Yes (Portgroup created for each fabric)	Yes	No	(To be tested for multi-VSAN)
Zoning change required after blade swap?	Yes	No (Fixed WWNs assigned)	No	No (FlexAttach feature available)
Management application?	Web Tools, CLI	Virtual Connect Manager, VC Software Utility	EFS2007 and Quicktools	Cisco Fabric / Device Manager

Brocade Access Gateway

The Access Gateway feature is a software feature that allows a Brocade switch to act as a transparent "port consolidator," connecting multiple Fibre Channel devices (typically host HBA ports) into a single FC fabric port (F_Port). Enabling the Access Gateway mode on a standalone switch or switch module presents all its ports or external ports (in a module) as N_Ports. The Access Gateway connects to the fabric using the FC N_Port protocol rather than the E_Port protocol typically used for switch-to-switch communication. Access Gateway uses the FC-LS N_Port ID Virtualization (NPIV) facility to allow its client devices to connect to the FC fabric.

Although it uses its switching logic to allow the attached devices to send and receive FC traffic to the fabric, it is not recognized by the fabric as a "switch" and therefore does not consume a Domain ID and does not participate in the switch-to-switch traffic normal to an FC fabric.

The Access Gateway provides the following benefits over an embedded switch:

- Since it requires minimal management operations, it reduces management complexities on large blade server fabrics.
- The use of N_Port protocol allows connection to non-Brocade fabrics with reduced interoperability challenges compared to E_Port connections.
- Improved fabric scalability for fabrics with large numbers of embedded blades or small edge switches.

These benefits are further detailed and explained in the following case studies in this section:

- "Case study #1" on page 227
- "Case study #2" on page 236
- "Case Study #3" on page 246

Hardware and software requirements for Access Gateway

The Access Gateway feature is currently supported for embedded blade server switch modules based on the 4 Gb GoldenEye (GE) and 8 Gb GoldenEye2 (GE2) ASICs. For a listing of the latest supported switch modules and firmware revs. please refer to the *EMC Support Matrix*. The Access Gateway feature has been introduced in the v5.2.1

release with a new operational mode, “Access Gateway mode” (also known as “agmode”).

The Access gateway uses the NPIV feature to connect a switch module to the enterprise fabric. The NPIV feature is a standard feature supported on the following fabric switches:

- Connectrix B switches with FOS 5.1.0 and higher
- Connectrix M switches with E0S 8.0 and higher,
- Connectrix MDS switches with SAN-OS 3.0(1) and higher

Each of Access Gateway's N_Ports will operate correctly when connected to a fabric switch that properly supports the NPIV feature. NPIV must be enabled on the ports of the fabric switch that is being connected to the Access Gateway module.

Access Gateway theory of operation

The Access Gateway mode of the switch presents standard F_Ports to the hosts, but it connects to the Enterprise fabric as an N_Port (rather than as an E_Port). The purpose of Access Gateway mode is to isolate the enterprise fabric and provide controlled access to it from hosts attached.

Figure 81 shows the “n “server blades attached to the external Fabrics A and B via the blade server embedded Brocade Fibre Channel Switch Modules (FCSM). In this case, all the external ports on the module are E_Ports and their connectivity to the external FC switch is an E_Port to E_Port connection.

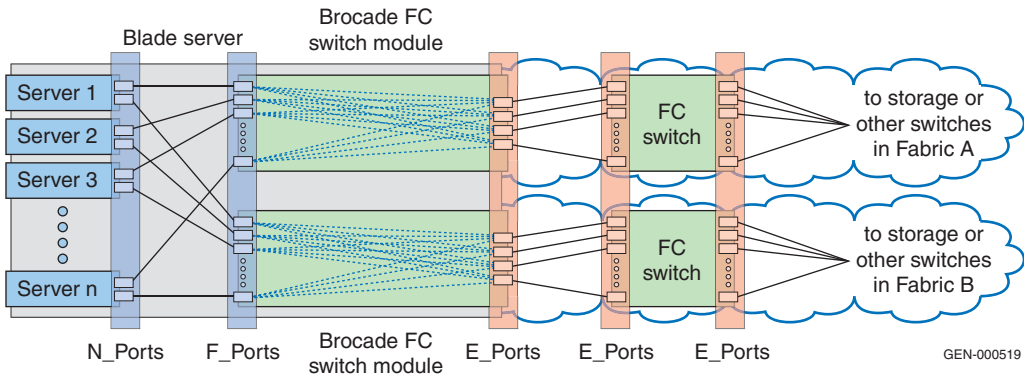


Figure 81 Blade servers using Fibre Channel switch modules

Figure 82 shows the "n" server blades now attached to the external Fabrics A and B via the blade server embedded Brocade Fibre Channel Switch Modules (FCSM) with Access Gateway mode enabled. In this case, all the external ports on the module are N_Ports and their connectivity to the external FC switch is an N_Port to F_Port connection. What we can also see is how one or more F_Ports can be mapped to a single N-port on the Access Gateway module.

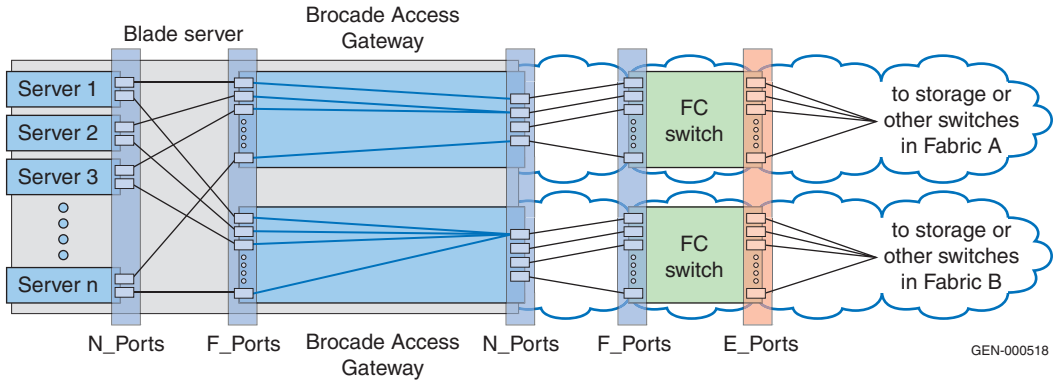


Figure 82 Blade servers using Access Gateway

Firmware upgrade and downgrade considerations

When Access Gateway mode is enabled for a switch, it will support hot code activation in the same way as base FOS. The code load is non-disruptive.

All firmware downloads are done out-of-band, using CLI. Since v5.2.1 is the first firmware capable of supporting agmode, firmware downgrade is *not* supported when agmode is enabled. Firmware downgrade can be performed only after disabling agmode.

Manageability considerations

Access Gateway management is supported through CLI beginning with the v5.2.1 release. Brocade CLI and the Connectrix Manager Data Center Edition (CMDCE) application GUI can be used to manage the Access Gateway modules.

N_Port ID Virtualization (NPIV) support

When agmode is enabled, NPIV is automatically enabled and no NPIV license is needed. It cannot be disabled by the user. Enterprise Connectrix B fabric can support up to 255 PIDs to be assigned to an N_Port using NPIV. The actual number depends on

the edge switch configuration and capability. The order in which hosts come online can be different every time Access Gateway is enabled. To make sure all the hosts get a predictable number of PIDs assigned using NPIV, the default value of the maximum number of logins that will be accepted by an F_Port is set to 20. This value can be changed using the **configure** CLI command.

PID assignment by AG

PIDs assigned by Access Gateway to a host or sever blade (with or without NPIV) can change any time the host or server blade goes offline and comes back online. The host operating system should be capable of handling PID changes. Otherwise, operating systems' specific steps need to be followed to update the host configuration to use new PID(s).

F_Port enable/disable

F_Port enable does not cause any link up or link down of the N_Ports. A link down event, or portdisable on an F_Port, will cause a logout of that F_Port on the enterprise fabric. If NPIV is being used on that F_Port, all the NPIV devices that have logged in to the enterprise fabric from that port will be logged out from the enterprise fabric.

N_Port enable/disable

If N_Port is disabled or the N_Port link goes down, all F_Ports that are mapped to that N_Port will be disabled. If N_Port failover is enabled for this N_Port, then the F_Ports mapped to this N_Port will be mapped to another N_Port connected to the same fabric. When the original N_Port becomes online, the F_Ports mapped to it will not failback to it (if the failover of those F_Ports to another N_Port was successful) because N_Port failover is disruptive for the F_Ports. PIDs assigned to the F_Ports get modified as a result of this failover. If the host drivers can handle the PID change transparently, no operator intervention or reboot will be required for the host.

N_Port Failover policy

N_Port failover will be supported only within N_Ports connected to the same fabric. When a port is configured as an N_Port, failover is enabled automatically. When an N_Port goes offline (cable removal or any other offline event), the F_Ports mapped to that N_Port are disabled. If another N_Port is connected to the same fabric is online, these F_Ports will be failed-over to it and re-enabled. The FLOGI and FDISC requests will be forwarded from F_Ports through the new

N_Port. Failover of F_Ports to next available N_Ports connected to the same fabric will continue until all the N_Ports are exhausted. If multiple N_Ports are available as candidates for failover, Access Gateway will select the port with lowest port number.

N_Port/F_Port bring up latency and error handling

When an N_Port is connected to the fabric, it will take some time to login to the enterprise fabric and get PID assigned. The upper bound on the time it takes to bring up an N_Port is 4 x E_D_TOV (e.g., 4 x 2 = 8 seconds if E_D_TOV is 2 seconds).

The amount of time required to bring up an F_Port depends on the timeout value used by the host between successive FLOGI attempts. Usually, one or more FLOGI attempts from the host are required before the F_Port comes online. The upper bound on the time it takes to bring up an F_Port is the maximum number of FLOGI retries (typically 4) multiplied by the time between consecutive retries (typically R_A_TOV = 10 seconds).

Access Gateway CLI commands

The Access Gateway CLI provides the following functionality:

- Enabling/disabling agmode
- Displaying current configuration and state of AG
- Configure/Display F_Port to N_Port mapping
- Configure N_Port failover/failback policies.

Table 45 on page 225 lists CLI commands that have been provided to perform Access Gateway-specific operations.

Table 45 New CLI commands

Command	Action	Description
ag <action> [arguments]		
	--modeshow	Displays current agmode setting for the switch.
	--modeeenable	Enabled Access Gateway mode for the switch.
	--modedisable	Disable Access Gateway mode for the switch. Switch is rebooted automatically. Before agmode is disabled the switch needs to be disabled and secure mode needs to be disabled (when enabling agmode).
	--show	Displays the current configuration and state of Access Gateway.
	--mapshow [N_Port]	Displays current F_Port to N_Port mapping. N_Port argument optional. If it is not specified, mapping for all the N_Ports is displayed, otherwise mapping for only the specified N_Port is displayed.
	--mapshow [N_Port] --mapset <N_Port> “<F_Port1;F_Port2; ...>”	Set specified list of F_Ports to the mapping for a given N_Port. It will overwrite the current mappings if any for that N_Port. An F_Port cannot mapped to more that one N_Port at the same time.
	--mapadd <N_Port> “<F_Port1;F_Port2; ...>”	Adds specified list of F_Ports to the mapping for a given N_Port. An F_Port cannot mapped to more than one N_Port at the same time.
	--mapdel <N_Port> “<F_Port1;F_Port2; ...>”	Removes specified list of F_Ports from the mapping for a given N_Port.
	--failovershow [N_Port]	If optional N_Port is specified, failover policy for N_Port is displayed. Otherwise failover policy for all the N_Ports is displayed.
	--failoverenable <N_Port>	Enable failover policy for the specified N_Port.
portcfgnport		To disable/enable N_Port capability for a port.
agshow		Display all Access Gateways in the Enterprise fabric.

Advantages of Access Gateway

Access Gateway addresses the following three major issues while maintaining many benefits of using the embedded switch model:

Scalability

When switches are added to or removed from a fabric, they tend to precipitate high volumes of interswitch management traffic causing CPUs of the constituent switches to get overloaded, which might result in data disruption due to fabric re-configurations. Fabrics also tend to become unstable while handling large volumes of fabric events. These problems may ultimately result in loss of service (e.g,. HBA logins may timeout) under heavy load conditions in the fabric.

The large number of embedded switch modules can cause fabric instability due to numerous domains, many more places to manage all of the switches in the fabric, and FSPF route calculations due to these events.

Access Gateway acts differently than a switch in the Fibre Channel fabric sense. For example, before we may have had a switch connecting 16 host ports to the fabric through 4 E_Port(s), whereas now we can have Access Gateway connecting 16 host ports to the fabric through 4 N_Ports. By expanding the number of device ports we can connect to a single fabric port, Brocade can now support a much larger fabric (in terms of the number of connected host and storage devices) with a dramatically reduced number of switches in the fabric. Thus, by not presenting an additional domain to the fabric, Access Gateway reduces the domain count when deployed in a fabric. Furthermore, its NPIV-based feature of presenting one N_Port representing multiple server N_Ports reduces the device port count (a concern when resolving scalability issues). Fewer domains increase fabric reliability, stability, and availability.

Multi-vendor interoperability

Access Gateway connects to the enterprise fabric as N_Port instead of E_Port, therefore interoperability with non-Brocade fabric will be much easier. Whereas E_Port interoperability requires exact compliance with a very large, complicated, and imprecisely defined interswitch protocol suite, the N_Port connects to the enterprise fabric using only the precisely defined FLOGI, FDISC, and LOGO

requests, ensuring compatibility with other Enterprise switch vendors' products.

Fabric management complexities

Access Gateway connects to Enterprise fabric N_Port, making it more of a device management tool instead of a fabric management tool. SAN management activities (e.g., zoning) remain entirely in the external fabric and does not include the switch module within the blade server chassis.

Case studies: How to set up an Access Gateway fabric and its benefits

This section contains the following three case studies for setting up an Access Gateway fabric and its benefits:

- "Case study #1," "Connectrix series switches with NPIV enabled linked through ISLs to Brocade Access Gateway" on page 227
- "Case study #2," "Migration from Brocade module (native) ISLed to Brocade switches (native) to Brocade module (in AG mode) connected to Cisco switches (interopmode irrelevant)" on page 236
- "Case Study #3," "Addition of switches or server blades in an existing Connectrix M fabric without increasing the domain count or port count respectively" on page 246

Case study #1 Connectrix series switches with NPIV enabled linked through ISLs to Brocade Access Gateway

The objective of this case study is to connect a Brocade switch module in Access Gateway mode to a Connectrix B, Connectrix M and Connectrix MDS switch.

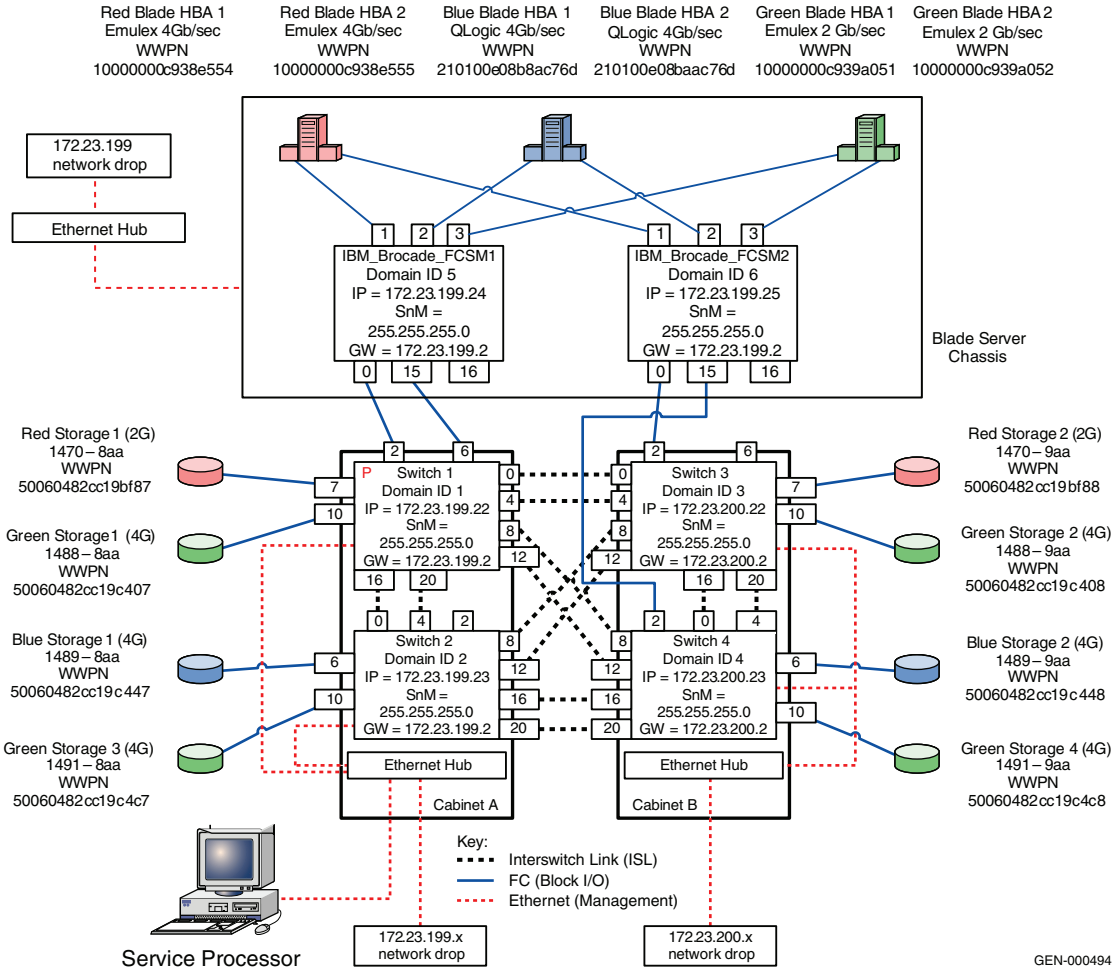


Figure 83 Topology

Figure 83 shows a four switch full mesh fabric topology as discussed in the "Four switch full mesh" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com. However, in this case, as can be seen above the red, green and blue hosts are replaced by the red, blue and green server blades that are attached to the fabric via the Brocade switch modules: IBM_Brcd_FCSM1 and IBM_Brcd_FCSM2 as shown

above. The connections between the switch modules and the switches are ISLs.

Assumptions specific to this case study:
The following are assumptions specific to this case study.

- An IBM blade server with two 4 G IBM Brocade modules (32R1812).is added to a 4-switch full mesh fabric comprising of Switches A, B, C and D which can be replaced by either Connectrix B, Connectrix M or Connectrix MDS switches which have been discussed in the "Four switch full mesh" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com.
- The red, blue, and green hosts in the 4-switch full mesh fabrics referred to in Figure 83 on page 228 now represent red, blue, and green server blades respectively in the blade server chassis.
- The server blades and switch modules in the blade server chassis are configured as explained in the "Blade switch with direct attached storage" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com. The IPs and Domain IDs on the Brocade switch modules are as follows:
  - For Brocade module 1:

    IP: 172.23.199.24
    Subnet mask: 255.255.255.0
    IP Gateway: 172.23.199.2
    Domain ID: 5

  - For Brocade module 2:

    IP: 172.23.199.25
    Subnet mask: 255.255.255.0
    IP Gateway: 172.23.199.2
    Domain ID: 6

- The IBM Brocade modules and standalone switches in the 4-switch full mesh fabric are running supported firmware versions and operating with the supported interoperable modes.
  - (For the 4-switch full mesh brocade fabric, all the Brocade standalone switches can continue to operate in the **native mode**. The attached IBM Brocade switch modules must also be set to Brocade native mode (**interopmode 0**).

- For the 4-switch full mesh Connectrix M fabric, all the Connectrix M standalone switches must now operate in **McData Open Fabric Mode** to support interoperability with the Brocade switch modules. In order to set the

  Open Fabric Mode, the Connectrix M switches must be disabled and the Fabric parameters/Operating mode must be changed from McData Fabric Mode to Open Fabric Mode. The attached IBM Brocade switch modules must be set to Brocade interopmode (**interopmode 1**). The detailed steps to change the interopmode in a Connectrix B/Connectrix M environment have been described in the "Four switch full mesh" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com.

- For the 4-switch full mesh Connectrix MDS fabric, the VSANs for the Connectrix MDS standalone switches must now be set to **Interop3** mode to support interoperability with the Brocade switch modules. In order to set the VSANs to Interop-3, the Connectrix MDS VSAN containing the switch E_Ports that are to be linked through ISLs to the switch modules and the ports on the path to the storage ports that the server blades are zoned, must be "suspended" and the interopmode must be changed from "default" to "Interop3". The attached IBM Brocade switch modules must be set to Brocade native mode (**interopmode 0**). Steps to change the interopmode in a Connectrix B/ Connectrix MDS environment have been described in the "Connectrix MDS example" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com.

◆ Two ISLs from one of the Brocade switch modules is going to the same standalone switch. This is referred to as a single-fabric attachment. Please refer to Figure 83 on page 228 for more details on the physical connections.

◆ The other module has two ISLs going to two different Brocade switches. This is referred to as a multi-fabric attachment. Please refer to Figure 83 on page 228 for more details on the physical connections.

- The zoning information that was previously on the 4 switch full mesh Connectrix fabric, as referenced in the "Four switch full mesh" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com, case study examples, must now be on the IBM Brocade FCSM1 and FCSM2. This must be validated using the **cfgactvshow** command. The zoning information on the FCSM must appear as follows:

  Effective configuration:

```
cfg: Oct_31_06_1140

zone: RedHBA1_1470_8aa
10:00:00:00:c9:38:e5:54
50:06:04:82:cc:19:bf:87

zone: RedHBA2_1470_9aa
10:00:00:00:c9:38:e5:55
50:06:04:82:cc:19:bf:88

zone: BlueHBA1_1489_8aa
21:01:00:e0:8b:8a:c7:6d
50:06:04:82:cc:19:c4:47

zone: BlueHBA2_1489_9aa
21:01:00:e0:8b:aa:c7:6d
50:06:04:82:cc:19:c4:48

zone: GreenHBA1_AllGreenStorage
10:00:00:00:c9:39:a0:51
50:06:04:82:cc:19:c4:07
50:06:04:82:cc:19:c4:08
50:06:04:82:cc:19:c4:c7
50:06:04:82:cc:19:c4:c8

zone: GreenHBA2_GreenStorage
10:00:00:00:c9:39:a0:52
50:06:04:82:cc:19:c4:07
50:06:04:82:cc:19:c4:08
50:06:04:82:cc:19:c4:c7
50:06:04:82:cc:19:c4:c8
```

- The final goal of this case study is to enable Access Gateway mode on these Brocade switch modules and to re-establish the existing connectivity without causing any disruption to the fabric.

To configure a switch:

In each case, i.e., for the Brocade module added to a Connectrix B, Connectrix M and Connectrix MDS fabric, it is essential to enable

NPIV on the switch/switches that is/are linked through ISLs to the Brocade modules. Thus, in our example, Switch 1, Switch 3,and Switch 4 must have NPIV enabled. NPIV need not be enabled on Switch 2, although it is a part of the fabric. Refer to the sections below for the steps to enable NPIV on the different vendor switches.

- "Case study A" on page 232 provides the steps for enabling NPIV on the Connectrix B switches, considering the Brocade modules are added to a Connectrix B fabric.
- "Case study B" on page 233 provides the steps for enabling NPIV on the Connectrix M switches, considering the Brocade modules are added to a Connectrix M fabric.
- "Case study C" on page 234 provides the steps for enabling NPIV on the Connectrix MDS switches, considering the Brocade modules are added to a Connectrix MDS fabric.

Case study A

Steps to enable NPIV on the Connectrix B switches

Most Brocade Fibre Channel switches running Fabric OS 5.1.0 or later, support NPIV. All Brocade 4 Gb capable Fibre Channel switches are, by default, configured with NPIV enabled.

Use the following procedure to enable NPIV on the Connectrix B switches when it is not enabled by default:

1. To enable or disable NPIV on a port-by-port basis from Brocade Fabric OS CLI, use the **portCfgNPIVPort** command.

   In our example, NPIV must be enabled on port 2 for switches 1, 3, and 4, and on port 6 for switch 1. The following commands need to be entered at the switch prompts:

   - For switch 1

     switch1:admin> **portCfgNPIVPort 2, 1**
     switch1:admin> **portCfgNPIVPort 6, 1**

   - For switch 3

     switch3:admin> **portCfgNPIVPort 2, 1**

   - For switch 4

     switch4:admin> **portCfgNPIVPort 2, 1**

2. To specify the number of virtual N_Port_IDs per port or per switch, use the **configure** command with either of the following parameters:

   - **`switch.login.perPortMax`**

Use this parameter to set the number of virtual N_Port_IDs per port to a value between 0 and 255. The default setting is 126. A blade server chassis can house a maximum of 16 server blades, thus the maximum number of virtual N_Port_IDs per port may be set to 16.

- **switch.login.perSwitchMax**

  Use this parameter to set the number of virtual N_Port_IDs per switch to a value between 0 and (126 * number of ports). The default setting is (15 * number of ports).

For our example, the IBM blade server can house a maximum of 14 blades so the Switch.login.perPortMax may be set to 15 = 1 FLOGI from the AG N_Port + 14 FDISCs from the 14 blade server N_Ports. The switch.login.perSwitchMax can be left at the default value.

The following commands need to be run at the switch prompt for switches 1, 3, and 4:

```
switch:admin> switchdisable
switch:admin> configure
Configure ...
Fabric parameters (yes, y, no, n): [no]
Virtual Channel parameters (yes, y, no, n): [no]
F_Port login parameters (yes, y, no, n): [no] y
Maximum logins per switch: (1..4032) [4032] 2048
Maximum logins per port: (1..255) [255] 15
switch:admin> switchenable
```

Case study B

Steps to enable NPIV on the Connectrix M switches

Connectrix M FC switches with E/OS 8.0 or later support NPIV. Connectrix M switches require an optional license to enable this function.

Use the following procedure to apply this license and enable NPIV on switches 1, 3, and 4:

1. From a browser, open the web user interface for all the Connectrix M switches that are to be connected to the IBM Brocade Access Gateway module, i.e., Switch 1, 3, and 4. On the switch EFCM GUI, the **Node List** view details the devices attached to the Connectrix M switch.
2. To install the NPIV license, click **Maintenance** and then select **Options** features.

3. Enter the license key for NPIV in the **Feature Key** field. Select the key as the "**N_Port ID Virtualization (NPIV)**." Link from the window and apply the key by clicking **OK**.

   A checkmark in the left window indicates that the N_Port ID Virtualization key is installed.

4. Click **Configure** and then select **Ports>NPIV**.
5. Click **Enable**.
6. At the prompt, click **OK** if you are sure you want to enable NPIV.
7. In the **Login** column, set the value to 17 or higher for each port connected to the IBM Brocade Access Gateway to ensure proper operation.
8. Click **OK** to save changes.

Case study C

Steps to enable NPIV on the Connectrix MDS switches

Connectrix MDS Fibre Channel switches running SAN-OS 3.0 or later will support NPIV.

To enable NPIV on Connectrix MDS Fibre Channel Switches 1, 3, and 4 running the Cisco Device Manager, use the following procedure:

1. From the **Cisco Device Manager,** click **Admin** and then select **FeatureControl**. The **Feature Control** window appears.
2. Click the row titled **NPIV**.
3. In the **Action** column select **Enable** and then click **Apply**.
4. Click **Close** to return to the **Name Server** screen.
5. Click **Refresh** to display the host ports.

The Cisco CLI may also be used to enable NPIV by running the following commands at the switch prompt for switches 1, 3, and 4:

```
switch# config t
switch(config)# npiv enable
```

To configure the Brocade switch module:

Once NPIV is enabled on the standalone switches, the AG mode can be enabled on the IBM Brocade modules, FCSM1 and FCSM2, by running the following commands in the switch module prompt:

1. Run the **msplmgmtdeactivate** command to deactivate the MS Platform Service before enabling AG mode.

2. Disable the Brocade module by running the **switchdisable** command at the switch prompt.
3. Backup the existing configuration (effective and defined zonesets) using the **configupload** command. Provide details of an ftp server as prompted where the configuration can be saved as a text file.
4. Enable the AG mode by running **ag --modeenable** on the switch prompt. This command also reboots the switch. When the switch comes up, the zoning configuration is erased. However, the zoning configuration still exists on switches 1, 2, 3, and 4.
5. The **ag --mapshow** command displays the factory default N_Port configuration and F_Port to N_Port mappings. The **Configured_F_Ports** display the initial configuration while the **Current_F_Ports** display the current mapping which, because of an N_Port failover, is same as the **Configured_F_Ports** until the configuration changes.

   In the CLI example below, the external N_Ports on the module specified in Column 1 are mapped to the internal F_Ports specified in Column 3 by default. Column 3, the **Current_F_Ports** column specifies the F_Ports that are currently online which is ports 1, 2 and 3 (the respective red, blue, and green HBA ports connected internally to the Access Gateway module. Their mapping is the same as the default mapping until an N_Port goes down and all the F_Ports mapped to it by default now failover to another N_Port.

FCSM1: **admin> ag --mapshow**

N_Port	Configured F_Ports	Current F_Ports	Failover	Failback
0	1; 2;	1; 2;	1	1
15	3; 4;	3;	1	1
16	5; 6; 7; 8;	None	1	1
17	9; 10; 11;	None	1	1
18	12;	None	1	1
19	13. 14;	None	1	1

If desired, the F_Port to N_Port mapping can be edited by using the following commands:

- **ag --mapadd**: This command adds new F_Ports to the list of currently mapped ports for a N_Port.
- **ag --mapdel**: This command removes F_Ports from the list of currently mapped ports for a N_Port
- **ag --mapset:** This command sets the F_Port mapping for a N_Port to the specified list of F_Ports.

For example, if we want to map F_Port 2 to N_Port 15 instead of N_Port 0, the following set of commands need to be run:

```
FCSM1:admin> ag --mapdel 0 "2"  //F_Port2 is not mapped to N_Port 0 now

FCSM1:admin> ag --mapset 15 "2" //F_Port 2 is now mapped to N_Port 15
```

6. Verify that all the F_Ports and N_Ports are now online by running the **switchshow** command.

Thus, the two primary steps that need to be executed to configure the module as an Access Gateway are:

- Enabling the AG mode
- Setting the desired F_Port to N_Port mapping

Case study #2 Migration from Brocade module (native) ISLed to Brocade switches (native) to Brocade module (in AG mode) connected to Cisco switches (interopmode irrelevant)

This example shows how any complexity created by using the interoperability modes for the IBM Brocade module/Connectrix MDS interop is eliminated by using the Access Gateway mode on the Brocade modules.

Figure 84 on page 237 shows a Brocade-based blade server chassis attached to a 4-switch full mesh Connectrix B fabric. The 4-switch Connectrix B fabric needs to be replaced by a Connectrix MDS fabric as shown in Figure 85 on page 238.

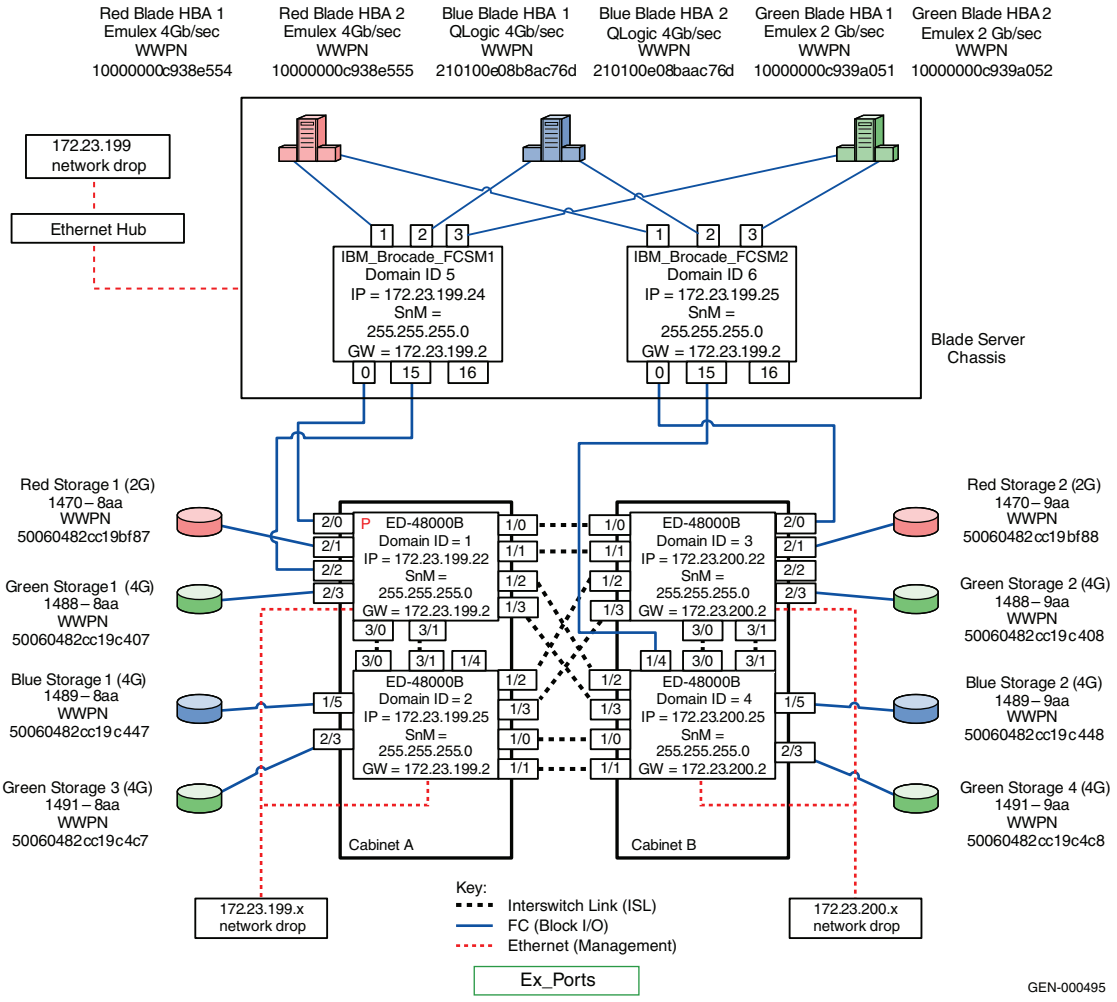


Figure 84 **Brocade-based blade server chassis attached to a 4-switch full mesh Connectrix B fabric**

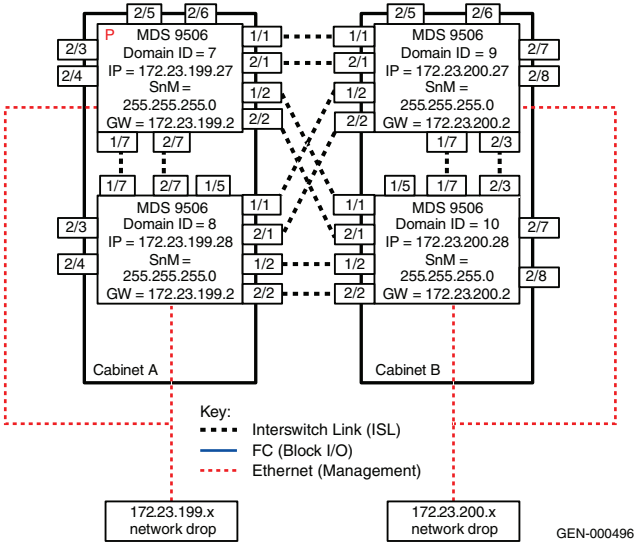


Figure 85 Connectrix MDS fabric

The completed migration is shown in Figure 86 on page 239 with the Brocade based blade server modules now in "Access Gateway" mode and connected to the Connectrix MDS 4-switch full mesh fabric.

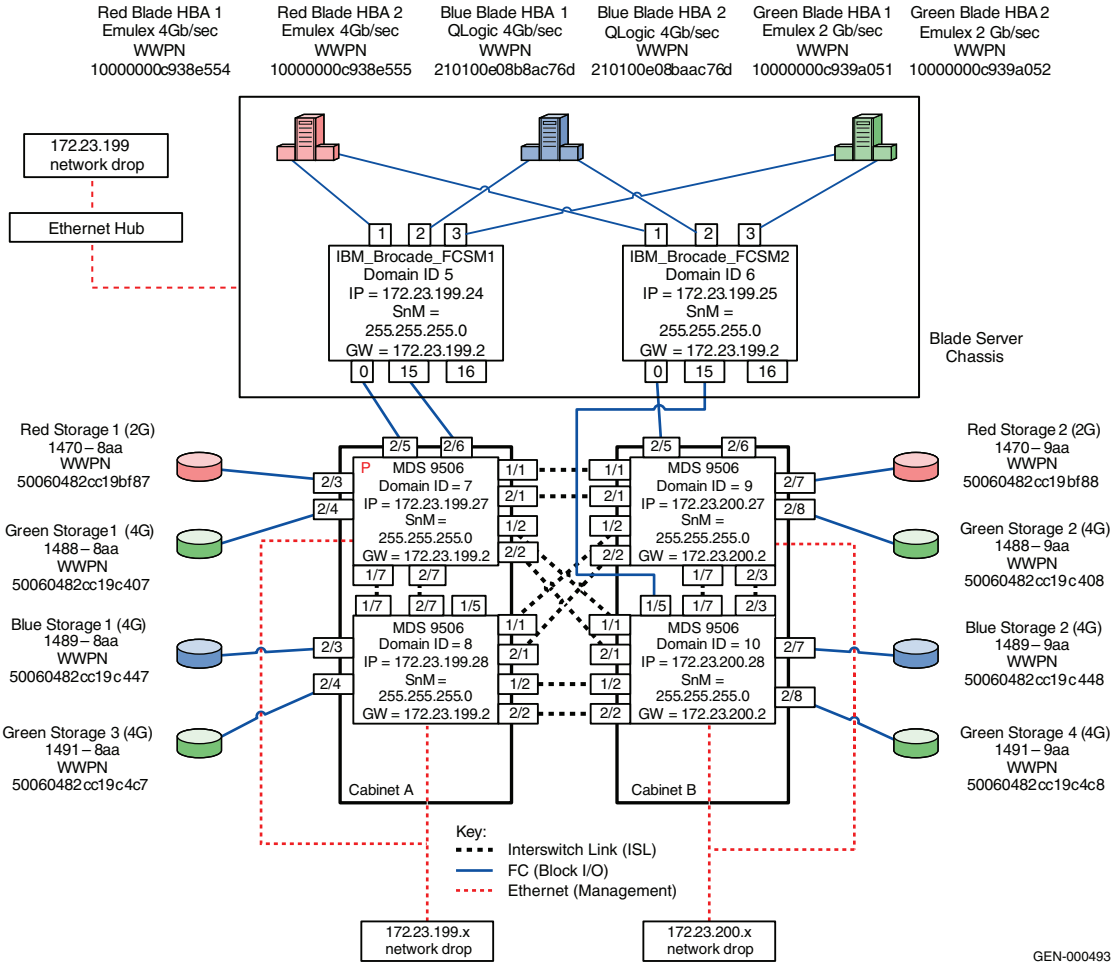


Figure 86 Completed migration

Assumptions specific to this case study:

The following are assumptions specific to this case study.

- An IBM blade server with two 4 G IBM brocade modules (32R1812) is added to the 4-switch full mesh fabric comprising of Connectrix B switches that have been discussed in the four switch full mesh "Connectrix B example" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com.

- The red, blue and green hosts in the 4-switch full mesh fabrics referred to in the four switch full mesh "Connectrix B example" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com, now represent red, blue, and green server blades respectively in the blade server chassis.
- The server blades and switch modules in the blade server chassis are configured. The IPs and domain IDs on the brocade switch modules are as follows:
  - For Brocade module 1:

    IP: 172.23.199.24
    Subnet mask: 255.255.255.0
    IP Gateway: 172.23.199.2
    Domain ID: 5
  - For Brocade module 2:

    IP: 172.23.199.25
    Subnet mask: 255.255.255.0
    IP Gateway: 172.23.199.2
    Domain ID: 6
- The IBM Brocade modules and standalone switches in the 4-switch full mesh fabric are running supported firmware versions and operating with the supported interoperable modes.For the 4-switch full mesh brocade fabric, all the brocade standalone switches can continue to operate in the **native mode**. The attached IBM brocade switch modules must be set to brocade native mode (**interopmode 0**) also.
- 2 ISLs from one of the brocade switch modules is going to the same standalone switch. This is referred to as a single-fabric attachment.
- The other module has 2 ISLs going to two different brocade switches. This is referred to as a multi-fabric attachment. Please refer to Figure 84 on page 237 for more details on the physical connections.
- The zoning information that was previously on the 4 switch full mesh Connectrix B fabric, per the "Connectrix B example" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com, must now be on the IBM

Brocade FCSM1and FCSM2. This must be validated using the **cfgactvshow** command. The zoning information on the FCSM must appear as follows:

Effective configuration:

```
cfg: Oct_31_06_1140

zone: RedHBA1_1470_8aa
10:00:00:00:c9:38:e5:54
50:06:04:82:cc:19:bf:87

zone: RedHBA2_1470_9aa
10:00:00:00:c9:38:e5:55
50:06:04:82:cc:19:bf:88

zone: BlueHBA1_1489_8aa
21:01:00:e0:8b:8a:c7:6d
50:06:04:82:cc:19:c4:47

zone: BlueHBA2_1489_9aa
21:01:00:e0:8b:aa:c7:6d
50:06:04:82:cc:19:c4:48

zone: GreenHBA1_AllGreenStorage
10:00:00:00:c9:39:a0:51
50:06:04:82:cc:19:c4:07
50:06:04:82:cc:19:c4:08
50:06:04:82:cc:19:c4:c7
50:06:04:82:cc:19:c4:c8

zone: GreenHBA2_AllGreenStorage
10:00:00:00:c9:39:a0:52
50:06:04:82:cc:19:c4:07
50:06:04:82:cc:19:c4:08
50:06:04:82:cc:19:c4:c7
50:06:04:82:cc:19:c4:c8
```

- The final goal of this case study is to replace all the standalone Connectrix B switches by Connectrix MDS switches. The blade server switch modules in Brocade native mode are then switched to Brocade Access Gateway mode with all external N_Ports connected to the NPIV enabled Connectrix MDS switches. The operating mode on the Connectrix MDS switch is irrelevant.

To migrate from a Connectrix B 4-switch fabric to a Connectrix MDS 4-switch fabric with brocade based blade servers, without changing the interoperability modes

1. While the Brocade modules are linked through ISLs to the Connectrix B standalone switches, enable the AG mode by executing the following steps:

   a. Run the **msplmgmtdeactivate** command to deactivate the MS Platform Service before enabling AG mode.

   b. Disable the Brocade module by running the **switchdisable** command at the switch prompt.

   c. Backup the existing configuration (effective and defined zonesets) using the **configupload** command. Provide details of an ftp server as prompted where the configuration can be saved as a text file.

   d. Enable the AG mode by running **ag --modeenable** on the switch prompt. This command also reboots the switch. When the switch comes up, the zoning configuration is erased.

   e. The **ag --mapshow** command displays the factory default N_Port configuration and F_Port to N_Port mappings. The **Configured_F_Ports** display the initial configuration while the **Current_F_Ports** display the current mapping which, because of an N_Port failover, is same as the **Configured_F_Ports** until the configuration changes.

   f. The F_Port to N_Port mapping can be edited as is desired by using any of the following commands:

      – **ag --mapadd**: This command adds new F_Ports to the list of currently mapped ports for a N_Port.

      – **ag --mapdel**: This command removes F_Ports from the list of currently mapped ports for a N_Port

      – **ag --mapset**: This command sets the F_Port mapping for a N_Port to the specified list of F_Ports.

      Note: For more detailed information on **ag –mapshow** and changing the N_Port to F_Port mapping please refer to Step 5 on page 235.

   g. Verify that all the F_Ports and N_Ports are now online by running the **switchshow** command.

2. Configure the IP for the individual Connectrix MDS standalone switches. Install the Fabric Manager and Device Manager as explained in the "Connectrix MDS example" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com, and link through ISLs the target Connectrix MDS fabric with only E_Ports as shown in Figure 85 on page 238.
3. Create an interop-3 (Brocade native mode) VSAN on the Connectrix MDS switches 7, 8, 9, and 10.
   a. Click the **Create VSAN** icon
   b. The **Create VSAN** dialog box displays.
   c. Check the switches that you want in this VSAN: Switch 7, 8, 9, and 10.
   d. Fill in the **VSAN Name** as "Brcd_module_interop_VSAN" and **VSAN ID** fields with an unused VSAN ID, for example "4".
   e. Set the **LoadBalancing** value to default and the **InterOperValue** to **Interop-3**.
   f. Set the **Admin State** to **active**.
   g. Check the **Static Domain Ids** checkbox to assign an unused static Domain IDs to the switches in the VSAN. For example, Switch 7, 8, 9, and 10 have to be assigned Domain IDs 7, 8, 9, and 10.
   h. Leave the other fields in this dialog box at default and click **Create** to add the VSAN.
4. Assign and enable all the E_Ports in Figure 85 on page 238 to VSAN ID 4 using the Device Manager for the respective switches. From the **Device Manager Menu** bar, go to **FC>VSANs** and click the **Membership** tab to add the ports to the desired VSAN.
5. Validate E_Port connectivity by comparing the topology in the Figure 84 on page 237 with the topology view of the Connectrix MDS fabric comprising of Switches 7, 8, 9, and 10 obtained using Fabric Manager.

6. Physically connect an ISL between the Connectrix MDS Switch 8 port FC 2/8 (or any other unused port) and Connectrix B Switch 2 port 1/5 (or any other unused port) so the existing active zoneset from the Connectrix B switches gets pulled onto the Connectrix MDS fabric.

   This can be validated by opening the **Zoning** menu in the Fabric Manager for VSAN ID 4.

   The **Active Zoneset** on the Connectrix MDS switch 8 will appear as follows:

```
Zone set name = Oct_31_06_1140
Zone name = "RedHBA1_1470_8aa"
Zone Member = "10000000c938e554"
Zone Member = "50060482cc19bf87"

Zone name = "RedHBA2_1470_9aa"
Zone Member = "10000000c938e555"
Zone Member = "50060482cc19bf88"

Zone name = "BlueHBA1_1489_8aa"
Zone Member = "210100e08b8ac76d"
Zone Member = "50060482cc19c447"

Zone name = "BlueHBA2_1489_9aa"
Zone Member = "210100e08baac76d"
Zone Member = "50060482cc19c448"

Zone name = "GreenHBA1_AllGreenStorage"
Zone Member = "10000000c939a051"
Zone Member = "50060482cc19c407"
Zone Member = "50060482cc19c408"
Zone Member = "50060482cc19c4c7"
Zone Member = "50060482cc19c4c8"

Zone name = "GreenHBA2_AllGreenStorage"
Zone Member = "10000000c939a052"
Zone Member = "50060482cc19c407"
Zone Member = "50060482cc19c408"
Zone Member = "50060482cc19c4c7"
Zone Member = "50060482cc19c4c8"
```

7. All switches in the Connectrix MDS fabric distribute active zone sets when new E_Port links come up or when a new zone set is activated in a VSAN if the full zone set propagation is set.

   To propagate the full zoneset across all switches in a VSAN, execute the following steps:

a. Select **VSAN ID 4 > Default Zone** from the **Logical Domains** pane.The zone set configuration displays in the **Information** pane.

b. Select the **Policies** tab.

c. Set the **Propagation** column to **fullZoneset** from the drop-down menu.

d. Click **Apply Changes** to propagate the full zone set, or click **Undo Changes** to discard any changes you made.

8. Enable NPIV on the Connectrix MDS Switches 7, 9, and 10 which are to be connected to the AG module by executing the following steps:

   a. From the **Cisco Device Manager**, click **Admin**, and then select **FeatureControl**. The **Feature Control** window appears.

   b. Click the row titled **NPIV**.

   c. In the **Action** column select **Enable**, and then click **Apply**.

   d. Click **Close** to return to the **Name Server** screen.

   e. Click **Refresh** to display the host ports.

9. Move half of the access gateway N_Ports and the storage ports from the Connectrix B fabric to the Connectrix MDS fabric.

   This requires connections to be physically removed from the Connectrix B director and connected to a Connectrix MDS 9506 director. The active zonesets propagates across the Connectrix MDS switches ensuring that connectivity is maintained even if the server blade connection is in one fabric and the storage connection is in the other fabric.

   a. Move one device at a time. Start by moving the cable for the "red host HBA 1".

   b. After it has been connected to the appropriate port in the Connectrix MDS fabric (Domain ID 7, 2/5), use the copa inquiry (**inq** command) on the red server blade to verify the connectivity.

   c. Review the "Checkpoints" (in "Case study #3" in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com) and verify that this action did not affect the connectivity and functioning of the fabric.

d. Repeat this procedure as you move each connection for the red host and red storage, and the blue host and storage, from the Connectrix B to the Connectrix MDS fabric.

10. This step is an extension of Step 9. After validating that the stable fabric exists after the completion of Step 9, execute this step by pulling the remaining host and storage connections in the Connectrix B fabric. Review the "Checkpoints" (in "Case study #3" in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com) to validate the connectivity.

11. Disable the ISLs between the Connectrix B and Connectrix MDS switches and validate stability of the Connectrix MDS fabric attached to the blade servers via the Access Gateway modules.

    After the migration is completed the fabric must appear as shown in Figure 86 on page 239.

Case Study #3 Addition of switches or server blades in an existing Connectrix M fabric without increasing the domain count or port count respectively

This case study discusses the advantage of using the brocade Access Gateway modules for scalability purposes.

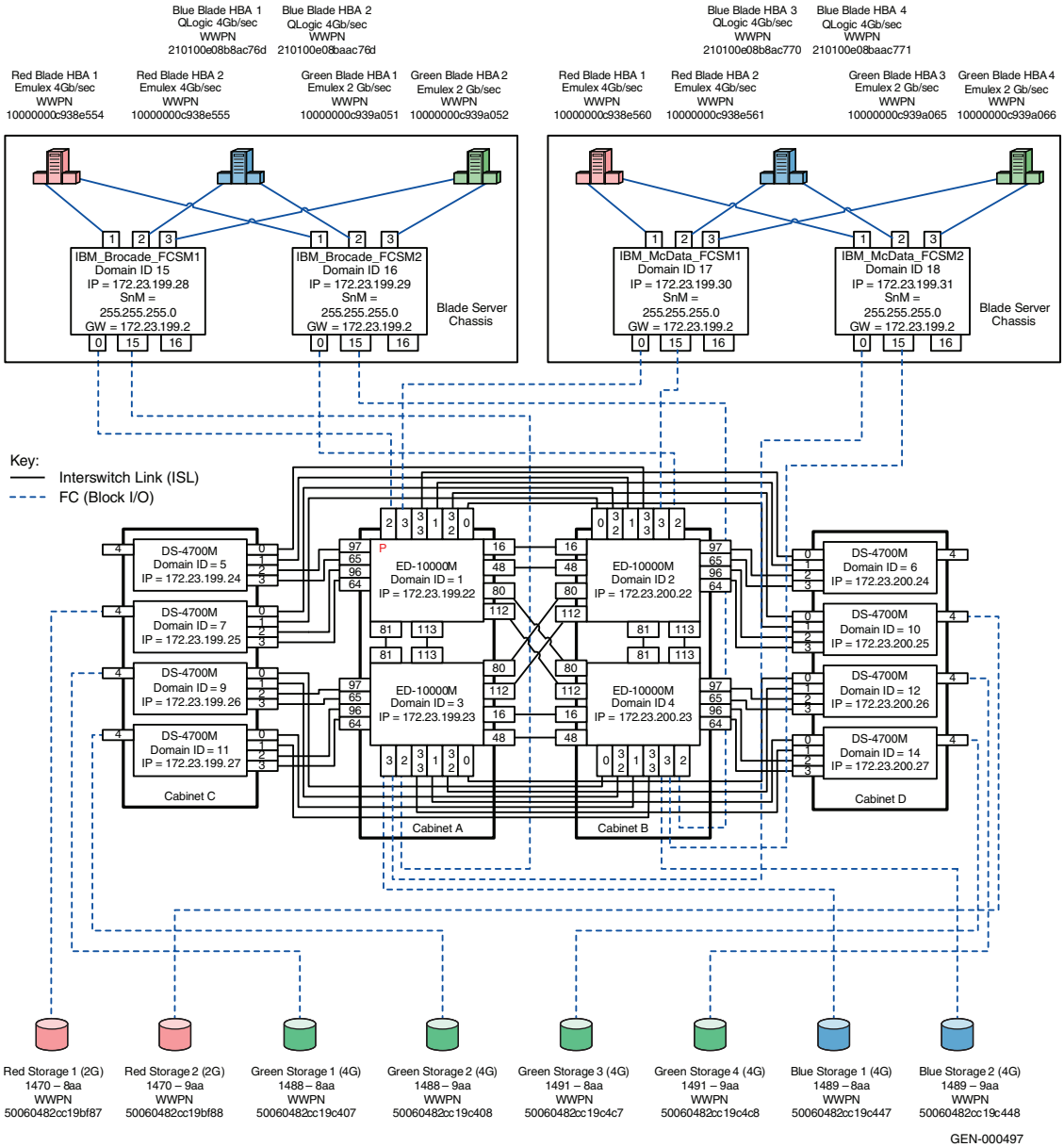


Figure 87 Topology

Figure 87 on page 247 shows the compound-core edge Connectrix M fabric discussed in the "Connectrix M example" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com, with the red, green, and blue hosts being replaced by red, blue, and green blade server chassis connecting via the Brocade and McDATA modules with ISLs, as described in the assumptions and steps to follow in this section.

Assumptions specific to this case study:

The following are assumptions specific to this case study.

- Consider the compound core-edge Connectrix M topology discussed in the "Connectrix M example" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com, with a mix of Brocade and McDATA-based blade servers attached to the fabric as shown in the Figure 87 on page 247. The Connectrix M switches are in Open Fabric 1.0 mode while the Brocade modules are operating in interopmode, and the McDATA modules are in standard mode. Setting up this kind of a configuration has not been explicitly explained in any previous section, and thus is explained in this case study.
- This example assumes that the customer already has a Connectrix M fabric with blade server modules and needs to increase the fabric size by adding more switch modules and server blades. If the customer is to start designing a scalable fabric with switch modules, then it is recommended to add switch modules with Access Gateway enabled.
- The final goal of this case study is to increase the fabric size by adding more switches to the existing setup, yet maintain the switch domain count, keeping it to a minimum. This is done by enabling Access Gateway on the existing Brocade modules and swapping the McDATA modules if required by Brocades in Access Gateway mode.

  If more blade servers are to be added into the fabric without significantly increasing the N_Port count, the existing Brocade modules can be set as Access Gateway and the newly added blade servers must have AG modules as the I/O modules. In that way, although we are expanding the number of device ports, we

can connect them through a single AG fabric port, thus enabling support for a much larger fabric in terms of number of connected host and storage devices.

To set up a Connectrix M core edge fabric with blade servers:

1. Set up a Connectrix M core edge fabric with E_Ports or ISLs only (i.e., without the server and storage ports) as explained in section Figure 87 on page 247.
2. Configure the Connectrix M switches as explained in the "Connectrix M example" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com, with Interop Mode set to Open Fabric 1.0.
3. Configure the IBM Brocade modules as explained in "IBM Brocade example" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com. Telnet into the FCSM1 and FCSM2 and run the following commands at the switch prompt to set the interopmode on.

   Fcsm1> **switchdisable**
   Fcsm1> **interopmode 1**

   Press **Yes** when prompted to continue.

   Fcsm1>**reboot**

   Note: A switch reboot is recommended after switching the interop mode.

4. ISL the blade server McDATA modules in standard mode to the Connectrix M fabric as shown in the Figure 87 on page 247.
   a. Using EFS 2007, (the McDATA switch module Fabric Manager application), add the IPs of the McDATA modules. These switches display in a column on the left pane of the GUI.
   b. Click on one of the switch modules from the left pane.
   c. When the selected switch shows up as a faceplate display:
      – Open the **Switch** menu on the top of the screen.
      – Select **Advanced Switch Properties**.
      – When the **Advanced Switch Properties** dialog displays, set the **Interop Mode** to **Standard**.

The switch will automatically be taken offline and restored once the changes (if any) are completed.

5. Attach the storage ports as shown in Figure 87 on page 247.

6. Create and activate the zoneset on the Connectrix M switches, discussed in the "Connectrix M example" section in the *Fibre Channel SAN Topologies TechBook*, available through the E-Lab Interoperability Navigator, **Topology Resource Center** tab, at http://elabnavigator.EMC.com. However, please note the addition of the new zones to this zoneset, which are created as a result of the addition of three more server blades (6 more server ports in the fabric): Red HBA3,4, Blue HBA3,4, and Green HBA 3,4. The zoneset on the Connectrix M switches must appear as follows:

```
Zone set name = "Oct_31_06_1140"

Zone name = "RedHBA1_1470_8aa"
Zone Member = "10000000c938e554"
Zone Member = "50060482cc19bf87"

Zone name = "RedHBA2_1470_9aa"
Zone Member = "10000000c938e555"
Zone Member = "50060482cc19bf88"

Zone name = "RedHBA3_1470_8aa"
Zone Member = "10000000c938e560"
Zone Member = "50060482cc19bf87"

Zone name = "RedHBA4_1470_9aa"
Zone Member = "10000000c938e561"
Zone Member = "50060482cc19bf88"

Zone name = "BlueHBA1_1489_8aa"
Zone Member = "210100e08b8ac76d"
Zone Member = "50060482cc19c447"

Zone name = "BlueHBA2_1489_9aa"
Zone Member = "210100e08baac76d"
Zone Member = "50060482cc19c448"

Zone name = "BlueHBA3_1489_8aa"
Zone Member = "210100e08b8ac770"
Zone Member = "50060482cc19c447"

Zone name = "BlueHBA4_1489_9aa"
Zone Member = "210100e08baac771"
Zone Member = "50060482cc19c448"

Zone name = "GreenHBA1_AllGreenStorage"
```

```
Zone Member = "10000000c939a051"
Zone Member = "50060482cc19c407"
Zone Member = "50060482cc19c408"
Zone Member = "50060482cc19c4c7"
Zone Member = "50060482cc19c4c8"

Zone name = "GreenHBA2_AllGreenStorage"
Zone Member = "10000000c939a052"
Zone Member = "50060482cc19c407"
Zone Member = "50060482cc19c408"
Zone Member = "50060482cc19c4c7"
Zone Member = "50060482cc19c4c8"

Zone name = "GreenHBA3_AllGreenStorage"
Zone Member = "10000000c939a065"
Zone Member = "50060482cc19c407"
Zone Member = "50060482cc19c408"
Zone Member = "50060482cc19c4c7"
Zone Member = "50060482cc19c4c8"

Zone name = "GreenHBA4_AllGreenStorage"
Zone Member = "10000000c939a066"
Zone Member = "50060482cc19c407"
Zone Member = "50060482cc19c408"
Zone Member = "50060482cc19c4c7"
Zone Member = "50060482cc19c4c8"
```

7. At this step, the connectivity and fabric stability can be verified by checking that all the ports are up, the switches are in the appropriate modes of operation, and that the zones have been propagated across all the Connectrix M switches and Brocade, McDATA switch modules.

To increase the fabric size by adding more switches or blade servers:

To keep the switch domain count to the minimum possible, we will use the scalability aspect of Access Gateway and enable Access Gateway on all the Brocade modules in the fabric. At the same time, if more blade servers are to be added, the total server N_Port count can be kept low by using the NPIV functionality of Access Gateway modules. Multiple server blade N_Ports can be mapped to a single N_Port on the Access Gateway module reducing the total number of N_Ports seen by the Connectrix M fabric.

The mode of operation (i.e., Open Fabric 1.0 in this case) on the Connectrix M switches is irrelevant for Access Gateway connectivity. Therefore, we can leave the interop mode as it is on the Connectrix M switches. The first step is to enable NPIV on the Connectrix M

switches that are currently linked through ISLs to the blade server Brocade modules.

Note: Connectrix M switches require an optional license to enable this function.

Use the following procedure to apply this license and enable NPIV:

1. From a browser, open the web user interface for the Connectrix M switch that is to be connected to the Brocade AG module. The **Node List** view details the devices attached to the Connectrix M switch.
2. To install the NPIV license, click **Maintenance**, and then select the **Options** features.
3. Enter the license key for NPIV in the **Feature Key** field. Select the key as the "**N_Port ID Virtualization (NPIV)**." Link from the window and apply the key by clicking **OK**.

   A checkmark in the left window indicates that the N_Port ID Virtualization key is installed.
4. Click **Configure** and then select **Ports>NPIV**.
5. Click **Enable**.
6. At the prompt, click **OK** if you are sure you want to enable NPIV.
7. In the **Login** column, set the value to 17 or higher for each port connected to the IBM Brocade Access Gateway to ensure proper operation.
8. Click **OK** to save changes.

The AG mode must be enabled on the Brocade modules by executing the following steps:

1. Run the **msplmgmtdeactivate** command to deactivate the MS Platform Service before enabling AG mode.
2. Disable the Brocade module by running the **switchdisable** command at the switch prompt.
3. Backup the existing configuration (effective and defined zonesets) using the **configupload** command. Provide details of an ftp server as prompted where the configuration can be saved as a text file.

4. Enable the AG mode by running **ag --modeenable** on the switch prompt. This command also reboots the switch. When the switch comes up, the zoning configuration is erased. However, the zoning configuration still exists on switches 1, 2, 3, and 4.
5. The **ag --mapshow** command displays the factory default N_Port configuration and F_Port to N_Port mappings. The **Configured_F_Ports** display the initial configuration while the **Current_F_Ports** display the current mapping which, because of an N_Port failover, is same as the **Configured_F_Ports** until the configuration changes.
6. The F_Port to N_Port mapping can be edited as is desired by using any of the following commands:
   - **ag --mapadd**: This command adds new F_Ports to the list of currently mapped ports for a N_Port.
   - **ag --mapdel**: This command removes F_Ports from the list of currently mapped ports for a N_Port
   - **ag --mapset:** This command sets the F_Port mapping for a N_Port to the specified list of F_Ports.

   Note: For more detailed information on ag –mapshow and changing the N_Port to F_Port mapping please refer to Step 5 on page 235.
7. Verify that all the F_Ports and N_Ports are now online by running the **switchshow** command.

To replace McDATA modules with Brocade modules in Access Gateway mode:

If required, the McDATA modules can also be replaced with Brocade modules in Access Gateway mode. This will further reduce the switch domain count. The following steps must be executed for the same:

1. Plan a downtime for the McDATA-based blade server.
2. Disable the McDATA switch module.
3. Physically disconnect the ISLs running between the McDATA modules and the Connectrix M Series switches.
4. Replace the McDATA modules with Brocade modules.
5. Configure the Brocade modules with an IP address.

6. Enable NPIV on the Connectrix switches that were originally connected through ISLs to the McDATA modules and which will now be connected through ISLs to the AG modules.
7. Telnet into the Brocade module, and enable Access Gateway mode using Step 1 on page 252 through Step 7 on page 253 under "The AG mode must be enabled on the Brocade modules by executing the following steps:".
8. Reconnect the Connectrix M switches to the Brocade Access Gateway module and validate the end-to-end connectivity and device discovery.

Access Gateway qualification plan

This section lists the "areas of concern" that are qualified as a part of the E-Lab Switch Interoperability qualification plan for Access Gateway features and functionality. The test plan has been designed to qualify both the F_Port to N_Port connectivity within the AG module, and the N_Port to F_Port connectivity between the AG modules and external NPIV switches.

Each of the Access Gateway features/functions have been tested for a specific 'purpose' as listed in this sub section. The 'background' provides a reasoning behind designing a test case around that particular area of concern.

AG manageability

Purpose: To verify the functionality of essential Access Gateway configuration commands.

Background: On enabling Access Gateway on the Brocade switch module, it loses its FC fabric switch functionality and introduces a new command set for management. As a part of this testing, E-Lab validates the custom configuration and management of Access Gateway using the supported interfaces, such as Web Tools and CLI commands used to enable AG mode, revert back to standard switch mode, configure/display F_Port to N_Port mapping, configure N_Port failover/failback policies and disable/enable N_Port capability must be validated. Verifying that NPIV logins are properly displayed in the Connectrix Manager fabric tree is also essential.

AG login

Purpose: To characterize the login behavior of an AG switch module which has been enabled for NPIV and the behavior after an N_Port failover.

Background: A clean and efficient login is essential for proper N_Port operation. By ensuring a similar login process can be accomplished across all platforms, we ensure that the users' experience will be similar across all the NPIV edge switch vendors tested by EMC. This will reduce support costs.

AG fabric connectivity

Purpose: To ensure that end-to-end (physical and logical) connectivity is possible across multiple platform types in a multi-vendor switch fabric.

Background: Seamless end-to-end connectivity is the whole purpose of an FC SAN. Ensuring that devices can communicate with each other across all different platform types in an interop fabric with AG is critical to achieving seamless connectivity.

AG stress test

Purpose: To validate that adding and removing NPIV logins does not impact other NPIV login sessions.

Background: Since NPIV virtual logins will be used to give each virtual host access to storage, it is important that each NPIV implementation insulates the actions of one virtual host from another.

AG firmware download

Purpose: To verify the hot code load feature for AG.

Background: The hot code load feature is supported on the Brocade switch with AG mode enabled. It would be interesting to verify whether the configuration details, AG port mapping, nameserver, and zoning details on the edge switches, etc., are maintained after a firmware upgrade/downgrade without a reboot.

AG N_Port failover/failback

Purpose: To validate the N_Port failover feature on the AG module.

Background: With the failover policy enabled on the AG modules, all F_Ports will be mapped to other N_Ports connected to the same fabric and re-enabled. It will first try the N_Ports connected to the same switch and then the same fabric. The delay between the disable and re-enable of F_Ports is of the order of 5-10 ms. The PIDs assigned to the F_Ports get modified in this case. When the original N_Port becomes active, the F_Ports configured to it will failback if failback policy is enabled for the N_Port. This needs to be validated.

Qualification results

The following are qualification results.

Supported configurations

The following are supported configurations:

- All the 4 Gb and 8 Gb IBM, Dell,and HP Blade Server Brocade modules currently listed in the *EMC Support Matrix* are supported for Access Gateway mode. No standalone switches running Brocade v5.2.1 and up are supported for Access Gateway at this time.
- For a list of the Connectrix B, Connectrix M, and Connectrix MDS edge switches that can be connected to the Access gateway with NPIV enabled, please refer to the most current *EMC Support Matrix*.
- The Connectrix M and Connectrix MDS connectivity will be supported starting from the following firmware versions only.
  - Connectrix M EOS v9.x
  - Connectrix MDS firmware v3.x
- Only FCP initiator ports can be connected to Access Gateway as F_Ports (ports from other Access gateway, FCP Target ports, loop device, and FICON channels/control unit connectivity are not supported).
- Dynamic POD will continue to be supported when agmode is enabled.

Limitations

The following are limitations:

- Access gateway does not support loop devices.
- Cascading an Access Gateway to another Access Gateway will not be supported.
- N_Port failover is supported only within N_Ports connected to the same switch for Brocade FOS 5.2.x (i.e., v5.2.1b, v5.2.2) and will be supported for N_Ports connected to the same fabric from Brocade FOS 5.3.

Some current FOS testing-related limitations that affect Access Gateway are:

- Maximum number of Access Gateways that can be connected to an edge switch is 30 (due to testing limitation).

- Maximum number of devices that can be connected to a FOS switch through Access Gateway depends on the maximum number of local devices that are supported in a fabric.
- Table 46 shows the scalability bounds for an Access Gateway based fabric due to the testing limitations in EMC's and Brocade's scalability testing lab.

Table 46 Fibre Channel Access Gateway support limitations

Max# of Access Gateways in a fabric	39
Max# of Access Gateways that can be connected to a switch	30
Max# of F-ports that can be mapped to the N-ports on an Access Gateway module	16
Max# of N-ports supported per Access Gateway module	8

Glossary

This glossary contains terms related to EMC products and EMC networked storage concepts.

A

access control A service that allows or prohibits access to a resource. Storage management products implement access control to allow or prohibit specific users. Storage platform products implement access control, often called LUN Masking, to allow or prohibit access to volumes by Initiators (HBAs). *See also* "persistent binding" and "zoning."

active domain ID The domain ID actively being used by a switch. It is assigned to a switch by the principal switch.

active zone set The Active Zone Set is the Zone Set Definition currently in effect and enforced by the Fabric or other entity (for example, the Name Server). Only one zone set at a time can be active.

agent An autonomous agent is a system situated within (and is part of) an environment that senses that environment, and acts on it over time in pursuit of its own agenda. Storage management software centralizes the control and monitoring of highly distributed storage infrastructure. The centralizing part of the software management system can depend on agents that are installed on the distributed parts of the infrastructure. For example, an agent (software component) can be installed on each of the hosts (servers) in an environment to allow the centralizing software to control and monitor the hosts.

alarm An SNMP message notifying an operator of a network problem.

any-to-any port connectivity A characteristic of a Fibre Channel switch that allows any port on the switch to communicate with any other port on the same switch.

application Application software is a defined subclass of computer software that employs the capabilities of a computer directly to a task that users want to perform. This is in contrast to system software that participates with integration of various capabilities of a computer, and typically does not directly apply these capabilities to performing tasks that benefit users. The term application refers to both the application software and its implementation which often refers to the use of an information processing system. (For example, a payroll application, an airline reservation application, or a network application.) Typically an application is installed "on top of" an operating system like Windows or LINUX, and contains a user interface.

application-specific integrated circuit (ASIC) A circuit designed for a specific purpose, such as implementing lower-layer Fibre Channel protocols (FC-1 and FC-0). ASICs contrast with general-purpose devices such as memory chips or microprocessors, which can be used in many different applications.

arbitration The process of selecting one respondent from a collection of several candidates that request service concurrently.

ASIC family Different switch hardware platforms that utilize the same port ASIC can be grouped into collections known as an ASIC family. For example, the Fuji ASIC family which consists of the ED-64M and ED-140M run different microprocessors, but both utilize the same port ASIC to provide Fibre Channel connectivity, and are therefore in the same ASIC family. For inter operability concerns, it is useful to understand to which ASIC family a switch belongs.

ASCII ASCII (American Standard Code for Information Interchange), generally pronounced [aeski], is a character encoding based on the English alphabet. ASCII codes represent text in computers, communications equipment, and other devices that work with text. Most modern character encodings, which support many more characters, have a historical basis in ASCII.

audit log A log containing summaries of actions taken by a Connectrix Management software user that creates an audit trail of changes. Adding, modifying, or deleting user or product administration

values, creates a record in the audit log that includes the date and time.

authentication Verification of the identity of a process or person.

B

backpressure The effect on the environment leading up to the point of restriction. See "congestion."

BB_Credit *See* "buffer-to-buffer credit."

beaconing Repeated transmission of a beacon light and message until an error is corrected or bypassed. Typically used by a piece of equipment when an individual Field Replaceable Unit (FRU) needs replacement. Beaconing helps the field engineer locate the specific defective component. Some equipment management software systems such as Connectrix Manager offer beaconing capability.

BER *See* "bit error rate."

bidirectional In Fibre Channel, the capability to simultaneously communicate at maximum speeds in both directions over a link.

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

blade server A consolidation of independent servers and switch technology in the same chassis.

blocked port Devices communicating with a blocked port are prevented from logging in to the Fibre Channel switch containing the port or communicating with other devices attached to the switch. A blocked port continuously transmits the off-line sequence (OLS).

bridge A device that provides a translation service between two network segments utilizing different communication protocols. EMC supports and sells bridges that convert iSCSI storage commands from a NIC-attached server to Fibre Channel commands for a storage platform.

broadcast Sends a transmission to all ports in a network. Typically used in IP networks. Not typically used in Fibre Channel networks.

broadcast frames Data packet, also known as a broadcast packet, whose destination address specifies all computers on a network. *See also* "multicast."

buffer Storage area for data in transit. Buffers compensate for differences in link speeds and link congestion between devices.

buffer-to-buffer credit The number of receive buffers allocated by a receiving FC_Port to a transmitting FC_Port. The value is negotiated between Fibre Channel ports during link initialization. Each time a port transmits a frame it decrements this credit value. Each time a port receives an R_Rdy frame it increments this credit value. If the credit value is decremented to zero, the transmitter stops sending any new frames until the receiver has transmitted an R_Rdy frame. Buffer-to-buffer credit is particularly important in SRDF and Mirror View distance extension solutions.

C

Call Home A product feature that allows the Connectrix service processor to automatically dial out to a support center and report system problems. The support center server accepts calls from the Connectrix service processor, logs reported events, and can notify one or more support center representatives. Telephone numbers and other information are configured through the Windows NT dial-up networking application. The Call Home function can be enabled and disabled through the Connectrix Product Manager.

channel With Open Systems, a channel is a point-to-point link that transports data from one point to another on the communication path, typically with high throughput and low latency that is generally required by storage systems. With Mainframe environments, a channel refers to the server-side of the server-storage communication path, analogous to the HBA in Open Systems.

Class 2 Fibre Channel class of service In Class 2 service, the fabric and destination N_Ports provide connectionless service with notification of delivery or nondelivery between the two N_Ports. Historically Class 2 service is not widely used in Fibre Channel system.

Class 3 Fibre Channel class of service Class 3 service provides a connectionless service without notification of delivery between N_Ports. (This is also known as datagram service.) The transmission and routing of Class 3 frames is the same

as for Class 2 frames. Class 3 is the dominant class of communication used in Fibre Channel for moving data between servers and storage and may be referred to as "Ship and pray."

Class F Fibre Channel class of service — Class F service is used for all switch-to-switch communication in a multiswitch fabric environment. It is nearly identical to class 2 from a flow control point of view.

community — A relationship between an SNMP agent and a set of SNMP managers that defines authentication, access control, and proxy characteristics.

community name — A name that represents an SNMP community that the agent software recognizes as a valid source for SNMP requests. An SNMP management program that sends an SNMP request to an agent program must identify the request with a community name that the agent recognizes or the agent discards the message as an authentication failure. The agent counts these failures and reports the count to the manager program upon request, or sends an authentication failure trap message to the manager program.

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

congestion — Occurs at the point of restriction. See "backpressure."

connectionless — Non dedicated link. Typically used to describe a link between nodes that allows the switch to forward Class 2 or Class 3 frames as resources (ports) allow. *Contrast with* the dedicated bandwidth that is required in a Class 1 Fibre Channel Service point-to-point link.

Connectivity Unit — A hardware component that contains hardware (and possibly software) that provides Fibre Channel connectivity across a fabric. Connectrix switches are example of Connectivity Units. This is a term popularized by the Fibre Alliance MIB, sometimes abbreviated to connunit.

Connectrix management software — The software application that implements the management user interface for all managed Fibre Channel products, typically the Connectrix -M product line. Connectrix Management software is a client/server application with the server running on the Connectrix service processor, and clients running remotely or on the service processor.

Connectrix service processor An optional 1U server shipped with the Connectrix -M product line to run the Connectrix Management server software and EMC remote support application software.

Control Unit In mainframe environments, a Control Unit controls access to storage. It is analogous to a Target in Open Systems environments.

core switch Occupies central locations within the interconnections of a fabric. Generally provides the primary data paths across the fabric and the direct connections to storage devices. Connectrix directors are typically installed as core switches, but may be located anywhere in the fabric.

credit A numeric value that relates to the number of available BB_Credits on a Fibre Channel port. *See*"buffer-to-buffer credit".

D

DASD Direct Access Storage Device.

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

default zone A zone containing all attached devices that are not members of any active zone. Typically the default zone is disabled in a Connectrix M environment which prevents newly installed servers and storage from communicating until they have been provisioned.

Dense Wavelength Division Multiplexing (DWDM) A process that carries different data channels at different wavelengths over one pair of fiber optic links. A conventional fiber-optic system carries only one channel over a single wavelength traveling through a single fiber.

destination ID A field in a Fibre Channel header that specifies the destination address for a frame. The Fibre Channel header also contains a Source ID (SID). The FCID for a port contains both the SID and the DID.

device A piece of equipment, such as a server, switch or storage system.

dialog box A user interface element of a software product typically implemented as a pop-up window containing informational messages and fields for modification. Facilitates a dialog between the user and the application. Dialog box is often used interchangeably with window.

DID An acronym used to refer to either Domain ID or Destination ID. This ambiguity can create confusion. As a result E-Lab recommends this acronym be used to apply to Domain ID. Destination ID can be abbreviated to FCID.

director An enterprise-class Fibre Channel switch, such as the Connectrix ED-140M, MDS 9509, or ED-48000B. Directors deliver high availability, failure ride-through, and repair under power to insure maximum uptime for business critical applications. Major assemblies, such as power supplies, fan modules, switch controller cards, switching elements, and port modules, are all hot-swappable.

The term director may also refer to a board-level module in the Symmetrix that provides the interface between host channels (through an associated adapter module in the Symmetrix) and Symmetrix disk devices. (This description is presented here only to clarify a term used in other EMC documents.)

DNS *See* "domain name service name."

domain ID A byte-wide field in the three byte Fibre Channel address that uniquely identifies a switch in a fabric. The three fields in a FCID are domain, area, and port. A distinct Domain ID is requested from the principal switch. The principal switch allocates one Domain ID to each switch in the fabric. A user may be able to set a Preferred ID which can be requested of the Principal switch, or set an Insistent Domain ID. If two switches insist on the same DID one or both switches will segment from the fabric.

domain name service name Host or node name for a system that is translated to an IP address through a name server. All DNS names have a host name component and, if fully qualified, a domain component, such as *host1.abcd.com*. In this example, *host1* is the host name.

dual-attached host A host that has two (or more) connections to a set of devices.

E

E_D_TOV A time-out period within which each data frame in a Fibre Channel sequence transmits. This avoids time-out errors at the destination Nx_Port. This function facilitates high speed recovery from dropped frames. Typically this value is 2 seconds.

E_Port Expansion Port, a port type in a Fibre Channel switch that attaches to another E_Port on a second Fibre Channel switch forming an Interswitch Link (ISL). This link typically conforms to the FC-SW standards developed by the T11 committee, but might not support heterogeneous inter operability.

edge switch Occupies the periphery of the fabric, generally providing the direct connections to host servers and management workstations. No two edge switches can be connected by interswitch links (ISLs). Connectrix departmental switches are typically installed as edge switches in a multiswitch fabric, but may be located anywhere in the fabric

Embedded Web Server A management interface embedded on the switch's code that offers features similar to (but not as robust as) the Connectrix Manager and Product Manager.

error detect time out value Defines the time the switch waits for an expected response before declaring an error condition. The error detect time out value (E_D_TOV) can be set within a range of two-tenths of a second to one second using the Connectrix switch Product Manager.

error message An indication that an error has been detected. *See also* "information message" *and* "warning message."

Ethernet A baseband LAN that allows multiple station access to the transmission medium at will without prior coordination and which avoids or resolves contention.

event log A record of significant events that have occurred on a Connectrix switch, such as FRU failures, degraded operation, and port problems.

expansionport *See* "E_Port."

explicit fabric login In order to join a fabric, an Nport must login to the fabric (an operation referred to as an FLOGI). Typically this is an explicit operation performed by the Nport communicating with the F_port of the switch, and is called an explicit fabric login. Some legacy Fibre Channel ports do not perform explicit login, and switch vendors perform login for ports creating an implicit login. Typically logins are explicit.

F

FA Fibre Adapter, another name for a Symmetrix Fibre Channel director.

F_Port Fabric Port, a port type on a Fibre Channel switch. An F_Port attaches to an N_Port through a point-to-point full-duplex link connection. A G_Port automatically becomes an F_port or an E-Port depending on the port initialization process.

fabric One or more switching devices that interconnect Fibre Channel N_Ports, and route Fibre Channel frames based on destination IDs in the frame headers. A fabric provides discovery, path provisioning, and state change management services for a Fibre Channel environment.

fabric element Any active switch or director in the fabric.

fabric login Process used by N_Ports to establish their operating parameters including class of service, speed, and buffer-to-buffer credit value.

fabric port A port type (F_Port) on a Fibre Channel switch that attaches to an N_Port through a point-to-point full-duplex link connection. An N_Port is typically a host (HBA) or a storage device like Symmetrix or CLARiiON.

fabric shortest path first (FSPF) A routing algorithm implemented by Fibre Channel switches in a fabric. The algorithm seeks to minimize the number of hops traversed as a Fibre Channel frame travels from its source to its destination.

fabric tree A hierarchical list in Connectrix Manager of all fabrics currently known to the Connectrix service processor. The tree includes all members of the fabrics, listed by WWN or nickname.

failover The process of detecting a failure on an active Connectrix switch FRU and the automatic transition of functions to a backup FRU.

fan-in/fan-out Term used to describe the server:storage ratio, where a graphic representation of a 1:n (fan-in) or n:1 (fan-out) logical topology looks like a hand-held fan, with the wide end toward n. By convention fan-out refers to the number of server ports that share a single storage port. Fan-out consolidates a large number of server ports on a fewer number of storage ports. Fan-in refers to the number of storage ports that a single server port uses. Fan-in enlarges the storage capacity used by a server. A fan-in or fan-out rate is often referred to as just the

n part of the ratio; For example, a 16:1 fan-out is also called a fan-out rate of 16, in this case 16 server ports are sharing a single storage port.

FCP *See* "Fibre Channel Protocol."

FC-SW The Fibre Channel fabric standard. The standard is developed by the T11 organization whose documentation can be found at T11.org. EMC actively participates in T11. T11 is a committee within the InterNational Committee for Information Technology (INCITS).

fiber optics The branch of optical technology concerned with the transmission of radiant power through fibers made of transparent materials such as glass, fused silica, and plastic.

Either a single discrete fiber or a non spatially aligned fiber bundle can be used for each information channel. Such fibers are often called optical fibers to differentiate them from fibers used in non-communication applications.

fibre A general term used to cover all physical media types supported by the Fibre Channel specification, such as optical fiber, twisted pair, and coaxial cable.

Fibre Channel The general name of an integrated set of ANSI standards that define new protocols for flexible information transfer. Logically, Fibre Channel is a high-performance serial data channel.

Fibre Channel Protocol A standard Fibre Channel FC-4 level protocol used to run SCSI over Fibre Channel.

Fibre Channel switch modules The embedded switch modules in the back plane of the blade server. See "blade server" on page 261.

firmware The program code (embedded software) that resides and executes on a connectivity device, such as a Connectrix switch, a Symmetrix Fibre Channel director, or a host bus adapter (HBA).

F_Port Fabric Port, a physical interface within the fabric. An F_Port attaches to an N_Port through a point-to-point full-duplex link connection.

frame A set of fields making up a unit of transmission. Each field is made of bytes. The typical Fibre Channel frame consists of fields: Start-of-frame, header, data-field, CRC, end-of-frame. The maximum frame size is 2148 bytes.

frame header Control information placed before the data-field when encapsulating data for network transmission. The header provides the source and destination IDs of the frame.

FRU Field-replaceable unit, a hardware component that can be replaced as an entire unit. The Connectrix switch Product Manager can display status for the FRUs installed in the unit.

FSPF Fabric Shortest Path First, an algorithm used for routing traffic. This means that, between the source and destination, only the paths that have the least amount of physical hops will be used for frame delivery.

G

gateway address In TCP/IP, a device that connects two systems that use the same or different protocols.

gigabyte (GB) A unit of measure for storage size, loosely one billion (10^9) bytes. One gigabyte actually equals 1,073,741,824 bytes.

G_Port A port type on a Fibre Channel switch capable of acting either as an F_Port or an E_Port, depending on the port type at the other end of the link.

GUI Graphical user interface.

H

HBA *See* "host bus adapter."

hexadecimal Pertaining to a numbering system with base of 16; valid numbers use the digits 0 through 9 and characters A through F (which represent the numbers 10 through 15).

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 A hop refers to the number of InterSwitch Links (ISLs) a Fibre Channel frame must traverse to go from its source to its destination.

Good design practice encourages three hops or less to minimize congestion and performance management complexities.

host bus adapter A bus card in a host system that allows the host system to connect to the storage system. Typically the HBA communicates with the host over a PCI or PCI Express bus and has a single Fibre Channel link to the fabric. The HBA contains an embedded microprocessor with on board firmware, one or more ASICs, and a Small Form Factor Pluggable module (SFP) to connect to the Fibre Channel link.

I

I/O *See* "input/output."

in-band management Transmission of monitoring and control functions over the Fibre Channel interface. You can also perform these functions out-of-band typically by use of the ethernet to manage Fibre Channel devices.

information message A message telling a user that a function is performing normally or has completed normally. User acknowledgement might or might not be required, depending on the message. *See also* "error message" *and* "warning message."

input/output (1) Pertaining to a device whose parts can perform an input process and an output process at the same time. (2) Pertaining to a functional unit or channel involved in an input process, output process, or both (concurrently or not), and to the data involved in such a process. (3) Pertaining to input, output, or both.

interface (1) A shared boundary between two functional units, defined by functional characteristics, signal characteristics, or other characteristics as appropriate. The concept includes the specification of the connection of two devices having different functions. (2) Hardware, software, or both, that links systems, programs, or devices.

Internet Protocol *See* "IP."

interoperability The ability to communicate, execute programs, or transfer data between various functional units over a network. Also refers to a Fibre Channel fabric that contains switches from more than one vendor.

interswitch link (ISL) Interswitch link, a physical E_Port connection between any two switches in a Fibre Channel fabric. An ISL forms a hop in a fabric.

IP Internet Protocol, the TCP/IP standard protocol that defines the datagram as the unit of information passed across an internet and provides the basis for connectionless, best-effort packet delivery service. IP includes the ICMP control and error message protocol as an integral part.

IP address A unique string of numbers that identifies a device on a network. The address consists of four groups (quadrants) of numbers delimited by periods. (This is called *dotted-decimal* notation.) All resources on the network must have an IP address. A valid IP address is in the form *nnn.nnn.nnn.nnn*, where each *nnn* is a decimal in the range 0 to 255.

ISL Interswitch link, a physical E_Port connection between any two switches in a Fibre Channel fabric.

K

kilobyte (K) A unit of measure for storage size, loosely one thousand bytes. One kilobyte actually equals 1,024 bytes.

L

laser A device that produces optical radiation using a population inversion to provide light amplification by stimulated emission of radiation and (generally) an optical resonant cavity to provide positive feedback. Laser radiation can be highly coherent temporally, spatially, or both.

LED Light-emitting diode.

link The physical connection between two devices on a switched fabric.

link incident A problem detected on a fiber-optic link; for example, loss of light, or invalid sequences.

load balancing The ability to distribute traffic over all network ports that are the same distance from the destination address by assigning different paths to different messages. Increases effective network bandwidth. EMC PowerPath software provides load-balancing services for server IO.

logical volume A named unit of storage consisting of a logically contiguous set of disk sectors.

Logical Unit Number (LUN) A number, assigned to a storage volume, that (in combination with the storage device node's World Wide Port Name (WWPN)) represents a unique identifier for a logical volume on a storage area network.

M

MAC address Media Access Control address, the hardware address of a device connected to a shared network.

managed product A hardware product that can be managed using the Connectrix Product Manager. For example, a Connectrix switch is a managed product.

management session Exists when a user logs in to the Connectrix Management software and successfully connects to the product server. The user must specify the network address of the product server at login time.

media The disk surface on which data is stored.

media access control *See* "MAC address."

megabyte (MB) A unit of measure for storage size, loosely one million (10^6) bytes. One megabyte actually equals 1,048,576 bytes.

MIB Management Information Base, a related set of objects (variables) containing information about a managed device and accessed through SNMP from a network management station.

multicast Multicast is used when multiple copies of data are to be sent to designated, multiple, destinations.

multiswitch fabric Fibre Channel fabric created by linking more than one switch or director together to allow communication. *See also* "ISL."

multiswitch linking Port-to-port connections between two switches.

N

name server (dNS) A service known as the distributed Name Server provided by a Fibre Channel fabric that provides device discovery, path provisioning, and

state change notification services to the N_Ports in the fabric. The service is implemented in a distributed fashion, for example, each switch in a fabric participates in providing the service. The service is addressed by the N_Ports through a Well Known Address.

network address A name or address that identifies a managed product, such as a Connectrix switch, or a Connectrix service processor on a TCP/IP network. The network address can be either an IP address in dotted decimal notation, or a Domain Name Service (DNS) name as administered on a customer network. All DNS names have a host name component and (if fully qualified) a domain component, such as *host1.emc.com*. In this example, *host1* is the host name and *EMC.com* is the domain component.

nickname A user-defined name representing a specific WWxN, typically used in a Connectrix -M management environment. The analog in the Connectrix -B and MDS environments is alias.

node The point at which one or more functional units connect to the network.

N_Port Node Port, a Fibre Channel port implemented by an end device (node) that can attach to an F_Port or directly to another N_Port through a point-to-point link connection. HBAs and storage systems implement N_Ports that connect to the fabric.

NVRAM Nonvolatile random access memory.

O

offline sequence (OLS) The OLS Primitive Sequence is transmitted to indicate that the FC_Port transmitting the Sequence is:

a. initiating the Link Initialization Protocol

b. receiving and recognizing NOS

c. or entering the offline state

OLS *See* "offline sequence (OLS)".

operating mode Regulates what other types of switches can share a multiswitch fabric with the switch under consideration.

operating system Software that controls the execution of programs and that may provide such services as resource allocation, scheduling, input/output control, and data management. Although operating systems are predominantly software, partial hardware implementations are possible.

optical cable A fiber, multiple fibers, or a fiber bundle in a structure built to meet optical, mechanical, and environmental specifications.

OS *See* "operating system."

out-of-band management Transmission of monitoring/control functions outside of the Fibre Channel interface, typically over ethernet.

oversubscription The ratio of bandwidth required to bandwidth available. When all ports, associated pair-wise, in any random fashion, cannot sustain full duplex at full line-rate, the switch is oversubscribed.

P

parameter A characteristic element with a variable value that is given a constant value for a specified application. Also, a user-specified value for an item in a menu; a value that the system provides when a menu is interpreted; data passed between programs or procedures.

password (1) A value used in authentication or a value used to establish membership in a group having specific privileges. (2) A 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 nodes.

persistent binding Use of server-level access control configuration information to persistently bind a server device name to a specific Fibre Channel storage volume or logical unit number, through a specific HBA and storage port WWN. The address of a persistently bound device does not shift if a storage target fails to recover during a power cycle. This function is the responsibility of the HBA device driver.

port (1) An access point for data entry or exit. (2) A receptacle on a device to which a cable for another device is attached.

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

port name A symbolic name that the user defines for a particular port through the Product Manager.

preferred domain ID An ID configured by the fabric administrator. During the fabric build process a switch requests permission from the principal switch to use its preferred domain ID. The principal switch can deny this request by providing an alternate domain ID only if there is a conflict for the requested Domain ID. Typically a principal switch grants the non-principal switch its requested Preferred Domain ID.

principal switch In a multiswitch fabric, the switch that allocates domain IDs to itself and to all other switches in the 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.

principle downstream ISL The ISL to which each switch will forward frames originating from the principal switch.

principle ISL The principal ISL is the ISL that frames destined to, or coming from, the principal switch in the fabric will use. An example is an RDI frame.

principle upstream ISL The ISL to which each switch will forward frames destined for the principal switch. The principal switch does not have any upstream ISLs.

product (1) Connectivity Product, a generic name for a switch, director, or any other Fibre Channel product. (2) Managed Product, a generic hardware product that can be managed by the Product Manager (a Connectrix switch is a managed product). Note distinction from the definition for "device."

Product Manager A software component of Connectrix Manager software such as a Connectrix switch product manager, that implements the management user interface for a specific product. When a product instance is opened from the Connectrix Manager software products view, the corresponding product manager is invoked. The product manager is also known as an Element Manager.

product name A user configurable identifier assigned to a Managed Product. Typically, this name is stored on the product itself. For a Connectrix switch, the Product Name can also be accessed by an SNMP Manager as the System Name. The Product Name should align with the host name component of a Network Address.

products view The top-level display in the Connectrix Management software user interface that displays icons of Managed Products.

protocol (1) A set of semantic and syntactic rules that determines the behavior of functional units in achieving communication. (2) A specification for the format and relative timing of information exchanged between communicating parties.

R

R_A_TOV *See* "resource allocation time out value."

remote access link The ability to communicate with a data processing facility through a remote data link.

remote notification The system can be programmed to notify remote sites of certain classes of events.

remote user workstation A workstation, such as a PC, using Connectrix Management software and Product Manager software that can access the Connectrix service processor over a LAN connection. A user at a remote workstation can perform all of the management and monitoring tasks available to a local user on the Connectrix service processor.

resource allocation time out value A value used to time-out operations that depend on a maximum time that an exchange can be delayed in a fabric and still be delivered. The resource allocation time-out value of (R_A_TOV) can be set within a range of two-tenths of a second to 120 seconds using the Connectrix switch product manager. The typical value is 10 seconds.

S

SAN *See* "storage area network (SAN)."

segmentation A non-connection between two switches. Numerous reasons exist for an operational ISL to segment, including interop mode incompatibility, zoning conflicts, and domain overlaps.

segmented E_Port E_Port that has ceased to function as an E_Port within a multiswitch fabric due to an incompatibility between the fabrics that it joins.

service processor *See* "Connectrix service processor."

session *See* "management session."

single attached host A host that only has a single connection to a set of devices.

small form factor pluggable (SFP) An optical module implementing a shortwave or long wave optical transceiver.

SMTP Simple Mail Transfer Protocol, a TCP/IP protocol that allows users to create, send, and receive text messages. SMTP protocols specify how messages are passed across a link from one system to another. They do not specify how the mail application accepts, presents or stores the mail.

SNMP Simple Network Management Protocol, a TCP/IP protocol that generally uses the User Datagram Protocol (UDP) to exchange messages between a management information base (MIB) and a management client residing on a network.

storage area network (SAN) A network linking servers or workstations to disk arrays, tape backup systems, and other devices, typically over Fibre Channel and consisting of multiple fabrics.

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. Subnet masking allows routers to move the packets more quickly. Typically, a subnet may represent all the machines at one geographic location, in one building, or on the same local area network.

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

T

TCP/IP Transmission Control Protocol/Internet Protocol. TCP/IP refers to the protocols that are used on the Internet and most computer networks. TCP refers to the Transport layer that provides flow control and connection services. IP refers to the Internet Protocol level where addressing and routing are implemented.

toggle To change the state of a feature/function that has only two states. For example, if a feature/function is *enabled*, toggling changes the state to *disabled*.

topology Logical and/or physical arrangement of switches on a network.

trap An asynchronous (unsolicited) notification of an event originating on an SNMP-managed device and directed to a centralized SNMP Network Management Station.

U

unblocked port Devices communicating with an unblocked port can log in to a Connectrix switch or a similar product and communicate with devices attached to any other unblocked port if the devices are in the same zone.

Unicast Unicast routing provides one or more optimal path(s) between any of two switches that make up the fabric. (This is used to send a single copy of the data to designated destinations.)

upper layer protocol (ULP) The protocol user of FC-4 including IPI, SCSI, IP, and SBCCS. In a device driver ULP typically refers to the operations that are managed by the class level of the driver, not the port level.

URL Uniform Resource Locater, the addressing system used by the World Wide Web. It describes the location of a file or server anywhere on the Internet.

V

virtual switch A Fibre Channel switch function that allows users to subdivide a physical switch into multiple virtual switches. Each virtual switch consists of a subset of ports on the physical switch, and has all the properties of a Fibre Channel switch. Multiple virtual switches can be connected through ISL to form a virtual fabric or VSAN.

virtual storage area network (VSAN) An allocation of switch ports that can span multiple physical switches, and forms a virtual fabric. A single physical switch can sometimes host more than one VSAN.

volume A general term referring to an addressable logically contiguous storage space providing block IO services.

VSAN Virtual Storage Area Network.

W

warning message An indication that a possible error has been detected. *See also* "error message" *and* "information message."

World Wide Name (WWN) A unique identifier, even on global networks. The WWN is a 64-bit number (XX:XX:XX:XX:XX:XX:XX:XX). The WWN contains an OUI which uniquely determines the equipment manufacturer. OUIs are administered by the Institute of Electronic and Electrical Engineers (IEEE). The Fibre Channel environment uses two types of WWNs; a World Wide Node Name (WWNN) and a World Wide Port Name (WWPN). Typically the WWPN is used for zoning (path provisioning function).

Z

zone An information object implemented by the distributed Nameserver (dNS) of a Fibre Channel switch. A zone contains a set of members which are permitted to discover and communicate with one another. The members can be identified by a WWPN or port ID. EMC recommends the use of WWPNs in zone management.

zone set An information object implemented by the distributed Nameserver (dNS) of a Fibre Channel switch. A Zone Set contains a set of Zones. A Zone Set is activated against a fabric, and only one Zone Set can be active in a fabric.

zonie A storage administrator who spends a large percentage of his workday zoning a Fibre Channel network and provisioning storage.

zoning Zoning allows an administrator to group several devices by function or by location. All devices connected to a connectivity product, such as a Connectrix switch, may be configured into one or more zones.