



HP BladeSystem c-Class SAN connectivity

technology brief, 3rd edition



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Abstract

Storage Area Network (SAN) connectivity with HP BladeSystem c-Class server blades is distinctly different from SAN connectivity with other HP ProLiant servers. This paper describes the hardware and software required to connect BladeSystem c-Class server blades to SANs¹ using Fibre Channel (FC) interconnect technology.

Introduction

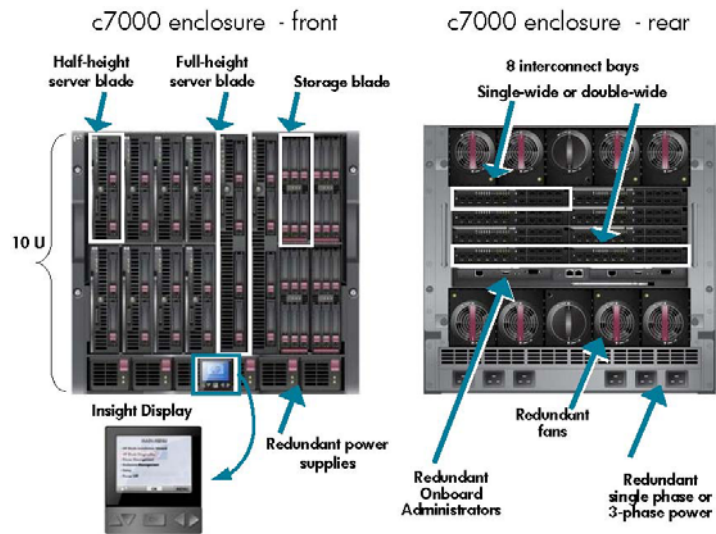
By centralizing data storage, Storage Area Networks (SANs) make it easier to manage stored data than in a Direct Attached Storage environment. SANs also support disaster recovery solutions that are easier to implement. HP BladeSystem c-Class architecture offers unique flexibility for connecting server blades to storage systems to provide high-performance, robust, and manageable SANs. Both HP BladeSystem c7000 and c3000 enclosures support SAN connectivity over Fibre Channel.

HP BladeSystem c-Class architecture

The HP BladeSystem c-Class architecture is modular and flexible enough to easily accommodate changing business needs. The BladeSystem c-Class architecture was first implemented in the HP BladeSystem c7000 Enclosure, a 10U-sized unit that can support half-height and full-height server blades, storage blades, and single-wide and double-wide interconnect modules (Figure 1). Front-loading server or storage blades and rear-loading interconnect modules slide into the enclosure and mate with a signal midplane that provides data connections, including those for optional interfaces.

The enclosure also houses power supplies and HP Active Cool Fans. An HP Insight Display on the front of the enclosure provides convenient local access to determine system status.

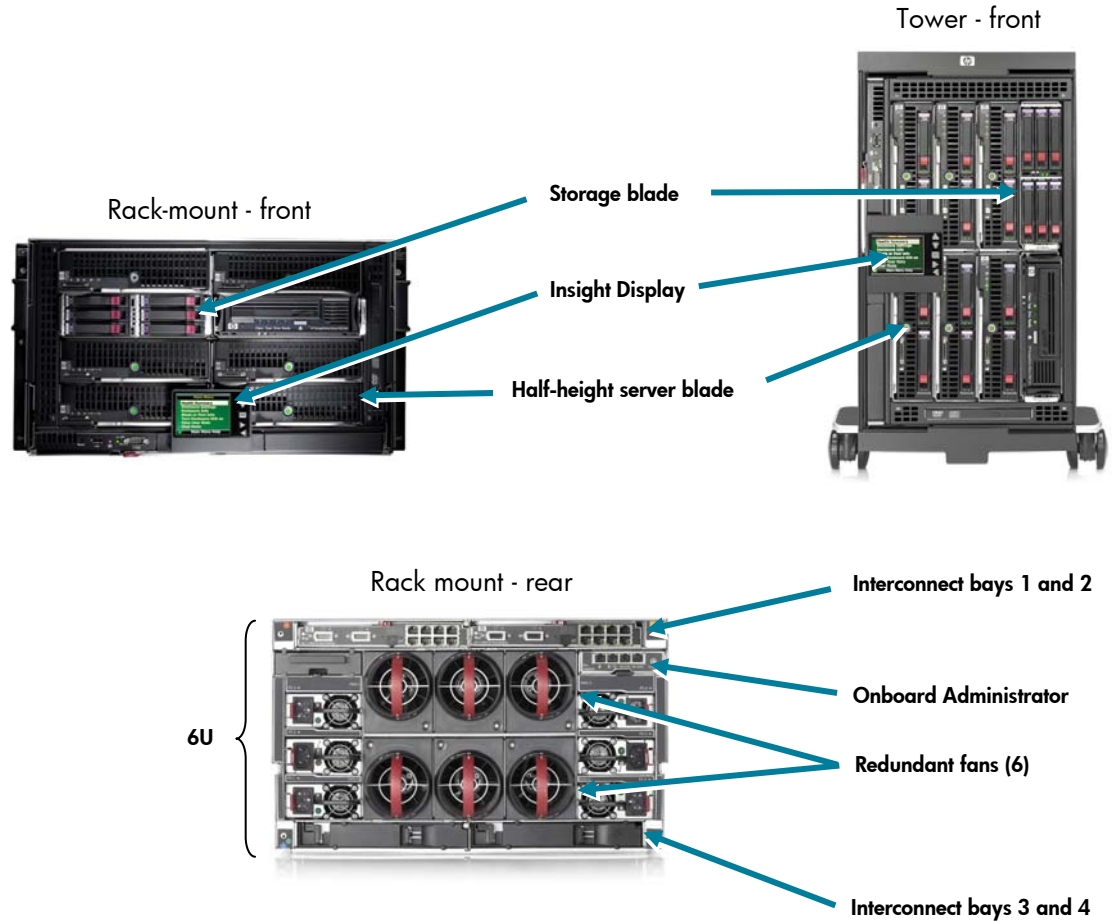
Figure 1. Architecture of the HP BladeSystem c7000 Enclosure



¹ For information about supported HP StorageWorks SAN configurations, refer to the "HP StorageWorks SAN design reference guide" at <http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00403562/c00403562.pdf>.

The HP BladeSystem c3000 enclosure (Figure 2) is similar in design and functionality to the c7000 enclosure but has a compact 6U chassis that can be installed in a rack or deployed as a stand-alone tower. The c3000 enclosure supports the same c-Class server blades and interconnects used in the c7000 enclosure.

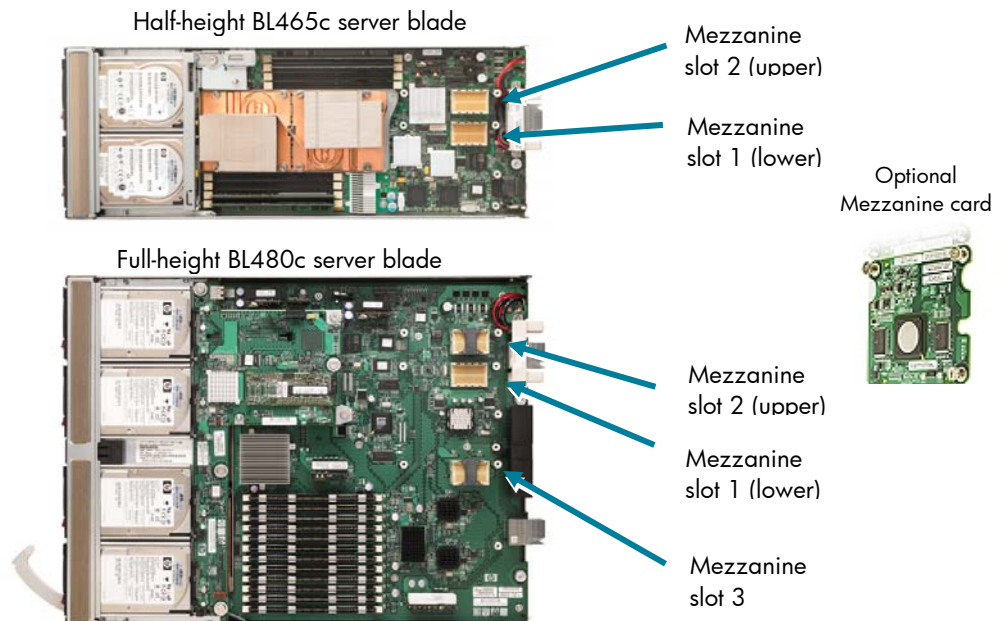
Figure 2. Architecture of the HP BladeSystem c3000 enclosure



c-Class server FC interconnect options

All c-Class server blades have expansion slots that accept optional mezzanine cards in support of several fabric options. Half-height server blades have two mezzanine slots; full-height blades have three slots (Figure 3).

Figure 3. BladeSystem c-Class server blades and mezzanine cards



FC Host Bus Adapters

The following FC Host Bus Adapter (HBA) mezzanine cards are available for c-Class server blades:

- Emulex LPe1205-HP 8Gb FC HBA mezzanine card for the HP c-Class BladeSystem
- Emulex LPe1105-HP 4Gb FC HBA mezzanine card for the HP c-Class BladeSystem
- QLogic QMH2562 8Gb FC HBA mezzanine card for the HP c-Class BladeSystem
- QLogic QMH2462 4Gb FC HBA mezzanine card for the HP c-Class BladeSystem

The Emulex cards provide dual-port, 8-Gb/s or 4-Gb/s FC connectivity and are driver-compatible with all Emulex HBAs. The Emulex card uses a firmware-based architecture that allows firmware upgrades without taking the server offline, rebooting, or upgrading the driver.

The QLogic cards provide dual-port, 8-Gb/s or 4-Gb/s FC connectivity along with intelligent networking features specific to enterprise class data centers. In addition, QLogic's unified driver model, whereby firmware is bundled with the driver, eliminates potential interoperability issues between the driver and firmware and reduces the number of software components that administrators must manage.

The Emulex and QLogic 4-Gb cards are compatible with all ProLiant c-Class and Integrity server blades. The Emulex and QLogic 8-Gb cards are compatible with ProLiant G6 server models but are not compatible with the Integrity servers. The 8-Gb FC HBA cards can also operate at 4-Gb, 2-Gb, and 1-Gb speeds. Software and drivers for Emulex and QLogic mezzanine cards are available at the following URL: <http://h18004.www1.hp.com/products/blades/components/c-class-sans.html>

c-Class FC SAN interconnect modules

The following FC options are available for connecting the c-Class FC HBAs to a SAN:

- HP Virtual Connect 8Gb 24-Port Fibre Channel Module for BladeSystem
- HP Virtual Connect 8Gb 20-Port Fibre Channel Module for BladeSystem
- HP Virtual Connect 4Gb Fibre Channel Module for BladeSystem
- HP 4Gb Fibre Channel Pass-Thru Module for the c-Class BladeSystem
- Brocade 8Gb SAN Switch for HP c-Class BladeSystem
- Brocade 4Gb SAN Switch for HP c-Class BladeSystem
- Cisco MDS 9124e Fabric Switch
- HP 4Gb FC Virtual Connect Pass-Thru Module for the c-Class BladeSystem

These single-wide, hot-pluggable modules can be installed into interconnect bays 3 through 8 of the HP BladeSystem c7000 enclosure and into bays 3 and 4 of the HP BladeSystem c3000 enclosure. Brocade, Cisco, and Pass-Thru modules can also be installed in bay 2 of the c3000 enclosure. The modules provide external ports that accept short wave or long wave 4- or 8-Gb small form-factor pluggable (SFP) optical transceivers. The SFPs can operate at 1, 2, 4, or 8 Gb/s as needed based on the SAN infrastructure. HP recommends installing the SAN interconnect modules in pairs to complement the high availability, dual-FC port capability of the HBA mezzanine cards.

Figure 4. ProLiant c-Class FC SAN interconnect modules



HP Virtual Connect Fibre Channel Modules for the c-Class BladeSystem

The HP Virtual Connect Fibre Channel Modules cleanly separate SAN and server management domains and simplify SAN installations. These modules appear to the SAN as an N_Port ID Virtualization (NVID) capable device. The modules are capable of aggregating connectivity from up to 255 physical or virtual server HBA ports to each interconnect module uplink port. The modules provide flexibility for server connectivity and certain switch-like benefits such as reduced cabling and shared, high-performance, auto-negotiating external SFP ports. The modules allow moving or replacing server blades efficiently without involving SAN administrators. Each module provides 16 internal ports for connections with server blade HBAs and four or eight external ports (depending on model) for connections to the SAN.

HP Virtual Connect Fibre Channel Modules provide the highest levels of availability and reliability by ensuring that server connectivity within each module is fault tolerant. The HP Virtual Connect Ethernet Module (required when HP Virtual Connect FC Modules are used) can manage server profiles and can be deployed anywhere within a Virtual Connect² domain.

The HP Virtual Connect Fibre Channel Modules are available in the following models:

- HP Virtual Connect 8Gb 24-Port Fibre Channel Module with eight 2-, 4-, and 8-Gb/s auto-negotiating uplink ports and sixteen 1-, 2-, 4-, and 8-Gb/s auto-negotiating downlink ports
- HP Virtual Connect 8Gb 20-Port Fibre Channel Module with four 2-, 4-, and 8-Gb/s auto-negotiating uplink ports and sixteen 1-, 2-, 4-, and 8-Gb/s auto-negotiating downlink ports
- HP Virtual Connect 4Gb Fibre Channel Module for the c-Class with four 1-, 2-, and 4-Gb/s auto-negotiating uplink ports and sixteen 1-, 2-, and 4-Gb/s auto-negotiating downlink ports

Brocade 8-Gb SAN Switch for the HP c-Class BladeSystem

The Brocade 8-Gb SAN Switch is a hot-pluggable module that provides 2-, 4-, or 8-Gb FC performance for an aggregate bandwidth of up to 384 Gbps [24 ports x 8 Gbps x 2 (full duplex)]. Available in 12- or 24-port configurations (12-port is upgradeable), the Brocade 8-Gb SAN Switch installs directly into HP c-Class enclosures. The Brocade 8-Gb SAN Switch includes WebTools software that allows IT administrators to easily monitor and manage the switch with a Java-capable Web browser running on a standard PC or laptop. The Brocade 8-Gb SAN Switch is provided with Brocade Access Gateway technology, a Brocade Fabric OS[®] feature that enables seamless connectivity to Brocade SAN fabrics and HP-supported SAN fabrics from other vendors for enhanced scalability and simplified manageability. The Brocade switch integrates with HP Onboard Administrator for BladeSystem, HP Systems Insight Manager, and HP Storage Essentials, and it can leverage HP B-series SAN Switch management tools. With an optional ISL Trunking license³, the external switch ports can be grouped into two 4-port trunks for increased bandwidth with other ISL-compatible switches.

The Brocade 8-Gb SAN Switch is available in the following configurations:

- The 12-port model supports any combination of internal-to-external ports with two short wave 8-Gb SFP+ transceivers included. The Dynamic Ports on Demand (DPOD) function of this model allows flexibility in switch port allocation without constraining server slot population. It includes hardware enforced zoning, Access Gateway technology, dynamic path selection, and web tools. It is upgradeable to 24-port support with a license key.
- The 24-port model provides connectivity for a full complement of servers (16) and 8 external ports with four short wave 8-Gb SFP+ transceivers. It includes hardware enforced zoning, Access Gateway technology, dynamic path selection, and web tools.
- The 24-port model with Power Pack configuration has the same functionality as the 24-port model above, but it also includes the Power Pack bundle and management tools for supporting ISL trunking, extended fabric operation, and advanced performance monitoring.⁴

² For more information about Virtual Connect technology, refer to the white paper "HP Virtual Connect Technology implementation for the HP BladeSystem c-Class," which is available at <http://h18004.www1.hp.com/products/servers/technology/whitepapers/index.html>.

³ ISL Trunking License is not supported with Brocade Access Gateway.

⁴ Brocade Access Gateway is available with this model but cannot be used with extended features and therefore is not recommended.

HP 4Gb Pass-Thru Module for the HP c-Class BladeSystem

The HP 4Gb Pass-Thru Module provides transparent, 1:1 port connectivity (16 internal/16 external) between HBA mezzanine ports and external SAN devices or switches. The module, which has 16 ports with short-wave 4-Gb SFP transceivers, provides a solution for connecting c-Class FC HBAs to a local SAN. It is suitable for installations where the SAN is in close proximity and the amount of cabling is not a major concern.

Cisco MDS 9124e Fabric Switch for HP c-Class BladeSystem

The Cisco MDS 9124e Fabric Switch installs directly into c-Class enclosures. Integrating the switch within the enclosure simplifies SAN network deployment by reducing the costs of cabling, SFP transceivers, and installation time. Cost is further reduced by sharing intelligent power and cooling resources provided by the enclosure. The Cisco 4-Gb SAN Switch includes Cisco Fabric Manager for integrated, comprehensive SAN management including fabric configuration, verification, and monitoring. Also included is a broad range of integration tools, including the Cisco MDS 9000 family Command Line Interface (CLI) and industry-standard third-party SNMP and SMI-S application programming interfaces (APIs). This switch is available in 12-port and 24-port models that include two and four short-wave 4-Gb SFP transceivers respectively. A 12-port upgrade license is available for the 12-port model. The Cisco switch provides the following additional capabilities:

- Traffic management – Simplified deployment with virtual output queuing and Fastest Shortest Path First (FSPF) technology optimizes the fabric performance.
- Virtual SAN (VSAN) support – Up to 16 VSANs per switch can be managed as independent fabrics for more efficiency and lower cost through shared use, and for increased security through isolation of devices on the same physical SAN.

Port mapping of server blade FC HBA mezzanine cards

The mapping of server blade communications ports is hard-wired into the signal midplane of c-Class enclosures. All c-Class server blades include two or four embedded network interface controllers (NICs) connected by the midplane to interconnect bays 1 and 2, which are dedicated for Ethernet modules. The fabric designation of interconnect bays 3 through 8 is dependent upon the optional mezzanine cards installed on the server blades.

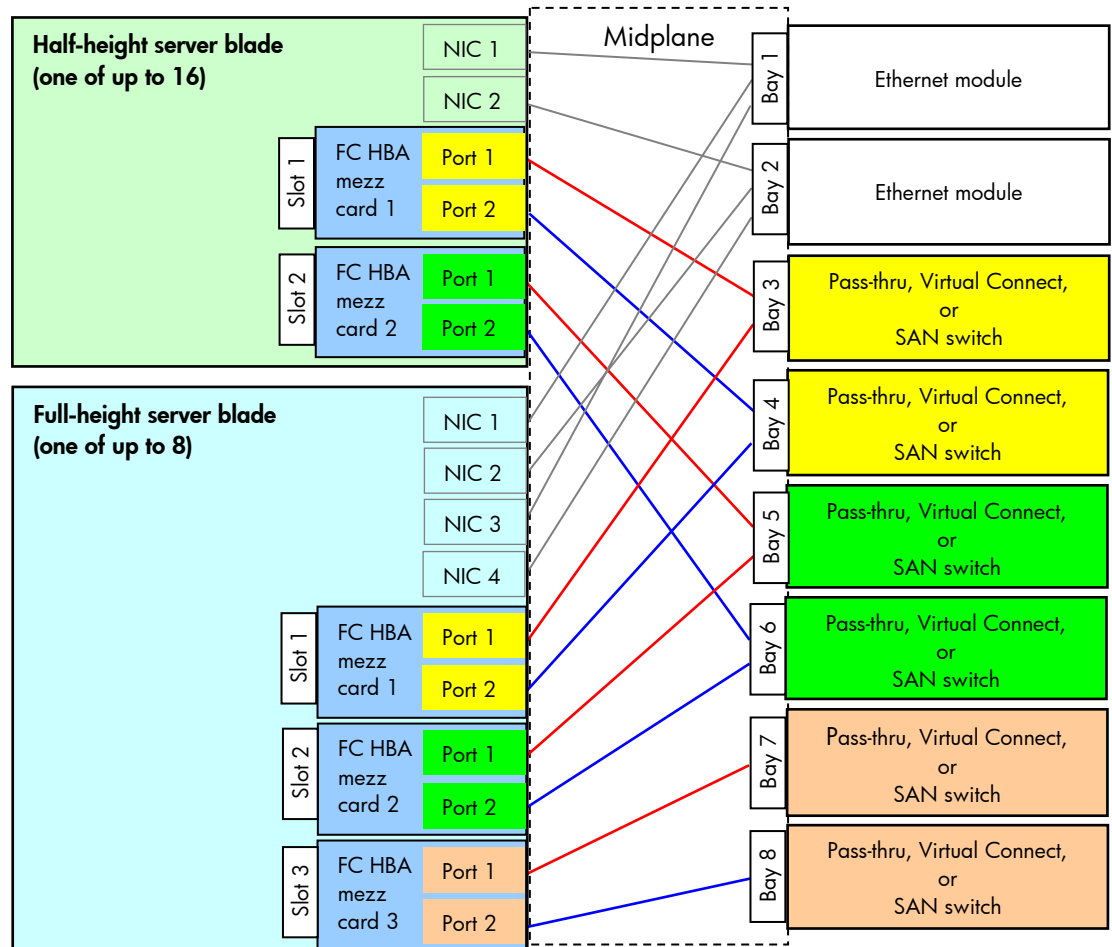
Figure 5 shows the mapping of FC options for the HP BladeSystem c7000 enclosure.

NOTE:

Mezzanine cards for c-Class server blades are defined as being 1x, 2x, or 4x port types, with *nx* referring to the number of interconnect lines per port provided by the controller. FC HBA mezzanine cards are 1x port type.

Figure 5 shows the mapping of the FC connectivity options for the c7000 enclosure. Figure 5 illustrates the maximum FC connection capability of the c7000 enclosure. In practice, server blades can support a mix of mezzanine cards of different interface types (FC, Ethernet, or InfiniBand) simultaneously within the enclosure. Having two or more FC HBA mezzanine cards on each server blade offers redundancy and enhanced throughput.

Figure 5. Mapping of server blade FC HBA ports (1x port connectivity) in the HP c7000 Enclosure

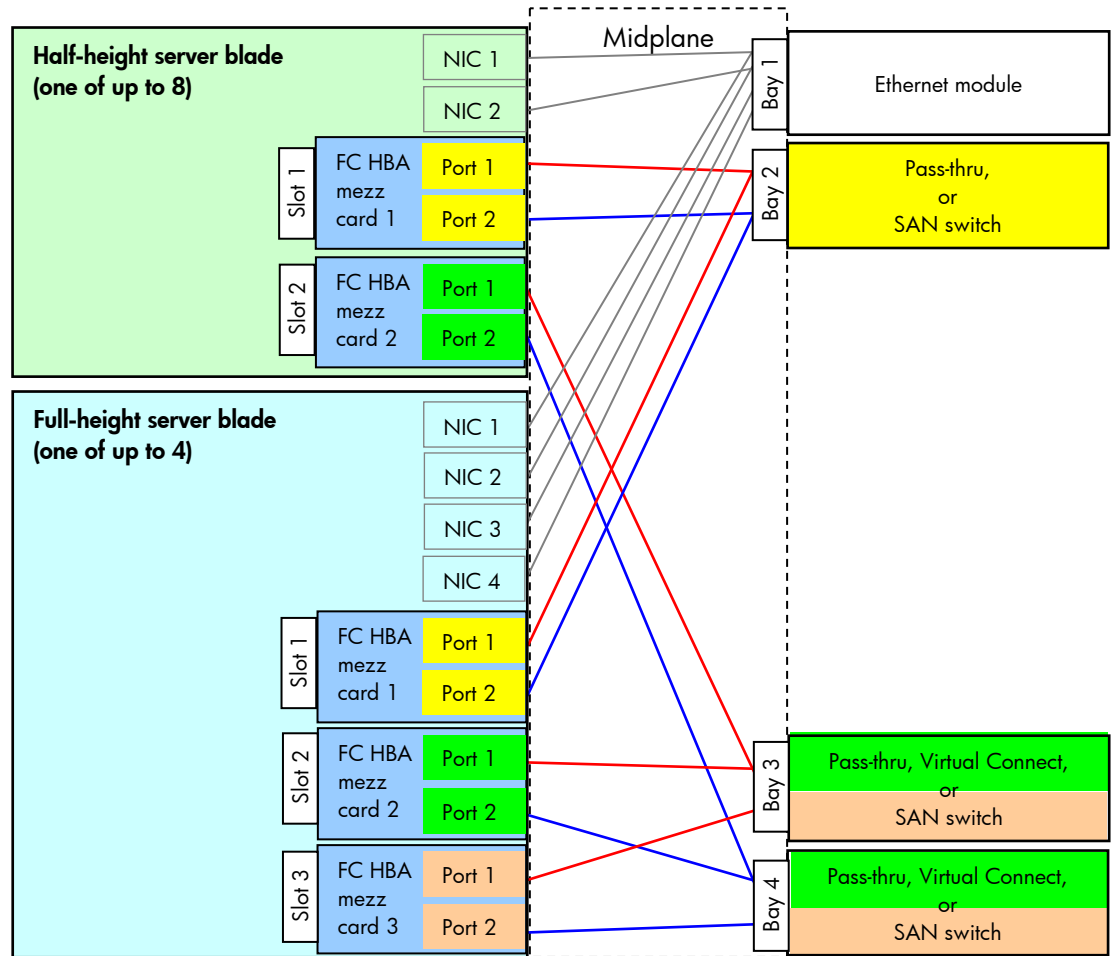


NOTE:

The mezzanine slot fabric designation of all blades in a given enclosure must be consistent. For example, the mezzanine card installed in slot 1 of each blade must be the same technology (FC, Ethernet, or InfiniBand) to work with the FC, Ethernet, or InfiniBand interconnect modules in interconnect bays 3 and 4. However, it is not mandatory that every server blade include a mezzanine card if a connection to a fabric is not required by a server. Technical information for c-Class enclosures is available at <http://h71028.www7.hp.com/enterprise/cache/316735-0-0-0-121.html>

Figure 6 illustrates the mapping of FC connectivity options for the c3000 enclosure. Figure 6 illustrates the maximum FC connection capability of the c3000 enclosure. In practice, server blades can support a mix of mezzanine cards of different interface types (FC, Ethernet, or InfiniBand) simultaneously within the enclosure. Having two or more FC HBA mezzanine cards on each server blade offers redundancy and enhanced throughput.

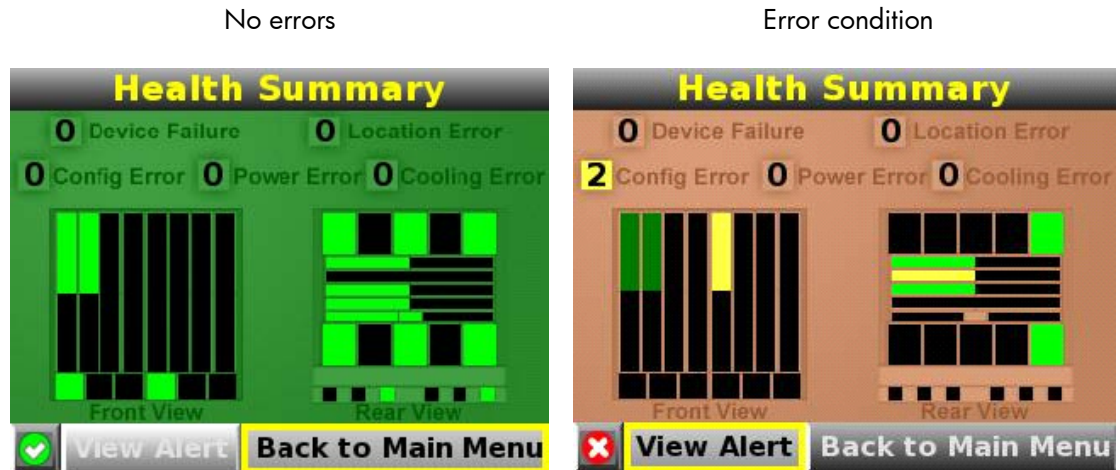
Figure 6. Mapping of server blade FC HBA ports (1x port connectivity) in the HP c3000 Enclosure



HP BladeSystem c-Class enclosures include an HP Onboard Administrator. The Onboard Administrator provides run-time management and configuration of all components in the enclosure. When the system is booted, the Onboard Administrator of the enclosure checks the configuration of server blades and interconnect modules for errors. The system status, including interconnect data, appears on the HP Insight Display at the front of the enclosure.

Figure 7 shows sample screen displays from the HP Insight Display of the c7000 enclosure. A display highlighted in green indicates no errors; a display highlighted in amber indicates that an error has been detected.

Figure 7. Onboard Administrator Health Summary screens for the HP BladeSystem c7000 Enclosure

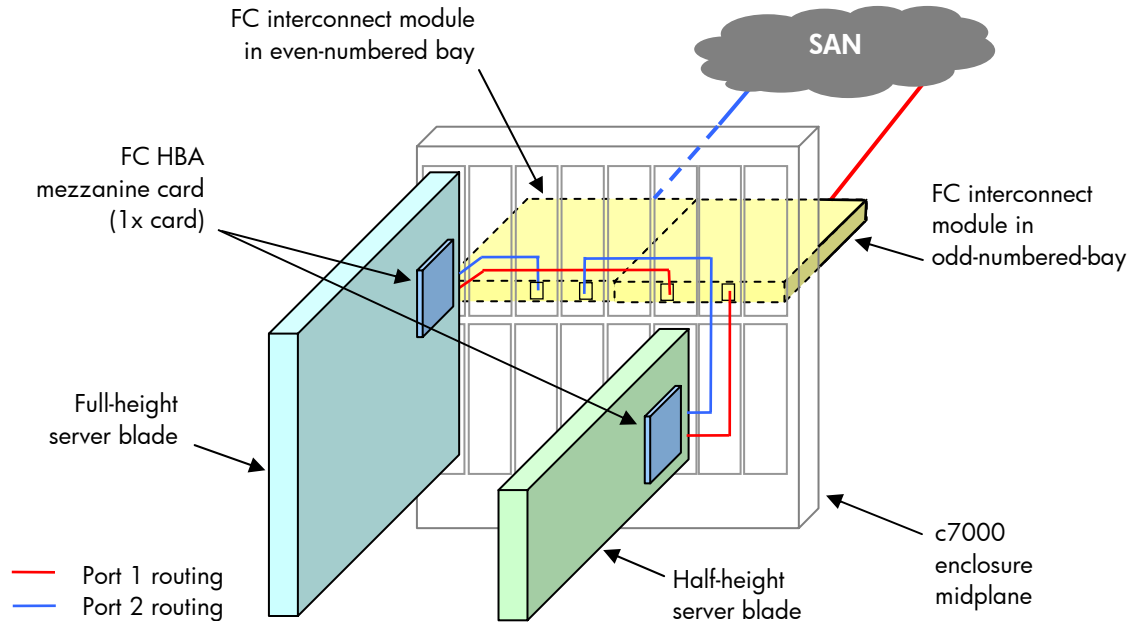


For more information, refer to the c-Class enclosure installation and user guides available at www.hp.com/servers/ blades.

FC SAN connectivity

Figure 8 shows FC port connectivity in the c7000 enclosure for full-height and half-height server blades connecting to a SAN through FC interconnect modules.

Figure 8. Server blade-to-SAN connectivity for the HP c7000 Enclosure, dimensional view



Each FC interconnect module (pass-thru, virtual connect, or switch) provides connections for up to 16 server blades. To ensure high availability, each FC HBA mezzanine card is dual-ported, and each port is routed to a separate interconnect bay. For example, as indicated in Figure 6 and in Table 1, the ports on an HBA mezzanine card in slot 1 are routed to bays 3 and 4. Interconnect modules must be installed in pairs if redundancy is required.

Table 1. c-Class server blade mezzanine slot-to-interconnect bay port routing for FC HBA (1x port type) mezzanine cards

Server blade mezzanine slot	C7000 Interconnect bay	C3000 Interconnect bay
Slot 1:		
Port 1	3	2
Port 2	4	2
Slot 2:		
Port 1	5	3
Port 2	6	4
Slot 3:		
Port 1	7	3
Port 2	8	4

The number of FC interconnect modules required for an HP BladeSystem c7000 Enclosure is determined by the number of FC ports per server blade (Table 2). HP recommends the use of redundant SANs. Redundancy for FC HBA mezzanine cards requires the following configurations:

- One or more server blades with a dual-port FC HBA card require two FC interconnect modules.
- One or more server blades with two dual-port FC HBA cards require four interconnect modules.
- One or more full-height server blades with three dual-port FC HBA cards require the maximum of six FC interconnect modules.

Table 2. FC SAN configurations for the HP BladeSystem c7000 Enclosure

Server blades	Total # of HBA ports	# of interconnect modules required	Server aggregate bandwidth
16 half-height blades, each with 1 dual-port FC HBA	32	2	256 Gb/s
16 half-height blades, each with 2 dual-port FC HBAs	64	4	512 Gb/s
8 full-height blades, each with 1 dual-port FC HBA	16	2	128 Gb/s
8 full-height blades, each with 2 dual-port FC HBAs	32	4	256 Gb/s
8 full-height blades, each with 3 dual-port FC HBAs	48	6	384 Gb/s
4 full-height blades, each with 3 dual-port FC HBAs and 8 half-height blades, each with 2 dual-port FC HBAs	56	6	448 Gb/s

Port redundancy strategies

The flexible HP BladeSystem c-Class architecture allows numerous configurations to achieve SAN availability and redundancy goals. Each FC HBA mezzanine card provides two FC ports. However, the infrastructure designer can choose to achieve redundancy by installing two mezzanine cards per server blade but using only one port per card.

For example, if both mezzanine slots 1 and 2 are populated with FC HBA mezzanine cards but only port 1 is enabled for each mezzanine card, interconnect modules installed in interconnect bays 3 and 5 will provide redundant server blade connectivity. In the event that an FC card, interconnect module, or associated external SFP transceiver or optical cable should fail, the server blade would retain connectivity through the alternate port path provided by the second HBA mezzanine card.

Selecting interconnect module types

The optimum type of interconnect module for use in a system will be determined by several factors such as SAN proximity, fabric size, number of server blades to be connected, and performance and availability goals. Pre-existing SAN attributes also affect the choice of interconnects.

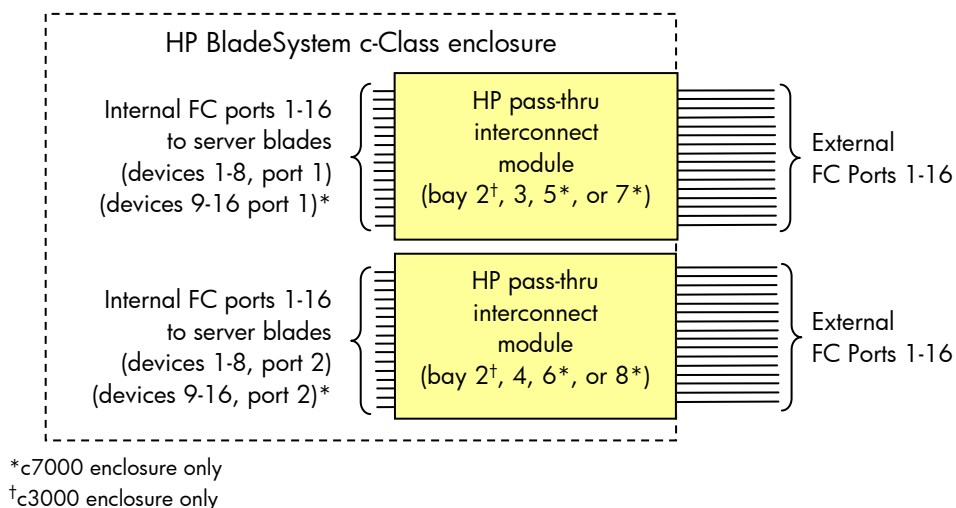
Connecting with pass-thru modules

The HP 4Gb FC Pass-Thru Module provides a solution for connecting server blades to a SAN when the customer does not want to deploy Fibre Channel switches in the BladeSystem enclosure. Such a choice may increase the number of SFPs and optical cables used. This solution may be desirable if only a small number of the server blades in the enclosure will ever require a SAN connection. Each pass-thru module provides dedicated paths between up to 16 server blades and an equal number of SAN switch ports or SAN target ports.

Note that the one-to-one nature of the pass-thru module means that connecting an external port directly to a SAN device will provide only one FC path for a server blade. A typical infrastructure would include an external switch that connects the pass-thru ports to the SAN device. For redundant paths between a server blade and a SAN device, two pass-thru modules and two external SAN switches are required.

There is a direct relationship between the server HBA ports and the external ports on the pass-thru module. No switching is provided by a pass-thru module. Each server HBA port has only one external port available on a pass-thru module.

Figure 9. Pass-thru connectivity for the HP BladeSystem c-Class enclosure



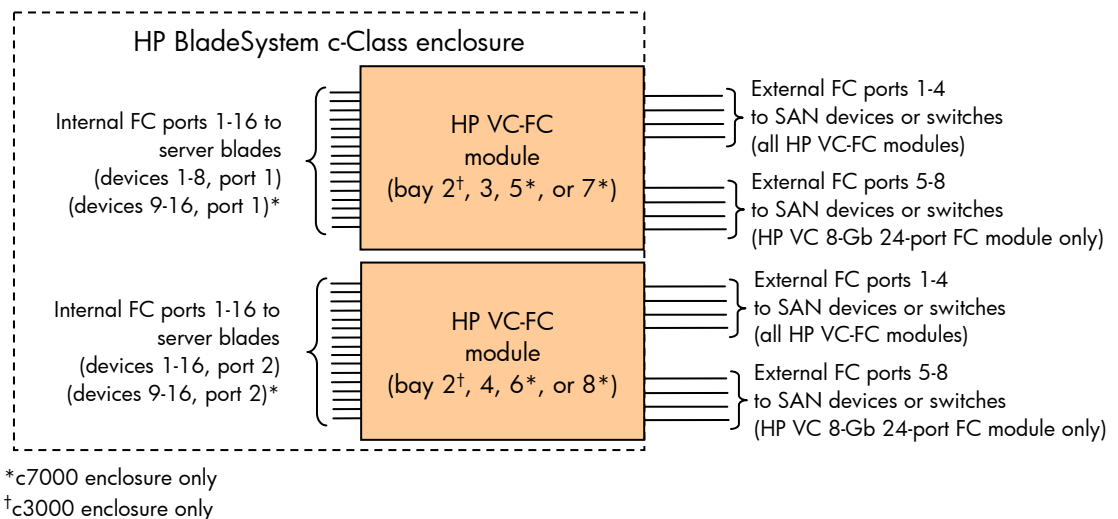
Note that mapping is direct between the device bays (server blades) and the external ports on each pass-thru module (HBA in server 1 to external FC port 1, HBA in server 2 to external FC port 2, etc.).

Connecting with HP Virtual Connect Fibre Channel modules

HP Virtual Connect Fibre Channel (VC-FC) modules provide the ability to quickly assign SAN storage to a server. Virtual Connect also provides the ability to quickly migrate server SAN storage assignments from one server to another for easy reallocation of servers and storage resources. In the event that a server needs to be taken offline, Virtual Connect allows another server to quickly assume the identity of the original server such that the assigned SAN Storage is accessible by the replacement server.

HP VC-FC modules provide high-speed switching for connecting up to 16 servers to four or eight external FC ports, significantly reducing cabling and SFP requirements (Figure 10) without restricting bandwidth. HP VC-FC modules provide switch-like performance *without* adding a switch to the domain. A SAN manager is able to see all the HBAs in the c-Class enclosure without having to manage an additional switch. A Virtual Connect Ethernet module that provides the shared management resources is required when using an HP VC-FC module. Each Server HBA port can see only one external port on one HP VC-FC Module. Two HP VC-FC Modules are required for redundant FC path support for server blades.

Figure 10. HP VC-FC Module connectivity for the HP BladeSystem c-Class enclosure



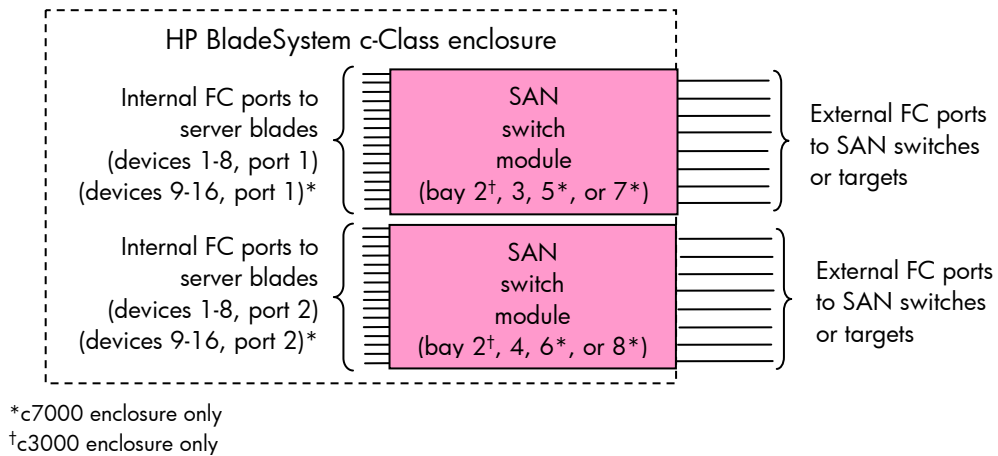
In the default configuration (before a Virtual Connect domain is created) all VC-FC module uplink ports are grouped together to form a single uplink port group. This allows for dynamic distribution of server blade connectivity, depending on the number of VC-FC module uplink ports connected to the Fabric SAN switches. The user may select other mappings as described in the [HP Virtual Connect Manager Command Line Interface Version 2.10 Users Guide](http://h18004.www1.hp.com/products/blades/components/c-class-tech-function.html) available at <http://h18004.www1.hp.com/products/blades/components/c-class-tech-function.html>.

Connecting with SAN switches

Embedded SAN switches provide all the features and high-speed switching of external switches. They also offer flexibility in connecting redundant paths from server blades to dual-path Fibre Channel SANs. Embedded Brocade and Cisco switches support a maximum of 16 internal ports to 8 external ports (Figure 11). The Access Gateway function of the Brocade 4-Gb SAN Switch enables the device to present its ports to the fabric as HBA ports. This allows for scalability and interoperability between supported fabrics. Customers can order either switch with 12 or 24 ports enabled. Modules with 12 ports enabled are upgradeable with a 12-port licensing option for a pay-as-you-grow strategy. Two switches are required for redundant path support. SAN Management controls the embedded SAN

switches and also manages SAN resource access and security. Each server HBA port can see any or all of the eight external FC ports on the SAN switch.

Figure 11. SAN switch connectivity for the HP BladeSystem c-Class enclosure



Interconnect bay loading summary

The previous examples illustrate interconnect modules being installed as pairs. Actual installations can involve a mixed configuration of FC modules. One interconnect bay can be populated with a pass-thru module while its associated redundant bay can have a SAN switch. The possible topography variations to meet availability and redundancy goals are too numerous to describe in this document. The general rule is that the technologies of redundant bays must be the same. However, not all combinations are supported even when this rule is followed. Always consult product-specific information to determine supported configurations.

HP software for server deployment/SAN connectivity

The HP ProLiant Essentials Rapid Deployment Pack (RDP) simplifies the installation, configuration, and deployment of high volumes of server blades via a drag-and-drop, GUI-based console. For example, IT personnel can install operating systems, service packs, virus patches, and other software on servers using either scripting or imaging technology. HP RDP combines two powerful products: Altiris eXpress Deployment Solution and the ProLiant Integration Module. Rapid Deployment Pack – Windows Edition 3.10 or later and Rapid Deployment Pack – Linux Edition 1.10 or later provide enhanced SAN support. For more information, select the web link for the RDP Knowledge Base in the "[For more information](#)" section of this document.

HP Storage Essentials is an additional software tool for efficiently deploying HP BladeSystem server blades to a large existing SAN or to a new SAN. The software can be used to set up and manage the Brocade 4-Gb SAN Switch and the Cisco MDS 9124e Fabric Switch.

HP SAN Visibility and SAN Designer are free HP programs that can be used to discover, view, and provide an extensive report on an existing SAN configuration. These programs can assist in determining what is needed to add HP BladeSystem server blades to an existing SAN. Both programs are available for downloading at the URLs provided in the "[For more information](#)" section of this paper.

Conclusion

The interconnect design of HP BladeSystem c-Class enclosures offers close integration with SAN devices. Since HP BladeSystem c-Class architecture supports various interconnect methods, HP BladeSystem c-Class products provide the flexibility to meet a wide range of SAN connectivity goals.

For more information

For additional information related to the topics covered in this document, refer to the resources listed below.

Resource description	Web address
HP StorageWorks SAN Design Guide	http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00403562/c00403562.pdf
HP SAN Visibility Software Utility	http://h18004.www1.hp.com/storage/networking/sansolutions.html?jumpid=reg_R1002_USEN
HP SAN Designer Software Utility	http://h18004.www1.hp.com/storage/networking/sandesigner.html?jumpid=reg_R1002_USEN
Care Pack (for hardware and software information and for orderable part numbers)	http://www.hp.com/hps/carepack/servers/
Rapid Deployment Pack Knowledge Base	http://www.hp.com/servers/rdp/kb
HP BladeSystem c-Class technical documentation	http://h71028.www7.hp.com/enterprise/cache/316735-0-0-121.html
HP Virtual Connect for c-Class BladeSystem Setup and Installation Guide	http://bizsupport1.austin.hp.com/bc/docs/support/SupportManual/c01732252/c01732252.pdf
HP Virtual Connect for c-Class BladeSystem User Guide	http://bizsupport1.austin.hp.com/bc/docs/support/SupportManual/c00865618/c00865618.pdf

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