

SAN Extension

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With the advent of extension technologies specifically developed for the transport of data it is now possible to consolidate, simplify, manage and integrate storage in Fibre Channel SAN fabrics within the enterprise to further exploit networking investments and lower the cost to manage global storage.

A SAN extension is considered an Inter Switch Link (ISL) connection between two Fibre Channel switches over extended distances. Extended distances are considered to be greater than 500 meters for 1 Gbps Fibre Channel switch pairs, or through an IP network using pairs of Fibre Channel over IP (FCIP) products, or greater than 300 meters for 2 Gbps Fibre Channel switch pairs. Whether it's called SAN Extension or SAN Bridging, HP seamlessly integrates these new technologies into the benefits of today's Fibre Channel SAN.

This chapter describes the current HP supported technologies and products available for heterogeneous SAN Extension, and the current HP provided products for Continuous Access and DRM SAN Extension. For additional information on disaster recovery SAN extension and a complete list of all supported third party extension products, please read the section [SAN/Continuous Access EVA Integration](#) or [SAN/DRM Integration](#) in Chapter 4, and refer to the *HP StorageWorks Continuous Access And Data Replication Manager SAN Extensions* available at:

<http://h18000.www1.hp.com/products/storageworks/san/documentation.html>

This chapter covers the following major topics:

- [Why Extend the SAN?](#)
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- [IP Network Considerations](#)
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Why Extend the SAN?

The growing need for storage data that is permeating the business community, coupled with the available bandwidth afforded by IP networks or WDM, for example, are making SAN extension an increasingly attractive option to grow the storage network. With SAN extension, end users can connect to data centers at opposite ends of a campus, metropolitan, and wide-area environment. The challenge is to do so at full-wire speed, with the same reliability and availability as the storage traffic within each data center.

Supported SAN Extension Technologies

Currently, HP supports the following technologies for Fibre Channel ISL SAN extension.

- Fibre Channel Long Distance Technologies
 - Long Wave Transceivers
 - Wavelength Division Multiplexing (WDM)
- TCP/IP Data Protocol Technologies
 - Fibre Channel over Internet Protocol (FCIP) using the SR2122-2 IP Storage Router
 - FCIP using the Cisco MDS 4/8-Port IP Storage module
 - FCIP using the Cisco MDS 14/2-Port Multiprotocol Services module
 - FCIP using the B-Series MP Router
 - FCIP using the SAN Valley SL700/SL1000 IP-SAN Gateway

Note: For additional SAN Extension products supported for DRM or Continuous Access refer to the *HP StorageWorks Continuous Access And Data Replication Manager SAN Extensions* available at: <http://h18000.www1.hp.com/products/storageworks/san/documentation.html>

Supported SAN Bridging Technology

- iSCSI to Fibre Channel Bridging using the SR2122 iSCSI Storage Router
- iSCSI to Fibre Channel Bridging using the SR2122-2 IP Storage Router
- iSCSI to Fibre Channel Bridging using the Cisco MDS 4/8-Port IP Storage module
- iSCSI to Fibre Channel Bridging using the Cisco MDS 14/2-Port Multiprotocol Services module

Note: Not all technologies are supported by all HP Fibre Channel switch product lines. Please read each technology description for further details.

Fibre Channel Long Distance Technologies

Long Wave Transceivers

Fibre Channel switches use two types or styles of fiber-optic transceivers that come in both short wave and long wave varieties. The 1-Gbps transceivers use “SC” style connectors that are known as Giga-Bit Interface Converters, or GBICs. The 2 Gbps transceivers use the “LC” style connectors that are known as Small Form Factor Pluggable transceivers, or SFPs. Long wave GBIC or SFP transceivers are required to go beyond the 500 meter limit for 1 Gbps and the 300 meter limit for 2 Gbps links respectively. There are long-wave optical transceivers that are capable of transmitting up to 100 km.

Currently HP supports the following long wave transceivers

- 10 km GBIC
- 100 km GBIC
- 10 km SFP
- 35 km SFP
- 100 km CWDM SFP (Refer to “[Wavelength Division Multiplexing](#)” below.)

Long wave transceivers are supported on HP B-Series, HP C-Series, and HP M-Series product lines. B-Series Fibre Channel switch products currently support 10 km and 100 km GBICs (certain switch models), 10 km and 35 km SFPs, and 100 km Coarse Wave Division Multi-plexing (CWDM) SFPs. The B-Series MP Router supports 10 km SFPs. C-Series Fibre Channel switch products currently support 10 km SFPs and 100 km CWDM SFPs. M-Series Fibre Channel switch products currently support 10 km and 35 km SFPs. M-Series Fibre Channel switch products are not supported with the 100 km CWDM SFPs.

Wavelength Division Multiplexing

Wavelength Division Multiplexing devices can be used to extend the distance between two Fibre Channel switches. These devices are transparent to the switches themselves and do not count as an additional hop. The only consideration that should be made to accommodate these devices is to have enough buffer-to-buffer credits in order to maintain line speed performance. Wavelength Division Multiplexing is supported for both 1 Gbps and 2 Gbps. This technology is ideally suited for metro data center deployments. When designing SAN extension across an optical ring, buffer-to-buffer credits becomes a very important consideration. In many WDM ring designs, the recovery path due to a link failure can be significantly longer distance than the primary path due to routing the traffic in the opposite direction around the ring. It is important to consider the distance over primary and recovery paths to ensure enough buffer-to-buffer credits exist for both so as not to impede performance during a ring fault event.

HP offers a CWDM technology solution which involves similar concepts as Dense Wave Division Multiplexing (DWDM) but is less expensive, less expandable (8 channels max) and works over a distance of 100 km. CWDM allows up to eight 1 Gbps or 2 Gbps channels (or colors) to share a single fiber pair. Each channel uses a different color or wavelength transceiver. These channels are networked with a variety of wavelength specific add-drop multiplexers to enable an assortment of ring or point-to-point topologies. A typical CWDM SFP can reach up to 100 km and in some cases, up to 200 km, in a point-point topology or around 40 km in a ring topology.

Refer to the individual switch product line WDM sections in this chapter for additional information about WDM support.

Note: HP supports the use of all WDM products as Fibre Channel ISLs provided the WDM equipment is configurable to 1 Gbps or 2 Gbps data rates, and does not implement time division multiplexing or any additional conversion method that alter the data links other than multiplexing different wavelengths.

The HP CWDM solution consists of the following components:

- 2-slot chassis for optical Add/Drop Multiplexers (OADMs)
- CWDM OADMs
 - Dual single-channel OADMs
 - channel OADM (1470nm, 1510nm, 1550nm, 1590nm)
 - 8-channel multiplexer/demultiplexer (1470nm, 1490nm, 1510nm, 1530nm, 1550nm, 1570nm, 1590nm, 1610nm)
 - Single fiber 4-channel multi-plexer/demultiplexer
- CSDM SFPs (1470nm, 1490nm, 1510nm, 1530nm, 1550nm, 1570nm, 1590nm, 1610nm)

A typical CWDM installation will include (2) OADMs, matched pairs (same frequency) of CWDM SFPs, (4) or (8) single mode fiber optic cables, and a single long distance fiber optic cable. Refer to the C-Series CWDM product documentation for more information at:

<http://h18006.www1.hp.com/storage/saninfrastructure.html>

Maintaining Performance beyond 5 or 10 km

A primary consideration with extended fabrics is maintaining the performance of the Inter Switch Link - connection(s) between a pair of switches. The flow control mechanism for a Fibre Channel connection is buffer-to-buffer credits. The number of credits a port has is equal to the number of frames a port can transmit before getting an acknowledgement that the frame was received.

At the speed of light in a fiber-optic cable, it takes a full second for light to travel 200,000 km or 5 microseconds per km. If you calculate the time it takes a frame to travel 100 km and for the "RRDY" (buffer available - analogous to a frame acknowledgement) to travel back the same 100 km at 1 Gbps you need about 60 buffer-to-buffer credits to keep the link running at full speed. The rule-of thumb in Fibre Channel is that to sustain 1 Gbps of bandwidth for full 2148B frames approximately one buffer-to-buffer credit is required for every 2 km of distance between two interfaces on a link. For a 2 Gbps link, one buffer-to-buffer credit is required for every 1 km of distance between two interfaces on a link. For smaller frame sizes, the number of buffer-to-buffer credits that are required increases.

There are different limits on the extended link parameters as well as the maximum number allowed across all HP switch product lines. In addition, the commands to configure the buffer-to-buffer credits for each switch product line also vary. The following sections detail these limits and the procedures for configuring extended links for each of the HP switch product lines.

HP B-Series product line

Extended Fabric Limits using WDM

WDM is supported on both 1 Gbps and 2 Gbps switch models.

The maximum number of hops allowed in an B-Series product line Fabric is 7, with a maximum total distance of 160 km across the SAN between any two devices.

B-Series switches are supported with the HP CWDM solution up to a maximum segment distance of 100 km. The maximum supported distance for other vendor WDM equipment is based on the specific WDM product used. In all cases the maximum total distance or total of all segments combined is 160 km.

The B-Series Trunking feature is supported with WDM up to a distance of 5 km with no more than 30m difference between trunk ports.

Note: HP supports up to 200 km across a WDM link at 1 Gbps Fibre Channel with reduced performance levels. The performance levels attained are dependent on the number of buffers available in the particular switch models used and the specific application data transfer size. In configurations where the WDM link is 200 km, the total device to device distance (sum of all segments) must not exceed 203 km for 1 Gbps Fibre Channel. 2Gbps WDM links are supported up to 100 km only.

Extended Fabric Compatibility Support

HP has three series of switches in the B-Series product line as listed below; these switches can be divided into two classes based on the internal ASIC technology used in the switch. The two classes are switches limited to 1 Gbps and those that are 2 Gbps capable.

- StorageWorks 1 Gbps SAN switch series with version 2.x installed,
- StorageWorks 2 Gbps SAN switch series with version 3.x installed, or
- HP StorageWorks SAN Switch 2/32, Core Switch 2/64, and SAN Director 2/128 switches with version 4.x installed.

An extended fabric link (a link >5 km at 2 Gbps or >10 km at 1 Gbps) can only exist between two switches of the same technology, meaning a B-Series 1 Gbps only switch can only have an extended fabric link to another B-Series 1 Gbps only switch. Likewise a B-Series 2 Gbps capable switch can only have an extended fabric link to another B-Series 2 Gbps capable switch regardless of the link speed.

ISL connections up to 10 km are supported between 1Gbps only and 2Gbps capable switches at the "L0" portcfglongdistance setting only.

"portcfglongdistance" Settings

Extended Fabric optimizes the internal buffering algorithm for StorageWorks switches, which results in line speed performance of close to full Fibre Channel speed. The "portcfglongdistance" setting is used to configure the port with the appropriate amount of buffers based on the speed and distance of the extended link.

The possible settings are:

- L0: 1 Gbps links up to 10 km or 2 Gbps links up to 5 km
No Extended Fabric license required
- LE: 2 Gbps links between 5 and 10 km
No Extended Fabric license required
- L0.5: Extended links greater than 10 km but not more than 25 km.
Extended Fabric license required
- L1: Extended Links greater than 10 km but not more than 50 km
Extended Fabric license required

- L2: Extended Links greater than 50 km but not more than 100 km

Extended Fabric license required

These port settings modify the number of Buffer-To-Buffer credits a particular port is allocated and there are limited numbers of these credits available. Buffer-To-Buffer credits are allocated to a group of 4 ports or what is referred to as a “Quad”. A quad consists of ports 0 through 3, 4 through 7, 8 through 11, 12 through 15 and so on.

The following table lists the configuration limits for a “Quad”.

Table 50: Long Distance Port Matrix

| Fabric OS | Speed | Port A | Port B | Port C | Port D |
|---|--------|-----------------|-----------------|-----------------|-----------------|
| HP StorageWorks FOS versions: 2.x | 1 Gbps | L2 | E/L1 | LE/L0.5/Fx | Disabled |
| | 1 Gbps | L2 | L0.5 | L0.5/LE/Fx | Disabled |
| | 1 Gbps | L2 | L0.5 | LE/Fx | LE |
| | 1 Gbps | L2 | LE/Fx | LE/Fx | LE/Fx |
| | 1 Gbps | E/L1/L0.5/LE/Fx | E/L1/LE/L0.5/Fx | E/L1/LE/L0.5/Fx | E/L1/LE/L0.5/Fx |
| | 1 Gbps | LD | LD | LD | LD |
| HP StorageWorks FOS versions: 3.0, 3.0.1, 3.0.2, 4.0, 4.0.2 | 1 Gbps | L2 | E/L1 | Fx | Disabled |
| | 1 Gbps | L2 | Fx | Fx | Fx |
| | 1 Gbps | E/Fx/L1 | E/Fx/L1 | E/Fx/L1 | E/Fx/L1 |
| HP StorageWorks FOS versions: 3.0, 3.0.1, 3.0.2, 4.0, 4.0.2 | 2 Gbps | L2 | Disabled | Disabled | Disabled |
| | 2 Gbps | L1 | L1 | Disabled | Disabled |
| | 2 Gbps | L1 | E | E/LE/Fx | Disabled |
| | 2 Gbps | L1 | LE/Fx | LE/Fx | Fx |
| | 2 Gbps | E/LE/Fx | E/LE/Fx | E/LE/Fx | E/LE/Fx |
| HP StorageWorks FOS Version: 3.1, 4.1, and 4.2 | 1 Gbps | L2 | E/L1 | LE/L0.5/Fx | Disabled |
| | 1 Gbps | L2 | L0.5 | LE/L0.5/Fx | Disabled |
| | 1 Gbps | L2 | L0.5 | LE/Fx | LE |
| | 1 Gbps | L2 | LE/Fx | LE/Fx | LE/Fx |
| | 1 Gbps | E/L1/L0.5/LE/Fx | E/L1/L0.5/LE/Fx | E/L1/L0.5/LE/Fx | E/L1/L0.5/LE/Fx |
| | 1 Gbps | LD | LD | LD | LD |

Table 50: Long Distance Port Matrix (Continued)

| Fabric OS | Speed | Port A | Port B | Port C | Port D |
|--|--------|---------|--------------|----------|----------|
| HP StorageWorks FOS Version: 3.1, 4.1, and 4.2 | 2 Gbps | L2 | E | Fx | Disabled |
| | 2 Gbps | L2 | LE/Fx | LE/Fx | Disabled |
| | 2 Gbps | L2 | L0.5 | Disabled | Disabled |
| | 2 Gbps | L1 | L1 | Disabled | Disabled |
| | 2 Gbps | L1 | E | E/LE/Fx | Disabled |
| | 2 Gbps | L1 | LE/Fx | LE/Fx | Fx |
| | 2 Gbps | L1 | L0.5 | LE/Fx | Disabled |
| | 2 Gbps | L0.5 | L0.5 | L0.5 | Disabled |
| | 2 Gbps | L0.5 | E/L0.5/LE/Fx | E/LE/Fx | Disabled |
| | 2 Gbps | L0.5 | E/L0.5/LE/Fx | LE/Fx | LE/Fx |
| | 2 Gbps | L0.5 | E/LE/Fx | E/LE/Fx | LE/Fx |
| | 2 Gbps | E/LE/Fx | E/LE/Fx | E/LE/Fx | E/LE/Fx |
| | 2 Gbps | LD | LD | LD | LD |

Fx = Fabric port

L0, LE, L0.5, L1, L2 = Inter Switch Links

Fabric Long Distance Bit Setting

The Fabric Long Distance Bit needs to be set on all switches in the fabric when any pair of StorageWorks 1 Gbps SAN series switches has an extended link greater than 10 km (portcflongdistance = L0.5, L1, or L2). This bit sets fabric wide parameters so that all switches know how to use the legacy method to calculate the number of buffer-to-buffer credits.

Whenever a pair or pairs of StorageWorks 2 Gbps SAN series or an HP StorageWorks core switch 2/64 switches have a port configured for LE, L0.5, L1, or L2 then the Fabric Long Distance Bit must be off. In other words you cannot have an extended link of greater than 10 km between a pair of StorageWorks 1 Gbps SAN series switches and an extended link greater than 5 km between a pair of StorageWorks 2 Gbps SAN series or an HP StorageWorks core switch 2/64 switches in the same fabric.

You can have extended links of up to 10 km (portcflongdistance = L0) between a pair of StorageWorks 1 Gbps SAN series switches and any length extended link between a pairs of StorageWorks 2 Gbps SAN series or an HP StorageWorks core switch 2/64 switches in the same fabric. Likewise you can have an extended link over 10 km between StorageWorks 1 Gbps SAN series switches as long as there are no Inter Switch Link (ISL) connections greater than 5 km between a pairs of StorageWorks 2 Gbps SAN series or an HP StorageWorks core switch 2/64 switches in the same fabric.

HP C-Series Product Line

Extended Fabric Limits using WDM

WDM is supported on all C-Series switches at both 1 Gbps and 2 Gbps speeds.

The maximum number of hops allowed in C-Series product line fabric is 7, with a maximum total distance of 160 km across the SAN between any two devices.

C-Series switches are supported with the HP CWDM solution up to a maximum segment distance of 100 km. The maximum supported distance for other vendor WDM equipment is based on the specific WDM product used. In all cases the maximum total distance or total of all segments combined is 160 km.

Note: HP supports up to 200 km across a WDM link at 1 Gbps Fibre Channel with reduced performance levels. The performance levels attained are dependent on the number of buffers available in the particular switch models used and the specific application data transfer size. In configurations where the WDM link is 200 km, the total device to device distance (sum of all segments) must not exceed 203 km for 1 Gbps Fibre Channel or 201 km. 2Gbps WDM links are supported up to 100 km only.

Refer to the C-Series switch product documentation on the HP Storage web page for more information.

Extended Fabric Compatibility Support

All C-Series switches are compatible from a functionality perspective. The long distance Fibre Channel connection can be formed between any two C-Series Fibre Channel switch models. All C-Series products support up to 255 buffer-to-buffer credits for extended distance configurations.

In C-Series, each port on the 16-port line card supports 255 buffer-to-buffer credits that are available on a per-port basis for an ISL when using either a single link or a link aggregated via Port Channel. A Port Channel forms a logical ISL and can bundle up to 16 x 2Gbps links to form a single 32 Gbps link. All links within the Port Channel must be the same speed.

HP M-Series Product Line

Extended Fabric Limits using WDM

WDM is supported on both 1 Gbps and 2 Gbps switch models.

The maximum number of hops allowed in a M-Series product line Fabric is 3, with a maximum total distance of 160 km across the SAN between any two devices.

Note: HP supports up to 200 km across a WDM link at 1 Gbps Fibre Channel with reduced performance levels. The performance levels attained are dependent on the number of buffers available in the particular switch models used and the specific application data transfer size. In configurations where the WDM link is 200 km, the total device to device distance (sum of all segments) must not exceed 203 km for 1 Gbps Fibre Channel or 201 km. 2Gbps WDM links are supported up to 100 km only.

Note: The HP CWDM solution is not supported on M-Series switch products.

HP StorageWorks edge switch 2/24 Limits

The HP StorageWorks edge switch 2/24 has a fixed buffer-to-buffer credit setting and are limited in which ports can support links beyond the 500 meter limit for 1 Gbps and 300 meter limit for 2 Gbps links.

Ports 0 through 3 are capable of supporting distances up to 20 km at 1 Gbps and up to 10 km at 2 Gbps per second.

Ports 4 through 23 do not have enough buffer-to-buffer credits to support long wave SFP transceivers and are limited to the short wavelength SFP transceiver limits of 500 meters at 1 Gbps or 300 meters at 2 Gbps.

10-100km Port setting

In order to maintain line speed performance of close to full Fibre Channel speed for extended lines over 10 km it is necessary to configure the applicable ports for 10-100km setting. Using the High Availability Fabric Manager (HAFM) select the configure ports menu option and then click on the 10-100 km box for the applicable ports. This will increase the number of buffer-to-buffer credits from 16 to 60 for the selected port.

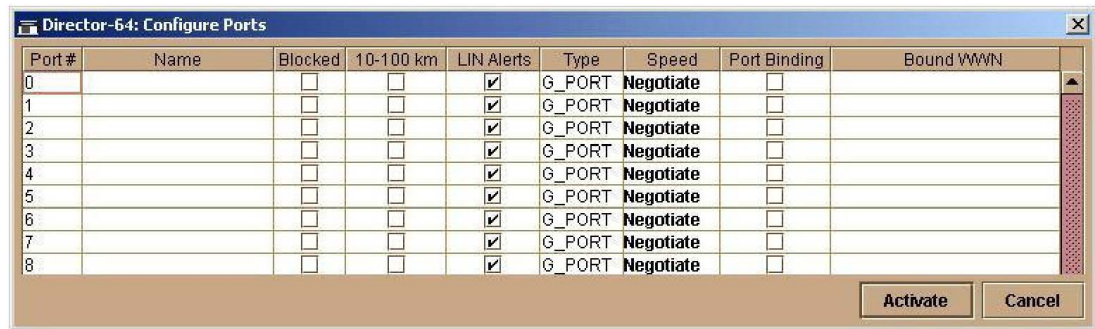


Figure 64: HAFM Configure Ports for 10-100 km setting

TCP/IP Data Protocol Technologies

Fibre Channel over Internet Protocol (FCIP)

FCIP is a protocol that encapsulates Fibre Channel frames into IP packets and tunnels them through an existing IP network infrastructure to transparently connect two or more SAN fabrics together. The IP tunnel acts as a dedicated link to transmit the Fibre Channel data stream over the IP network, while maintaining full compatibility with the Fibre Channel SAN.

FCIP Gateways perform Fibre Channel encapsulation process into IP Packets and reverse that process at the other end.

Fibre Channel switches (B-series and M-series) connect to the FCIP gateways through an E_Port for SAN fabric extension to remote locations. C-series switches use plug-in modules for FCIP functionality.

A tunnel connection is set up through the existing IP network routers and switches across LAN/WAN/MAN.

This example shows a configuration that connects Fibre Channel SANs using an Internet Protocol (IP) intersite link.

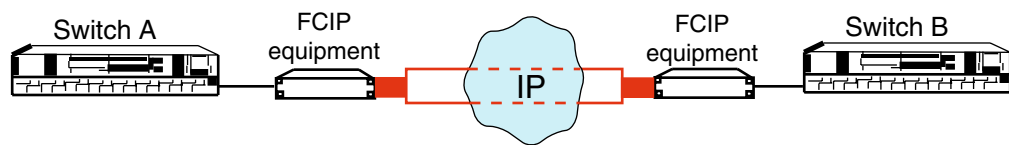


Figure 65: Connecting Fibre Channel SANs with an IP link

Using Internet Protocol over an IP-based network, FCIP can link sites over any extended distance. Local SANs are connected through an IP network to create an extended SAN. An FCIP gateway is used at each end of the intersite link. Each FCIP gateway box encapsulates received Fibre Channel frames into IP packets for transmission over the IP network. Similarly, the FCIP box extracts the original Fibre Channel frame from received IP packets and retransmits them to the destination Fibre Channel node. The FCIP boxes also handle IP-level error recovery.

FCIP Products supported for Heterogeneous SAN Extension

The HP StorageWorks SR2122-2 IP Storage Router provides heterogeneous SAN FCIP extension support on HP Series B-Series, C-Series, and M-Series Fibre Channel switches.

The HP StorageWorks MP Router provides heterogeneous SAN FCIP extension support on HP B-Series Fibre Channel switches.

The Cisco MDS 4/8-Port IP Storage Module and MDS 14/2-Port Multiprotocol Services Module are supported with C-Series product line switches.

The SAN Valley SL700/SL1000 IP-SAN Gateways are supported with B-Series and M-Series product line switch models for heterogeneous SAN FCIP extension. Please read the manufacturers documentation for further configuration details.

IP Network Considerations

Considerations Relevant to Using the Existing IP Network

The ability to use your existing network with FCIP depends on the type of storage I/O you plan to do and the traffic already existing on your current network. The key consideration is whether you have enough unused/available bandwidth from your network to continue the current network load, accommodate future growth, and handle FCIP SAN load demands.

Table 51: IP Network Issues to Consider

| Storage I/O Type | Use Existing IP Network? | Factors |
|---|---|--|
| Mirrored I/O or continuous I/O throughput over the FCIP intersite link. | A separate network is recommended. | For peak performance for your current network, and for peak Storage I/O performance a separate network is recommended. |
| Data Migration or Adhoc Data Updates | The use of your existing network may be possible. | <p>Data migration is a one-time movement of data for upgrade or maintenance purposes.</p> <p>Adhoc Data Updates is more of a 'burst' of data from one site to another for remote backups, database content delivery, etc.</p> <p>It is possible to use your existing network, however the network performance may be significantly affected.</p> |

Network Speeds

In general, the FCIP equipment supports Ethernet speeds of 10/100 Mb/s, and 1 Gbps (Gigabit Ethernet). The network connection should be selected to match the amount of data to be transferred.

The speed of light through fibre is approximately 200,000 km per second or 5 microseconds to travel one km.

Network Distance Considerations

The HSG80 controller uses SCSI protocol to manage the storage devices. Before a SCSI I/O can be transmitted, it must be encapsulated into Fibre Channel frames. Because of SCSI protocol, a minimum of 4 trips over the long-distance link is required.

These trips conceptually:

1. Tell the remote site you want to transmit data.
2. Wait for the acknowledgment from the remote site.
3. Send the data to the remote site.
4. Wait for the acknowledgment from the remote site.

When sending data over fiber, the one-way transmission time is approximately 5 microseconds per km of optical cable. Since a minimum of four trips is required for each SCSI data transfer, this translates to a total transmission delay per command of 20 microseconds per km, or about 32.2 microseconds per mile. For example, if a remote site is located 150 miles away from the local site, the total time will be 4,830 microseconds (4.83 milliseconds) for every data transfer. Since a typical I/O operation on a non-DRM configuration with write-back cache takes approximately 500 microseconds, long distances can have a significant effect on performance.

Note: The above calculations for a link of 150 miles do not include any latency induced by the FC-to-IP conversions, or latency of the routers and switches in the network.

Additional I/Os, either from additional LUNs on the same controller or from a different controller, will require additional bandwidth. Care must be taken to understand this principle. Adding bandwidth to a given link at a given distance will not increase the time it takes to complete an I/O operation. It will, however, allow you to add additional I/Os from different LUNs, thereby consuming the available bandwidth.

Conversely, if enough bandwidth is not given to a link, then the number of I/Os per second will decrease, possibly to the point of failure

Note: The time it takes an I/O to complete an operation is more complex than the above example, and there are additional factors involved with this calculation. This discussion is an attempt to help you understand the importance that distance latency has on the time it takes to complete an I/O operation.

Network Distance/Latency Example Calculations**1. 1.0 MB Link**

Link Bandwidth: 1.0 MB/s

Write size: 8 KB

Available bandwidth divided by size of I/O equals maximum I/Os per second:

$$\frac{1.0 \text{ MB/s}}{8 \text{ KB per I/O}} = 125 \text{ I/Os per second}$$

2. 50 Miles of Latency

Distance: 50 miles (80 km)

Latency: 8 μ s/mile (5 μ s/km)

Write size: 8 KB

Latency for 1 I/O per mile: 4 trips * 8 μ s/mile = 32 μ s per mileLatency for 1 I/O at 50 miles: 50 miles * 32 μ s/mile = 1.6 ms per I/O

Reciprocal of total latency indicates maximum I/Os:

$$\frac{1.0}{1.6 \text{ ms per I/O}} = 625 \text{ I/Os per second}$$

I/O's multiplied by size of I/O = bandwidth used:

$$625 \text{ I/O per second} * 8 \text{ KB per I/O} = 5 \text{ MB/s}$$

3. 150 Miles of Latency

Distance: 150 miles (241 km)

Latency: 8 μ s/mile (5 μ s/km)

Write size: 8 KB

Latency for 1 I/O per mile: 4 trips * 8 μ s/mile = 32 μ s per mileLatency for 1 I/O at 150 miles: 150 miles * 32 μ s/mile = 4.8 ms per I/O

Reciprocal of total latency indicates maximum I/Os:

$$\frac{1.0}{4.8 \text{ ms per I/O}} = 208 \text{ I/Os per second}$$

I/Os multiplied by size of I/O = bandwidth used:

$$208 \text{ I/O per second} * 8 \text{ KB per I/O} = 1.6 \text{ MB/s}$$

In summary, when an IP Network is used in a situation where the local and remote sites are located many miles apart, the speed of light through fiber may cause unacceptable delays in the completion of an I/O transaction. Increasing the amount of available bandwidth cannot solve this problem. Careful consideration must be given to these factors when matching your needs and wants to a particular application.

IP Network Best Practices

Currently most IP networks do not manage bandwidth to each individual connection. As traffic increases due to other demands on the network, bandwidth can be robbed from the FCIP Intersite Link. The following techniques can be used to minimize this effect:

- Create virtual private networks (VPNs) with Quality of Service (QoS) through premise routers for the FCIP circuit.
- Create separate physical networks.
- Guarantee the bandwidth using a third-party router/QoS vendor.

As mentioned, distance has a dramatic effect on the amount of work that can be done across a link. Therefore, site planning should include:

- Using the shortest possible distance between remote sites.
- Minimizing the amount data transferred over the FCIP link.
- Designing a plan to add additional storage I/O that will not impact normal data traffic.
- Consider additional controller pairs to effectively use available bandwidth.

Cisco MDS 4/8-Port IP Storage and MDS 14/2-Port Multiprotocol Services Modules

The Cisco MDS 4/8-Port IP Storage and MDS 14/2-Port Multiprotocol Services modules extend the reach of Fibre Channel SANs by using open-standard, IP-based technology. The switches connect separated SAN islands using Fibre Channel over IP (FCIP). They integrate seamlessly into the C-Series MDS 9000 Family, and support the full range of features available on other switching modules, including VSANs, security, and traffic management.

The MDS 4/8-Port IP Storage and MDS 14/2-Port Multiprotocol Services Modules can be used in the C-Series 9500 and 9200 families of switches and have 4, 8 and 2 Gigabit Ethernet ports respectively.

- FCIP-FCIP transports Fibre Channel frames transparently over an IP network between two C-Series MDS 9000 Family switches. Figure 66 depicts the FCIP scenarios in which the IPS module is used.
- Simplifies data protection and business continuance strategies by enabling backup, remote replication, and disaster recovery over WAN distances using open-standard FCIP tunneling.
- Improves utilization of WAN resources for backup and replication by tunneling up to 3 virtual Inter Switch Links (ISLs) on a single Gigabit Ethernet port.
- Reduces SAN complexity by eliminating the need to deploy and manage a separate remote connectivity platform.
- Preserves C-Series MDS9000 Family enhanced capabilities including VSANs, advanced traffic management, and security across remote connections.

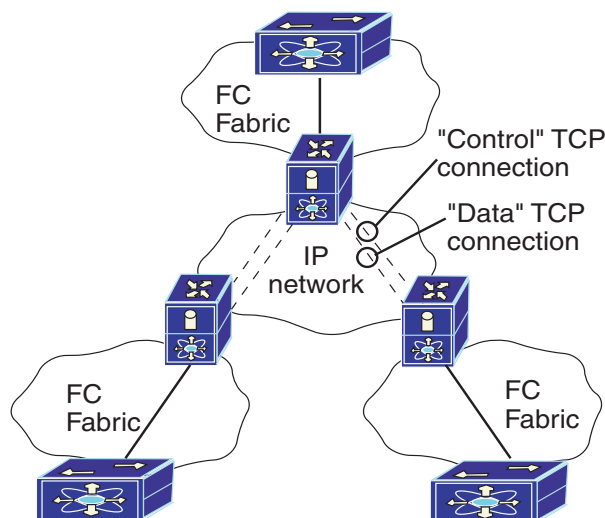


Figure 66: FCIP Scenarios

Table 52: Supported SFPs

| Optics | Media | Distance |
|----------------------|---------------------------|----------|
| 1-Gbps—SX, LC SFP | 50/125 micron multimode | 500 m |
| 1-Gbps—SX, LC SFP | 62.5/125 micron multimode | 200 m |
| 1-Gbps—LX/LH, LC SFP | 9/10 micron singlemode | 10 km |

Cisco MDS 4/8-Port IP Storage and MDS 14/2-Port Multiprotocol Services Module Documentation

Refer to:

http://www.cisco.com/en/US/products/hw/ps4159/ps4358/products_data_sheet09186a00800c465b.html
for more information related to the use of the MDS IP 4/8-Port Services Module.

Cisco MDS 4/8-Port IP Storage and MDS 14/2-Port Multiprotocol Services Module Hardware and Software Support

This section lists the hardware and operating systems that are supported with the Cisco MDS 4/8-Port IP Storage Module for iSCSI.

IP Network Support

Network Protocols: TCP/IP IPv4, Ethernet 10Mbps/100Mbps/1000Mbps

Operating System and Network Interface Controller (NIC) Hardware Support for iSCSI

- HP-UX 11i v1, 11i v2 - All NICs supported by HP for HP-UX
- IBM AIX 5.1. 5.2 – All NICs currently supported by IBM
- Microsoft Windows 2000 AS, Windows 2003 Enterprise Edition, Standard Edition, Windows 2003 Enterprise Edition 64-bit – All NICs supported by HP for Windows
- Red Hat AS/ES 2.1, SuSE SLES 8 – All NICs supported by HP for Linux
- Sun Solaris 8 and 9 – All NICs currently supported by Sun
- Netware 5.1 – All NICs supported by HP for Novell

Fibre Channel Switch Hardware Support for iSCSI and FCIP with the IP Services Module

- C-Series MDS 9216/9116A/9216i Multilayer Fabric Switches
- C-Series MDS 9506 Multilayer Director Switch
- C-Series MDS 9509 Multilayer Director Switch

Storage Array Hardware Support for iSCSI

This section lists the storage array support when using the MDS IP 4/8-Port and MDS 14/2 Multiprotocol Services Modules for iSCSI or when using the 9120 and 9140 with the SR2122-2 for iSCSI. Not all storage arrays are supported on all supported iSCSI operating systems. Contact an HP storage representative for specific support information. Direct connection of storage arrays to the MDS IP 4/8-Port and MDS 14/2 Multiprotocol Services Modules is not supported.

- MSA1000
- EVA3000/5000
- XP48/512, XP128/XP1024
- VA7110, VA7410
- EMA/ESA12000/MA/RA8000

Storage Array Hardware Support for FCIP

This section lists the storage array support when using the MDS 4/8-Port IP Storage Module for FCIP. Refer to Chapter 4, "[Heterogeneous SAN Platform and Storage System Rules](#)" for specific operating system support.

- Continuous Access Enterprise Virtual Array (EVA), VCS v3.0x
- Continuous Access XP48/1024
- Data Replication Manager for RA/MA8000, ESA/MSA12000, EMA16000, (HSG80)

C-Series iSCSI Configuration Rules

C-Series iSCSI limits

Table 53: C-Series iSCSI limits

| C-Series iSCSI limits | Maximum |
|---|---------|
| Maximum iSCSI host connections per port | 200 |
| Maximum active logical units (LUNs) per port | 200 |
| Maximum number of Initiator/Target (IT) Nexus per port | 200 |
| Maximum number active logical units (LUNs) per IT Nexus | 256 |
| Maximum number of IT Nexus/LUNs combinations per port | 1200 |

Here are some examples of maximum configurations for initiator/target Nexus:

1. 200 iSCSI Initiators each connecting to 1 Target (Storage Controller Port)
2. 100 iSCSI Initiators each connecting to 2 Targets
3. 50 iSCSI Initiators each connecting to 2 Targets and
100 iSCSI Initiators each connecting to 1 Target

Note: The maximum supported 200 TCP connections with 256 LUNs per connection yields 51,200 possible active LUNs. Simultaneous access to 51,200 LUNs via a single 100 Megabit Ethernet port will have poor performance characteristics. The speed of the port and the number of configured TCP connections and LUNs configured should reflect the bandwidth requirements for the sum of all simultaneous storage accesses to that port.

Operating System Rules

- Linux Clustering is not supported.
- HP Secure Path for MSA1000, RA/MA8000, EMA/ESA12000 and for Enterprise Virtual Array for Linux are not supported.
- HP Auto Path for VA/XP for Windows 2000 and Linux are not supported.
- HP Secure Manager on XP and VA is not supported.
- Windows MSCS and Windows Secure Path not supported with the Microsoft iSCSI Initiator.

HP StorageWorks MP Router

The B-Series HP StorageWorks MP Router offers FCIP SAN extension functionality and Fibre Channel routing capabilities. Individual ports on the MP Router can be configured as GigE ports for connectivity to an IP network for FCIP Tunneling services, or as Fibre Channel EX-Ports for connectivity to B-Series Fibre Channel fabrics for Fibre Channel Routing services. The two features can be combined to provide an FCIP configuration with very specific device connectivity without the need to fully merge the local and remote fabrics. This prevents unwanted access to all devices on both the local and remote fabrics.

HP StorageWorks MP Router Documentation

The following MP Router product specific documentation is available on the external web at:

<http://h18006.www1.hp.com/storage/saninfrastructure.html>

- hp StorageWorks Multi-protocol Router XPath OS Version 7.1.x Installation Guide
- hp StorageWorks XPath OS Version 7.1.x Advanced Web Tools User Guide
- hp StorageWorks XPath OS Version 7.1.x Command Reference Guide
- hp StorageWorks XPath OS Version 7.1.x Procedures User Guide
- hp StorageWorks XPath OS Version 7.1.x MIB Reference Guide
- hp StorageWorks XPath OS Version 7.1.x System Error Messages Reference Guide

HP StorageWorks MP Router - FCIP Overview

FCIP enables a tunnel connection between Fibre Channel switches through an IP network. If the two MP Routers are configured for FCIP only, the switches and associated fabrics connected through the FCIP tunnel merge into a single Fibre Channel fabric. Using FCIP in conjunction with the Fibre Channel routing feature, device access can be limited to those devices requiring access such as local and remote storage arrays and associated servers used with HP's disaster tolerant Continuous Access storage products. LSANs can be defined that contain only the devices requiring access, avoiding a full merge of fabrics and access to all devices. Refer to Chapter 2, [SAN Topologies](#) for information about Fibre Channel routing.

To deploy FCIP, two MP Routers are required, each acting as a local or remote router from the perspective of each respective fabric. Each MP Router is configured for FCIP and connected to the same IP network.

A Fibre Channel device in a local fabric needs no additional hardware or software to access other devices in the remote fabric via an MP Router deployed for FCIP, other than connectivity to an IP network.

With FCIP, peer systems transport Fibre Channel frames over an IP network. From the perspective of the SAN the storage devices accessed through the peer systems appear to be part of one unified SAN.

Once configured, FCIP instances, or connections, on each system become active and establish their connectivity via the IP network. The storage devices in one SAN access the storage devices in the connected SAN using Fibre Channel frames, which are encapsulated in IP packets by the FCIP instance, and transmitted to the peer system. The peer FCIP instance strips the IP packet data and passes only the Fibre Channel frames over the Fibre Channel interfaces to the storage devices. The peer systems are connected to each other through an IP network.

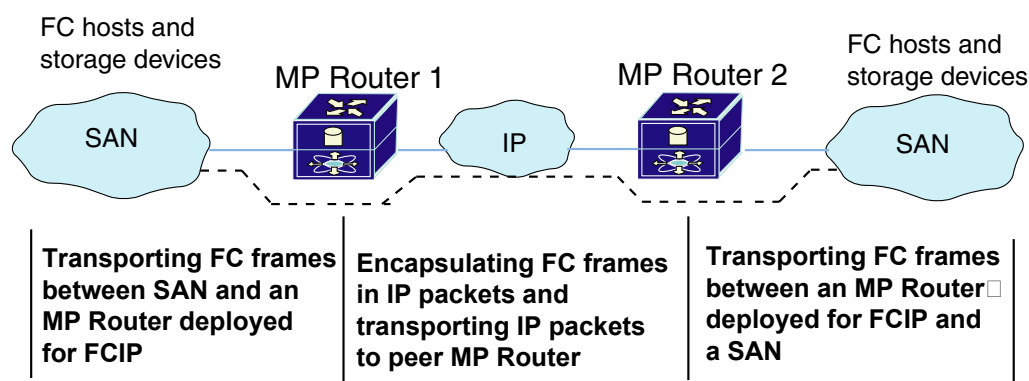


Figure 67: MP Routers connecting peer systems through an IP network

Note: All MP Router FCIP configurations require a minimum level of IP bandwidth for Continuous Access XP, Continuous Access EVA, and DRM replication. For specific IP bandwidth requirements, refer to the *CA/DRM SAN Extension reference guide* at:

<http://h200006.www2.hp.com/bc/docs/support/SupportManual/c00244034/c00244034.pdf>

In this example a FC host or FC device connects to one or more B-Series Fibre Channel switches within the SAN. The B-Series Fibre Channel switch or switches connect to the MP Router's Fibre Channel interface. Each MP Router connects to the IP network through one of its Gigabit Ethernet interfaces. Through the IP network each FCIP instance accesses its peer, thereby connecting the SANs.

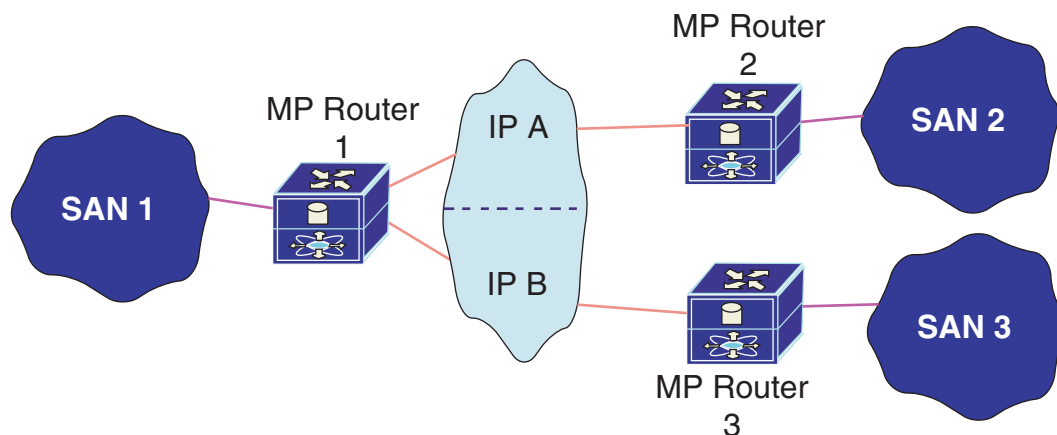


Figure 68: Sample configuration using two IP subnets

In this sample configuration, MP Router 1 must have one GigE connection into an IP Subnet for the IP A network and one GigE connection into a different IP subnet for the IP B network. In this example configuration, an FC host or FC device connected to SAN 1 could have access to devices located in SANs 2 and/or 3.

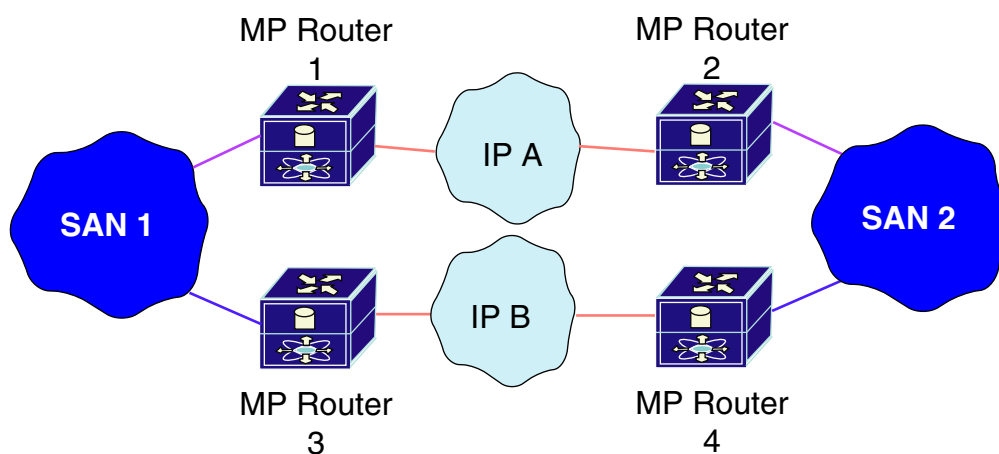


Figure 69: Fully redundant MP Routers with FCIP

This example shows a more reliable FCIP configuration, in which pairs of MP Routers provide full redundancy. In this configuration, loss of an MP Router or loss of connectivity through one of the IP networks can be tolerated with no loss of connectivity between the SANs.

Note: For multiple paths between SANs, multiple pairs of systems deployed for FCIP need to be connected to the Fibre Channel hosts or Fibre Channel devices. It is assumed that the multipath management is being done by an entity outside the MP Router (for example, by management applications on the Fibre Channel host or storage devices).

MP Router FCIP Hardware and Software Support

This section lists the hardware, devices, and operating systems that are compatible with the MP Router for FCIP.

Note: For more information on support, contact an HP storage representative.

Storage Array Hardware Support

This section lists the storage array support for FCIP when using the MP Router. Contact an HP storage representative for specific support information.

- Continuous Access for Enterprise Virtual Array
- Continuous Access for XP12000, XP128/1024, XP 48/512
- Data Replication Manager for RA/MA8000, ESA/MSA12000, EMA16000, (HSG80)

Fibre Channel Switch Hardware Support

The MP Router is supported with the HP B-Series product line switches listed in Chapter 3.

Operating System Support

The MP Router is supported for FCIP on the following operating systems, refer to the appropriate storage system type support documentation for specific version support:

- HP-UX
- OpenVMS
- Tru64
- IBM AIX
- Microsoft Windows
 - Windows 2000
 - Windows 2003
 - Windows NT 4.0
- NetWare
- Sun Solaris
- Redhat Linux
- United Linux

HP StorageWorks SR2122-2 IP Storage Router

The HP StorageWorks SR2122-2 IP Storage Router offers FCIP SAN extension functionality and iSCSI to Fibre Channel Bridge capability within a single chassis.

The HP StorageWorks SR2122-2 IP Storage Router can be configured to run either in Single-Mode (FCIP or iSCSI Routing only) or in Multi-mode (FCIP and iSCSI Routing concurrently).

IP SR2122 Storage Router Documentation

Further SAN configuration documentation, including:

- *HP StorageWorks IP Storage Router 2122-2 Command Line Interface Reference Guide*
- *HP StorageWorks IP Storage Router 2122-2 User Guide*
- *HP StorageWorks IP Storage Router 2122-2 Getting Started Guide*

is available via the HP website at:

HP StorageWorks SR2122-2 IP Storage Router - FCIP Overview

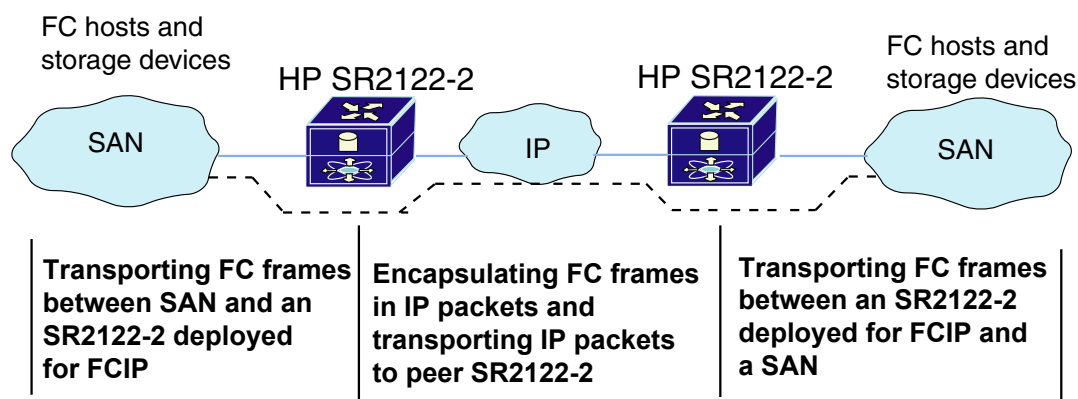
Fibre Channel over IP (FCIP) enables SR2122-2 Storage Routers to provide connectivity between Fibre Channel hosts and Fibre Channel storage devices over an IP network. To deploy FCIP, two SR2122-2 Storage Routers are required. Each system is configured for FCIP and connected to a SAN. A Fibre Channel host or Fibre Channel device needs no additional hardware or software to access storage devices via an SR2122-2 Storage Router deployed for FCIP.

Note: Refer to [Table 28](#) for a list of devices supported for FCIP heterogeneous SAN extension.

With FCIP, peer systems transport Fibre Channel frames over an IP network. From the perspective of the SANs the storage devices accessed through the peer systems appear to be part of one unified SAN.

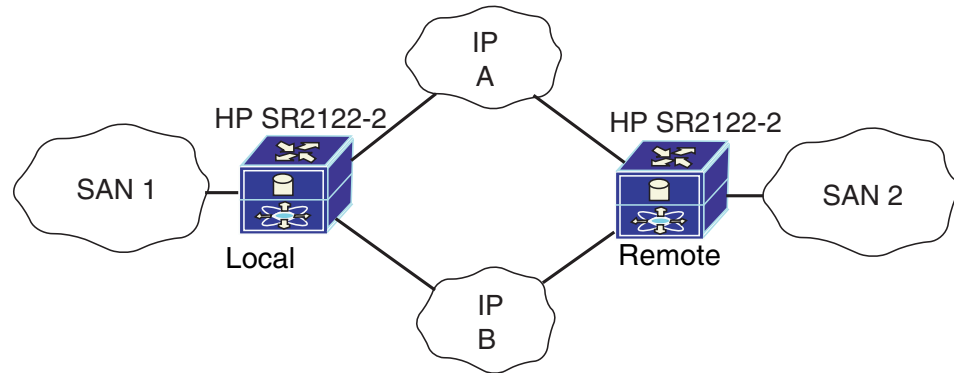
Once configured, FCIP instances, or connections, on each system become active and establish their connectivity via the IP network. The storage devices in one SAN access the storage devices in the connected SAN using Fibre Channel frames, which are encapsulated in IP packets by the FCIP instance, and transmitted to the peer system. The peer FCIP instance strips the IP packet data and passes only the Fibre Channel frames over the Fibre Channel interfaces to the storage devices.

The peer systems are connected to each other through an IP network.



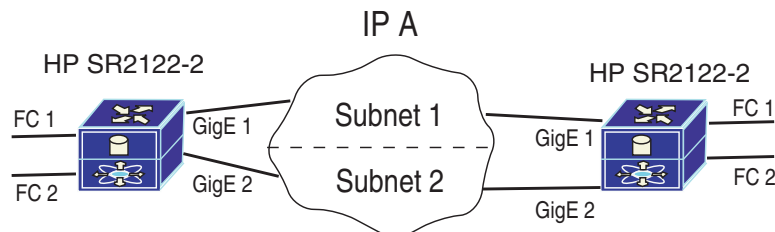
Note: SR2122-2 FCIP configurations require a minimum level of IP bandwidth. For specific IP bandwidth requirements, refer to the *CA/DRM SAN Extension reference guide* at: <http://h200006.www2.hp.com/bc/docs/support/SupportManual/c00244034/c00244034.pdf>

In this example a Fibre Channel host or Fibre Channel device connects to one or more Fibre Channel interfaces of each peer SR2122-2 Storage Router deployed for FCIP. Each SR2122-2 connects to the IP network through one of its Gigabit Ethernet interfaces. Through the IP network each FCIP instance accesses its peer, thereby connecting the SANs.



Note: In this sample configuration, only one side of each instance can be an SR2122-2 server. The opposite side must be an SR2122-2 client. (Use of the terms “server” and “client” in this context relates to the role of the SR2122-2 instance, not a physical server or client.)

In this example configuration, a Fibre Channel host or Fibre Channel device connects to one or more Fibre Channel interfaces of each peer SR2122-2 Storage Router deployed for FCIP, and each SR2122-2 connects to two separate IP networks through each of its Gigabit Ethernet interfaces. Through the IP network, each FCIP instance accesses the peer storage router deployed for FCIP, connecting the SANs. In this configuration, IP A and IP B are redundant paths, so that the loss of connectivity via either path does not cause a loss of connectivity between the SANs.

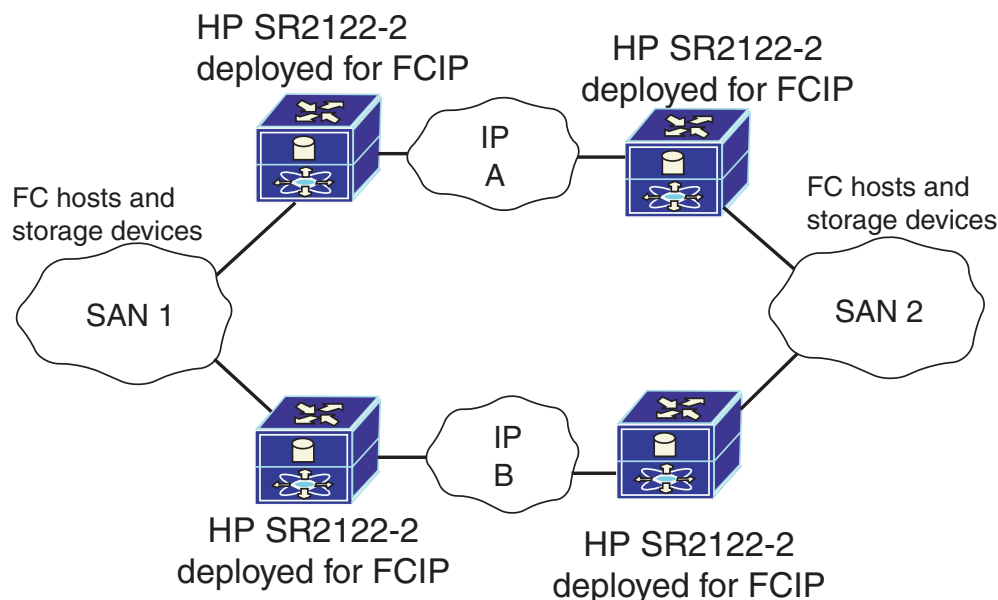


This next example uses two separate subnets in the same IP network for the two redundant IP paths between the SR2122-2's.

Each SR2122-2 is capable of 2 FCIP instances running simultaneously. At most, there can only be one server per SR2122-2. To connect to another SR2122-2 a server/client relationship must exist.

For example:

- SR2122-2 *local* FC1/GE1 -> server connects to SR2122-2 *remote* FC1/GE1 -> client
- SR2122-2 *local* FC2/GE2 -> client connects to SR2122-2 *remote* FC2/GE1 -> server
- SR2122-2 *remote* FC1/GE1 -> client connects to SR2122-2 *local* FC1/GE1 -> server
- SR2122-2 *remote* FC2/GE2 -> server connects to SR2122-2 *local* FC2/GE1 -> client
- SR2122-2 *local* contains 1 server and 1 client, likewise for SR2122-2 *remote*. For each instance there is a server/client relationship.



This example shows an even more reliable FCIP configuration, in which pairs of SR2122-2 Storage Routers provide full redundancy. In this configuration, loss of an SR2122-2 or loss of connectivity through one of the IP networks can be tolerated with no loss of connectivity between the SANs.

Note: For multiple paths between SANs, multiple pairs of systems deployed for FCIP need to be connected to the Fibre Channel hosts or Fibre Channel devices. It is assumed that the multipath management is being done by an entity outside the SR2122-2 (for example, by management applications on the Fibre Channel host or storage devices).

SR2122-2 FCIP Hardware and Software Support

This section lists the hardware, devices, and operating systems that are compatible with the SR2122-2 for FCIP.

Note: For more information on support, contact an HP storage representative

Storage Array Hardware Support

This section lists the storage array support for FCIP when using the SR2122-2 IP storage router. Contact an HP storage representative for specific support information.

- Continuous Access for Enterprise Virtual Array
- Continuous Access for XP12000, XP128/1024
- Data Replication Manager for HSG80

Fibre Channel Switch Hardware Support

The SR2122-2 is supported for FCIP with the HP B-Series, C-Series, and M-Series product line switches listed in Chapter 3.

Operating System Support

The SR2122-2 is supported for FCIP on the following operating systems:

CA EVA

- HP-UX 11i v1, 11i v2, 11.0
- OpenVMS 7.3-2, 7.3-1, 7.2-2
- Tru64 5.1a, 5.1b
- IBM AIX 5.2, 5.1, 4.3.3
- Microsoft Windows 2003 Advanced Server, Windows 2000 Server, Windows NT 4.0 SP6a
- NetWare 6.5, 6.0 SP3, 5.1 SP6
- Redhat Linux Advanced Server 2.1
- SuSE Linux SLES 7, 8, United Linux 1.0
- Sun Solaris 2.6, 7, 8, 9

CA XP12000/1024/128

- HP-UX 11i v1
- OpenVMS 7.3-1, 7.2-2
- Tru64 5.1a
- IBM AIX 5.2
- Microsoft Windows 2003 Advanced Server, Windows 2000 Server
- Redhat Linux Advanced Server 2.1
- SuSE Linux SLES 8
- Sun Solaris 8

DRM RA/MA8000, ESA/EMA12000, EMA16000 (HSG80)

- HP-UX 11i v1, 11.0
- OpenVMS 7.3-1, 7.3, 7.2-2
- Tru64 5.1a, 5.1b
- IBM AIX 5.1, 4.3.3
- Microsoft Windows 2000 Server, Windows NT 4.0 SP6a
- NetWare 6, 5.1
- Sun Solaris 2.6, 7, 8, 9

SR2122-2 FCIP Configuration Rules**SR2122-2 Router Rules**

- IP network speeds less than 10 Mb/sec are not supported.
- When the SR2122-2 is configured with HP data replication products, two separate long distance links must be implemented.
- If the router is to be configured for both FCIP and iSCSI, then the FCIP and iSCSI traffic is not supported through the same SR2122-2 GbE port.

Sample SR2122-2 Configurations

This section provides a brief overview of three recommended host/storage configuration using the HP SR2122-2 IP Storage Router:

- FCIP Only
- FCIP with Local iSCSI Hosts
- FCIP with Remote iSCSI Hosts

Further SAN configuration documentation, including the

- HP StorageWorks IP Storage Router 2122-2 Command Line Interface Reference Guide
- HP StorageWorks IP Storage Router 2122-2 User Guide
- HP StorageWorks IP Storage Router 2122-2 Getting Started Guide

are available via the HP website at:

<http://h18000.www1.hp.com/products/storageworks/san/documentation.html>

SR2122-2 Sample Configuration - FCIP Only

Two SAN islands may be joined into a single large, geographically dispersed SAN using the HP SR2122-2s as Fibre Channel to IP gateways to translate between Fibre Channel protocol and FCIP protocol.

FCIP protocol transmitted over a WAN network is used to extend the connection between the two SAN islands beyond the nominal 10 km maximum length for direct Fibre Channel.

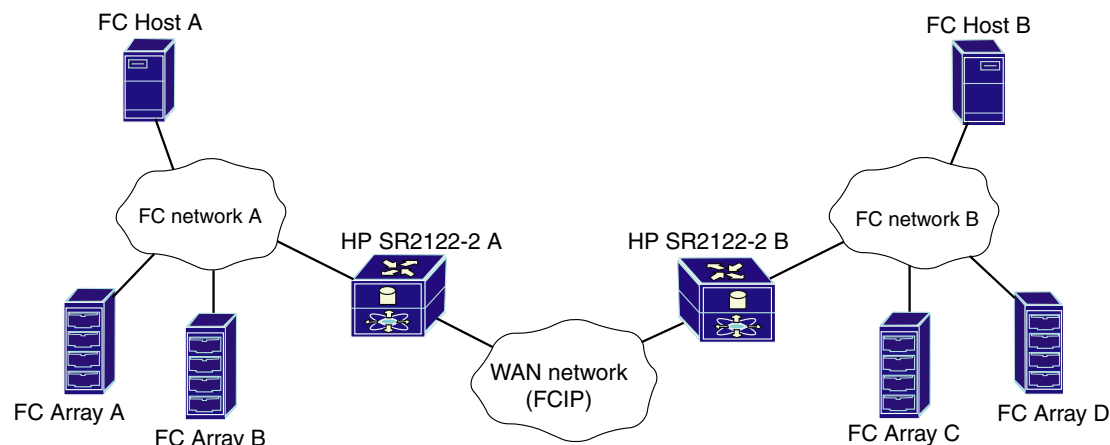


Figure 70: FCIP only

Disk LUNs at either site A or site B may be assigned either to local hosts or to remote hosts.

This basic configuration may also be used when Data Replication Manager or Continuous Access is employed to replicate disk data between the two sites. Since these data replication products use redundant Fibre Channel fabrics, two separate long distance links must be implemented. Although the two Fibre Channel fabrics could be routed through only two SR2122-2's, to avoid a single point of failure, a total of four SR2122-2 units should be included in this configuration.

As shown in [Figure 70](#), a single Fibre Channel connection is required between the SR2122-2 and the Fibre Channel network at each site. The second Fibre Channel port on the SR2122-2 is not used. The iSCSI protocol is not used in this configuration.

SR2122-2 Sample Configuration - FCIP with Local iSCSI Hosts

One or more host servers may be connected to the extended SAN through a local IP network at site A using the iSCSI protocol. This connection uses the second Gigabit Ethernet port on the site A SR2122-2.

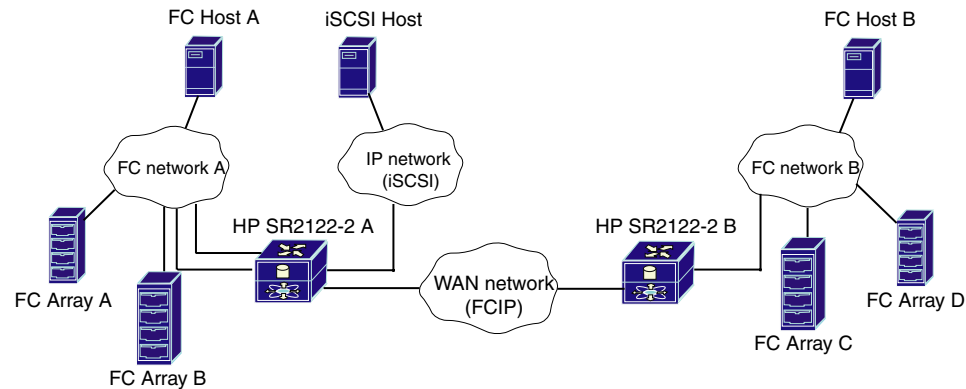


Figure 71: FCIP with Local iSCSI Hosts

For this configuration, two connections from the SR2122-2 to the Fibre Channel network at site A are required. One SR2122-2 Gigabit Ethernet (Fibre Channel) port is assigned to the FCIP connection and the second is designated for the iSCSI connection.

Disk LUNs at site A may be assigned to the iSCSI hosts. The SR2122-2 translates the iSCSI I/O commands into Fibre Channel protocol commands. The iSCSI hosts at site A are also able to access the disk LUNs at site B. The iSCSI protocol I/O commands are converted to FCIP protocol in the site A SR2122-2 and transmitted to site B using FCIP. The iSCSI host applications must be able to tolerate the total latency incurred through the multiple protocol conversions plus the overall network delay to access disk LUNs at site B. A further expansion of this configuration would be to mirror the site A iSCSI configuration to include iSCSI hosts at site B. This would provide access to site B disk LUNs, as well as site A disk LUNs, through the SR2122-2 at site B.

SR2122-2 Sample Configuration - FCIP with Remote iSCSI Hosts

The FCIP configuration with local iSCSI hosts may be extended by locating the iSCSI hosts apart from either site A or site B. This configuration requires that the iSCSI IP network be connect to the large SAN through a WAN network as shown below.

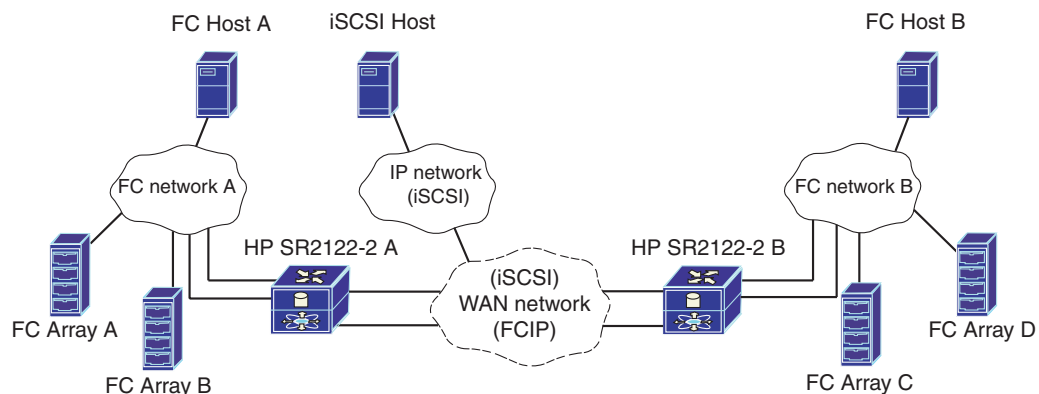


Figure 72: FCIP with Remote iSCSI Hosts

This configuration allows the iSCSI hosts to access disk LUNs at either site A or site B, providing maximum configuration flexibility.

Note: Within the WAN network the iSCSI protocol traffic is kept isolated from the FCIP protocol traffic and connects to the SR2122-2s through the second Gigabit Ethernet port on each gateway.

The SR2122-2 has the capability to rate-limit or "pace" the FCIP protocol traffic that it handles. This is accomplished using standard Fibre Channel flow control mechanisms that allows the user to limit the amount of FCIP traffic through the SR2122-2 so that it does not exceed the bandwidth allotted for this connection through the WAN network.

However, the iSCSI protocol traffic has no corresponding flow control mechanism. If the iSCSI protocol traffic and the FCIP protocol traffic are combined on a single network and if the combined traffic exceeds the available network bandwidth, the iSCSI protocol traffic can theoretically consume some or all of the bandwidth allotted to the FCIP connection. If that happens, both iSCSI and FCIP I/O commands are subject to failure due to dropped packets in the WAN network.

By isolating the iSCSI protocol from the FCIP protocol using separate network connections, it is possible to prevent a failure in the FCIP portion of the system due to over-subscription of the WAN connection.

HP StorageWorks SR2122-2 IP Storage Router - iSCSI Overview

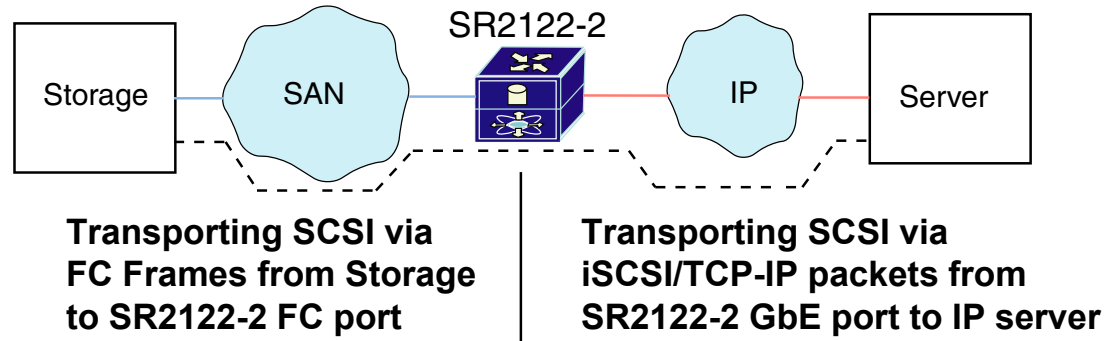
The SCSI transport protocol iSCSI maps block-oriented (CDB) storage data over TCP/IP networks. The iSCSI protocol enables universal access to storage devices and storage-area networks (SANs) over standard Ethernet-based TCP/IP networks.

These networks may be dedicated networks or may be shared with traditional Ethernet applications. IP LAN/WAN routers and switches can be used to extend the IP storage network to the wide area of applications such as synchronous and asynchronous remote disk copy or tape backup and restore.

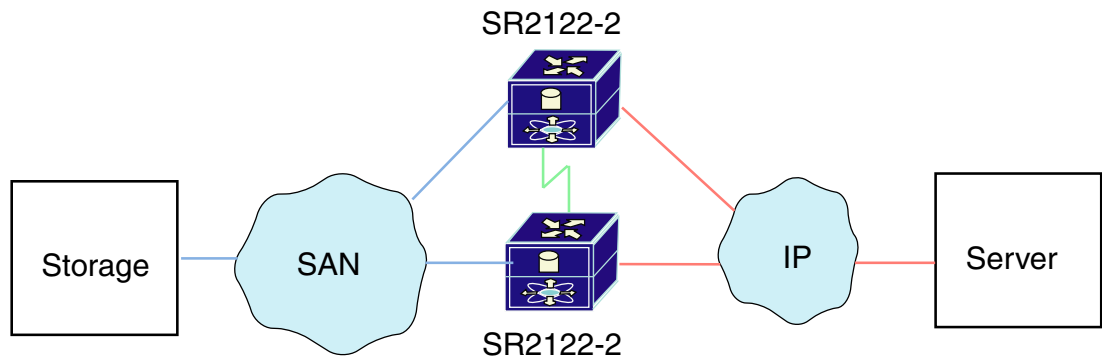
Note: Although the iSCSI protocol is written as a complete data transport from host to storage, this section will only discuss the current HP supported topology of iSCSI hosts to Fibre Channel storage using the HP SR2122-2 IP Storage Router.

SCSI routing provides IP hosts with access to Fibre Channel storage devices as if the storage devices were directly attached to the hosts, with access to devices being managed primarily in the storage router. An iSCSI target (also called logical target) is an arbitrary name for a group of physical storage devices. The iSCSI targets are created and mapped to physical storage devices attached to the storage router. The SR2122-2 presents the iSCSI targets to IP hosts (iSCSI initiators) as if the physical storage devices were directly attached to the hosts.

With SCSI routing, storage devices are not aware of each IP host; the storage devices are aware of the storage router and respond to it as if it were one Fibre Channel host.



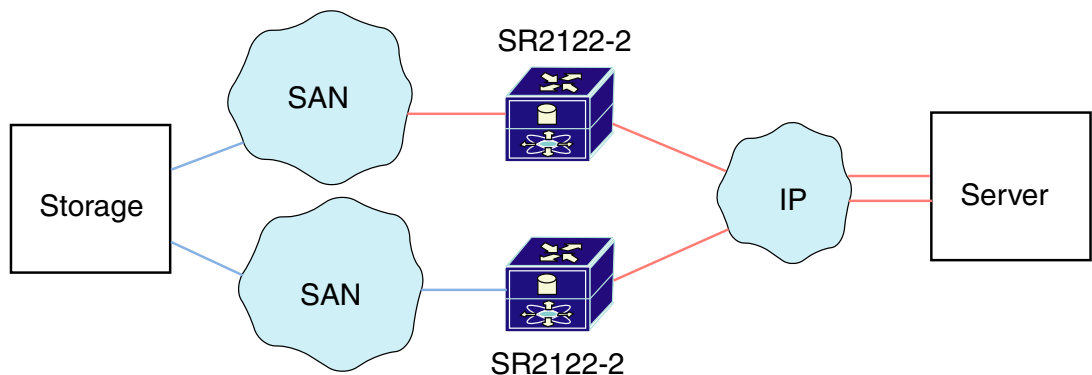
In this example Fibre Channel storage connects to the Fibre Channel interface of the SR2122-2 Storage Router deployed for iSCSI. The SR2122-2 connects to the IP network through one of its Gigabit Ethernet interfaces. The server accesses the storage served from the router through the IP network.



In this example configuration, two storage routers are connected (clustered) together to allow the storage routers to back each other up in case of failure.

Note: A storage router can participate in a cluster only if it is deployed for SCSI routing.

In a cluster, storage routers continually exchange High Availability information to propagate configuration data to each other and to detect failures in the cluster. The storage routers exchange HA information through a separate network connected to the HA interface of each storage router.



This example shows an even more reliable iSCSI configuration in which pairs of SR2122-2 Storage Routers and SANs provide full redundancy. In this configuration, loss of a SR2122-2 or loss of connectivity through one of the SANs can be tolerated with no loss of connectivity between the storage and server.

Note: For multiple paths between SANs, it is assumed that the multipath management is being done by an entity outside the SR2122-2 (for example, by management applications on the Fibre Channel host such as HP Secure Path).

SR2122-2 iSCSI Hardware and Software Support

This section lists the hardware, devices, and operating systems that are compatible with this SR2122-2 IP Storage Router.

Note: For more information on support, see the SR2122-2 Product Support Matrix. This document is available through this webpage:

<http://h18000.www1.hp.com/products/storageworks/san/documentation.html>

Storage Array Hardware Support

This section lists the storage array support for iSCSI when using the SR2122-2. Not all storage arrays are supported on all supported iSCSI operating systems. Contact an HP storage representative for specific support information.

- MSA1000
- RA/MA8000
- ESA/EMA12000
- EMA16000
- Enterprise Virtual Array
- VA7100
- VA7400/7410
- XP128/1024

Fibre Channel Switch Hardware Support

The SR2122-2 Storage Router is supported with the HP B-Series, C-Series and M-Series product line switches listed in Chapter 3.

Operating System and Network Interface Controller Hardware Support

- HP-UX 11i v1, 11i v2 - All NICs are supported by HP-UX
- Microsoft Windows 2000 SP2 with either Microsoft hotfix Q302895 or Q248720 and Microsoft hotfix Q318271, SP3, Microsoft Windows 2003 Enterprise Edition, Standard Server - All NICs are supported by HP for Windows
- MSCS support (HP iSCSI driver only)
- Red Hat Advanced Server 2.1 - All NICs are supported by HP for Linux
- Secure Path (Windows 2000, Windows 2003 only)

Compaq Network Teaming Software Support

- Compaq Network Teaming (Windows 2000, Windows 2003 only)

SR2122-2 Management Software Support

The following HP management software is supported:

- Compaq Insight Manager 7
- hp OpenView Storage Area Manager (SAM)

iSCSI Initiator Software Support

- HP
- Microsoft (MSCS, Secure Path not supported)

SR2122-2 iSCSI Configuration Rules**SR2122-2 Router Rules****Table 54: SR2122-2 Router Rules**

| Router Rule | Maximum |
|--|---------|
| Maximum scsirouter instances per SR2122-2 Router (and per SR2122-2 Router Cluster) | 12 |
| Maximum iSCSI host connections per SR2122-2 SCSI Router instance | 32 |
| Maximum active logical units (LUNs) per SR2122-2 Router | 120 |
| Maximum active targets per SR2122-2 Router | 120 |

- The SR2122-2's 2nd fibre Channel port (FC2) is not supported as a redundant iSCSI SAN port for FC1. FC2 can, however, be configured as an FCIP port
- Direct connect of the SR2122-2 Fibre Channel ports to any HP storage array is not supported.
- The SR2122-2 Management port must be in a different subnet than the SCSI Router Instances.
- The SR2122-2 fibre channel ports appear as host bus adapters to the Fibre Channel switches and to all storage arrays.

iSCSI Host Rules**Table 55: iSCSI Host Rules**

| iSCSI Host Rule | Operating System | Maximum |
|---|--|---------|
| Maximum targets accessed per iSCSI host | Windows 2000, Windows 2003, Linux, HP-UX | 120 |
| Maximum active LUNs per target | Windows 2000, Windows 2003, Linux, HP-UX | 120 |

Operating System Rules

- Linux Clustering is not supported.
- hp Secure Path for MSA1000, RA/MA8000, EMA/ESA12000 and for Enterprise Virtual Array for Linux are not supported.

- hp Auto Path for VA/XP for Windows 2000 and Linux are not supported.
- hp Secure Manager on XP and VA is not supported.
- Windows MSCS and Windows Secure Path not supported with the Microsoft iSCSI Initiator

Storage Array Rules

- The HSG80 is supported in both SCSI-3 Transparent Failover Mode and Multiple-Bus Failover Mode.
- Without hp Secure Path the RA8000/MA8000 and the Enterprise Virtual Array is supported with the SR2122 accessing only one controller port. This will disable controller failover protection.
- The MSA1000 is supported with the SR2122-2 accessing only one MSA controller port. This will disable controller failover protection.

Fibre Channel Switch/Fabric Rules

- The SR2122-2 is supported on the HP B-Series, C-Series and M-Series Switches.

Note: The SR2122-2 is not supported for iSCSI on HP-UX with the M-Series product line.

- The SR2122-2 should only be zoned with the storage devices that it will access. Zoning the SR2122-2 with other servers is not supported.

Management Software Rules

- hp OpenView Storage Area Manager (SAM) support is limited to property support only. It will identify the device, and by clicking on it, one can launch the device embedded web server interface or telnet. A device specific plug-in for the SR2122 is available on the
- SAM Website.
- CIM 7 Supports the SR2122's SNMP management capabilities.
- Management of the storage arrays through the SR2122 is not supported. Please use the recommended application/element manager to configure the storage array.

Sample iSCSI Configurations

For maximum supported SAN and Storage configurations, see Chapter 3 and Chapter 4.

For maximum supported IP configurations please consult with your network administrator

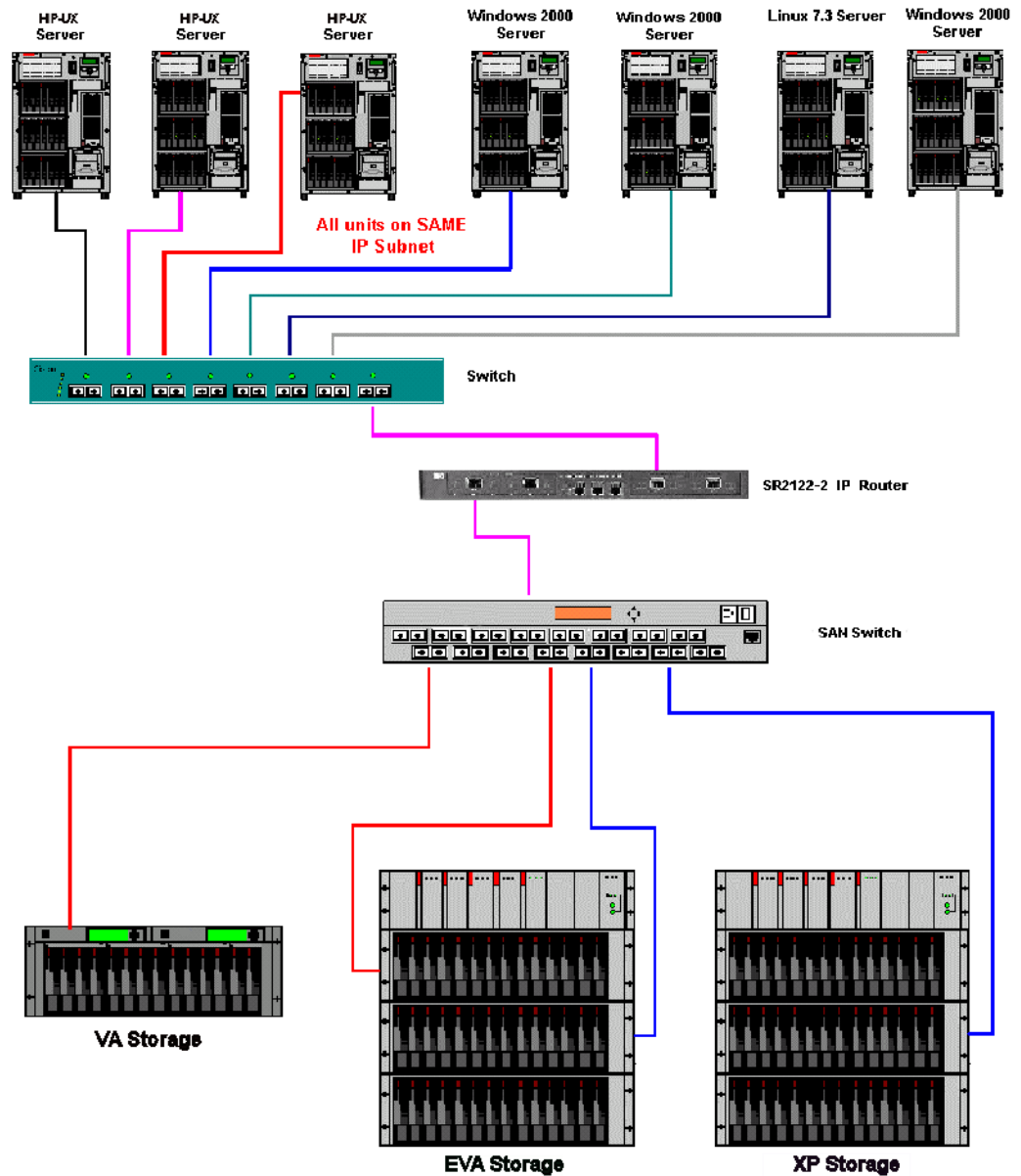


Figure 73: Example of Multiple OS Systems in a Non-Redundant Path Configuration

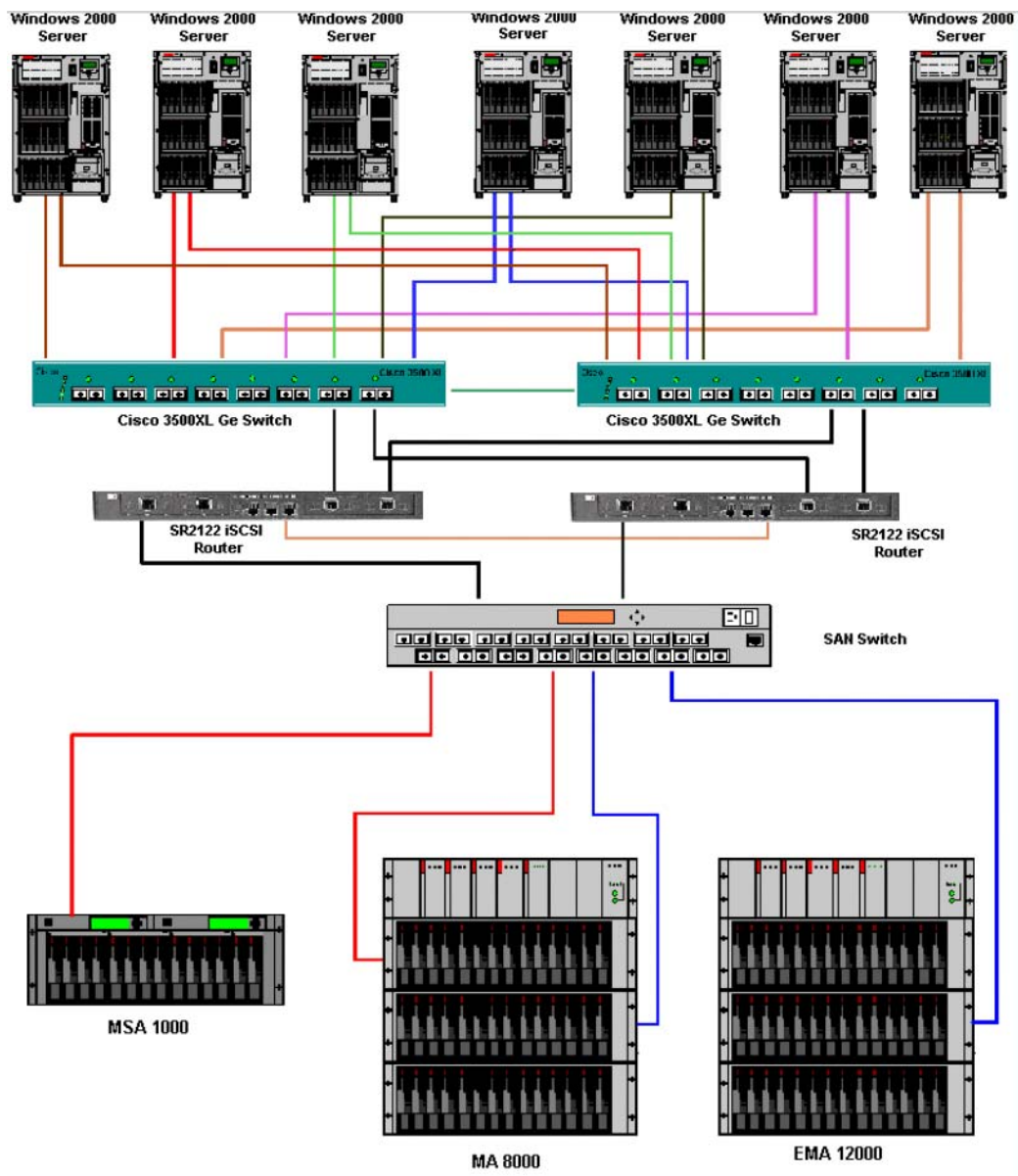


Figure 74: Windows 2000 Servers with NIC Teaming: 2 Node SR2122-2 Cluster

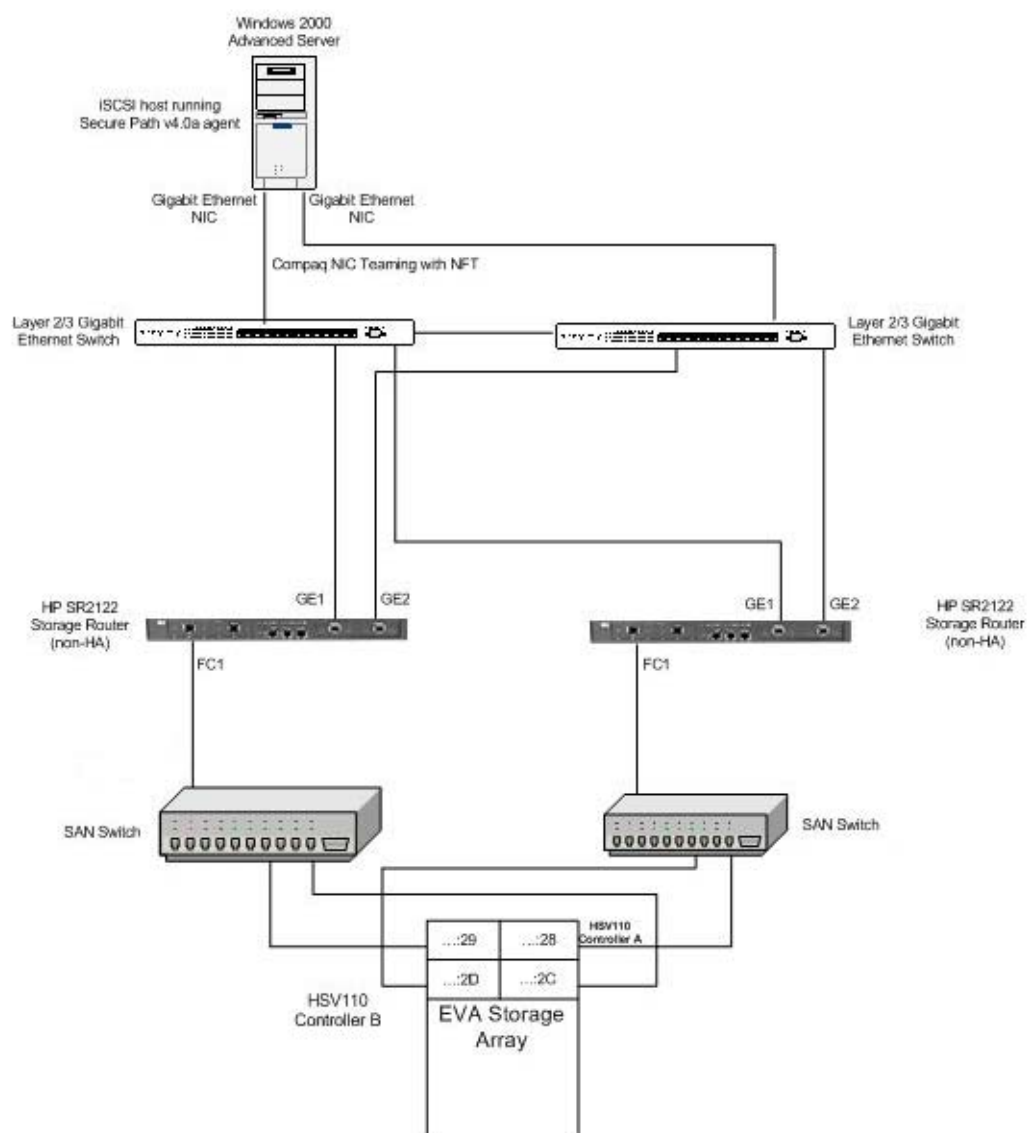


Figure 75: Secure Path Configuration

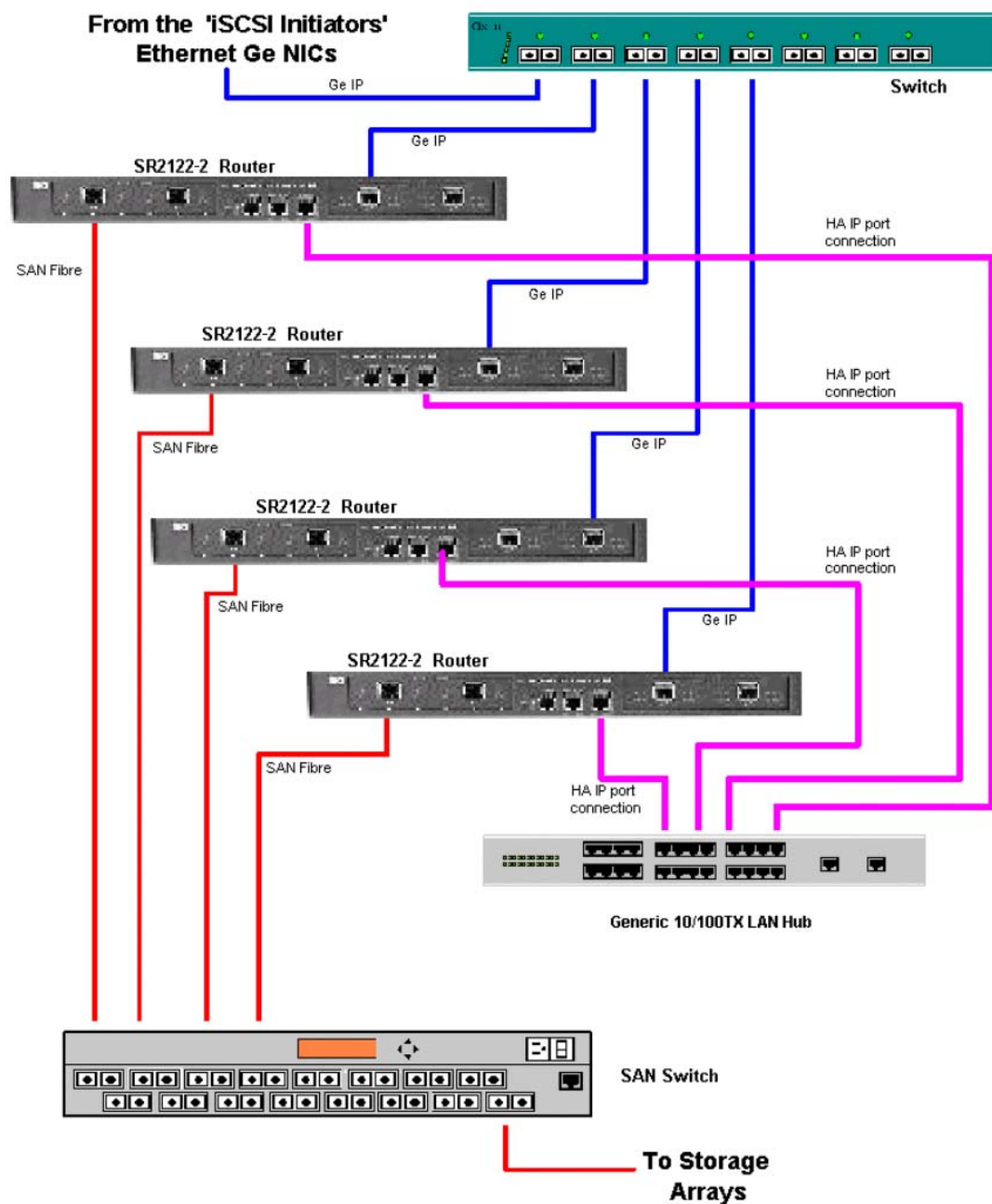


Figure 76: Maximum SR2122-2 Cluster Configuration Using HA Ports

