Networking for Storage Virtualization and EMC RecoverPoint

• EMC VPLEX and RecoverPoint Solutions
• Interswitch Link Hops Basics and Examples
• EMC RecoverPoint SAN Connectivity Information
# Networking for Storage Virtualization and EMC RecoverPoint TechBook

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This EMC Engineering TechBook provides a high-level overview of using a block storage virtualization solution, such as EMC VPLEX, as well as EMC RecoverPoint replication protection. It also describes how RecoverPoint can be integrated into the design of a simple or complex topology. Basic information on interswitch link hops, along with examples showing hop counts in four different fabric configurations, are included.

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

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

This TechBook is intended for EMC field personnel, including technology consultants, and for the storage architect, administrator, and operator involved in acquiring, managing, operating, or designing a networked storage environment that contains EMC and host devices.

For the most up-to-date information, always consult the EMC Support Matrix (ESM), available through the EMC E-Lab Interoperability Navigator (ELN), at http://elabnavigator.EMC.com.
Related documents include several TechBooks and reference manuals. The following documents, including this one, are available through the E-Lab Interoperability Navigator at http://elabnavigator.EMC.com

- Backup and Recovery in a SAN TechBook
- Building Secure SANs TechBook
- Extended Distance Technologies TechBook
- Fibre Channel over Ethernet (FCoE): Data Center Bridging (DCB) Concepts and Protocols TechBook
- Fibre Channel over Ethernet (FCoE): Data Center Bridging (DCB) Case Studies TechBook
- Fibre Channel SAN Topologies TechBook
- iSCSI SAN Topologies TechBook
- Networked Storage Concepts and Protocols TechBook
- WAN Optimization Controller Technologies TechBook
- EMC Connectrix SAN Products Data Reference Manual
- Non-EMC SAN Products Data Reference Manual

- **EMC Support Matrix**, available through E-Lab Interoperability Navigator at http://elabnavigator.EMC.com

- RSA security solutions documentation, which can be found at http://RSA.com > Content Library

- White papers include:
  - Workload Resiliency with EMC VPLEX Best Practices Planning

All of the following documentation and release notes can be found at EMC Online Support at https://support.emc.com.

Hardware documents and release notes include those on:

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

Software documents include those on:

- EMC ControlCenter
- RecoverPoint
- TimeFinder
- PowerPath
The following E-Lab documentation is also available:

- Host Connectivity Guides
- HBA Guides

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

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

This TechBook was authored by Ron Dharma and Li Jiang, along with other EMC engineers, EMC field personnel, and partners.

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**IMPORTANT**

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

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**Note:** A note presents information that is important, but not hazard-related.
Typographical conventions
EMC uses the following type style conventions in this document.

Normal
Used in running (nonprocedural) text for:
- Names of interface elements, such as names of windows, dialog boxes, buttons, fields, and menus
- Names of resources, attributes, pools, Boolean expressions, buttons, DQL statements, keywords, clauses, environment variables, functions, and utilities
- URLs, pathnames, filenames, directory names, computer names, links, groups, service keys, file systems, and notifications

Bold
Used in running (nonprocedural) text for names of commands, daemons, options, programs, processes, services, applications, utilities, kernels, notifications, system calls, and man pages
Used in procedures for:
- Names of interface elements, such as names of windows, dialog boxes, buttons, fields, and menus
- What the user specifically selects, clicks, presses, or types

Italic
Used in all text (including procedures) for:
- Full titles of publications referenced in text
- Emphasis, for example, a new term
- Variables

Courier
Used for:
- System output, such as an error message or script
- URLs, complete paths, filenames, prompts, and syntax when shown outside of running text

Courier bold
Used for specific user input, such as commands

Courier italic
Used in procedures for:
- Variables on the command line
- User input variables

<> Angle brackets enclose parameter or variable values supplied by the user

[ ] Square brackets enclose optional values

| Vertical bar indicates alternate selections — the bar means “or”

{} Braces enclose content that the user must specify, such as x or y or z

... Ellipses indicate nonessential information omitted from the example
Where to get help

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

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Note: To open a service request through the EMC Online Support site, you must have a valid support agreement. Contact your EMC sales representative for details about obtaining a valid support agreement or to answer any questions about your account.

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

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Technical support
EMC offers a variety of support options.

Support by Product — EMC offers consolidated, product-specific information on the Web at:

https://support.EMC.com/products

The Support by Product web pages offer quick links to Documentation, White Papers, Advisories (such as frequently used Knowledgebase articles), and Downloads, as well as more dynamic content, such as presentations, discussion, relevant Customer Support Forum entries, and a link to EMC Live Chat.

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This chapter contains the following information on virtualization:

- Introduction ................................................................. 14
- Benefits of VPLEX and storage virtualization ...................... 15
- Benefits of EMC RecoverPoint ............................................ 16
You can increase your storage infrastructure flexibility through storage virtualization. To enable simultaneous information access of heterogenous storage arrays from multiple storage vendors within data centers, use block storage virtualization solutions, such as EMC VPLEX™ described in this TechBook in Chapter 2, “EMC VPLEX.”

The VPLEX solution complements EMC’s virtual storage infrastructure and provides a layer supporting virtual storage between host computers running the applications of the data center and the storage arrays providing the physical storage used by these applications.

EMC block storage virtualization provides seamless data mobility and lets you manage multiple arrays from a single interface within and across a data center, providing the following benefits:

- **Mobility** — Achieve transparent mobility and access in and across a data center.
- **Scalability** — Start small and grow larger with predictable service levels.
- **Performance** — Improve I/O performance and reduce storage array contention with advanced data caching.
- **Automation** — Automate sharing, balancing, and failover of I/O across data centers.
- **Resiliency** — Mirror across arrays without host impact and increase high availability for critical applications.

EMC RecoverPoint provides cost-effective, continuous remote replication and continuous data protection, enabling on-demand protection and recovery to any point in time. Chapter 3, “EMC RecoverPoint,” provides more information on RecoverPoint.
Benefits of VPLEX and storage virtualization

EMC VPLEX™ is an inline block-based virtualization product that share a common set of features and benefits. There are numerous benefits to storage virtualization. These benefits include (but are not limited to) the following:

- Create an open storage environment capable of easily supporting the introduction of new technologies that are incorporated in the storage virtualizer. Customers can use heterogenous storage arrays that do not have an interoperable feature set, such as Heterogenous Array Mirroring, and accomplish the mirroring using a storage virtualizer.

- Significantly decrease the amount of planned and unplanned downtime by providing the ability for online migration and data protection across heterogeneous arrays.

- Increase storage utilization and decrease the amount of “stranded” heterogeneous storage.

- Reduce management complexity through single pane of glass management with simplified policies and procedures for heterogeneous storage arrays.

- Improve application, storage, and network performance (in optimized configurations) through load balancing and multipathing.

VPLEX provides the following key benefits:

- The combination of a virtualized data center and EMC VPLEX provides customers entirely new ways to solve IT problems and introduce new models of computing.

- VPLEX eliminates boundaries of physical storage and allows information resources to be transparently pooled and shared over distance for new levels of efficiency, control, and choice.

- VPLEX Local and VPLEX Metro products address the fundamental challenges of rapidly relocating applications and large amount of information on-demand within and across data centers, which is a key enabler of the private cloud.

Chapter 2, “EMC VPLEX,” provides more details on VPLEX.
Benefits of EMC RecoverPoint

RecoverPoint provides the following key services in a data center:

- **Intelligent fabric splitting** — Allows data to be split and replicated in a manner that is transparent to the host. By having the switch intercept host writes and duplicate, or split, those writes to the RecoverPoint appliance allows for data replication with minimal impact to the host.

- **Heterogeneous replication of data volumes** — RecoverPoint is a truly heterogeneous replication solution, enabling the replication of data between different storage array volumes. This enables the ability to migrate from a virtualized environment to a non-virtualized environment or replication between different tiers of storage, thus allowing greater flexibility in the data center.

- **Continuous data protection (CDP)** — Enables a fine granularity of recovery to a block level and refers to local replication of SAN volumes. The fine granularity provides DVR-like point-in-time snapshots of the user volume.

- **Continuous remote replication (CRR) via IP** — Allows data replication across completely separate fabrics over distances limited only by IP technology. The RecoverPoint appliances transfer data from one appliance to another via TCP/IP, greatly extending the distance between source and target volumes.

- **Continuous remote replication (CRR) via FC** — Allows data replication within a fabric over distances limited only by FC distance extension technology.

- **Compression and bandwidth reduction** — By implementing block-level compression algorithms before sending traffic over the IP network, RecoverPoint significantly reduces the network cost required for matching the RPO/RTO expectations.

For more information on RecoverPoint, refer to Chapter 3, "EMC RecoverPoint." Chapter 4, "SAN Connectivity and Interswitch Link Hops," explains how RecoverPoint can be integrated into the design of simple and complex topologies.
This chapter contains the following information on EMC VPLEX:

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- VPLEX hardware .................................................................... 25
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EMC VPLEX

VPLEX overview

This section contains the following information:

◆ “Product description” on page 18
◆ “VPLEX advantages” on page 18
◆ “SAN switches” on page 19
◆ “VPLEX limitations” on page 19

For complete details about VPLEX, refer to the documentation listed in “VPLEX documentation” on page 43.

Product description

The EMC VPLEX™ family delivers data mobility and availability within, across, and between data centers. VPLEX Local™ provides simplified management and mobility across heterogeneous arrays within a data center. VPLEX Metro™ provides availability and mobility between two VPLEX clusters within a data center and across synchronous distances. VPLEX Geo™ further dissolves the distances between data centers within asynchronous distances.

Note: See “VPLEX product family” on page 20 for more information.

With a unique scale-up and scale-out architecture, VPLEX’s advanced data caching and distributed cache coherency provide continuous availability, non-disruptive data mobility, stretching clusters across distance, workload mobility, automatic sharing, load balancing, and enable local access within predictable service levels.

Note: For more information, refer to the EMC VPLEX GeoSynchrony Product Guide, located at EMC Online Support at https://support.emc.com.

VPLEX advantages

VPLEX addresses three primary IT needs:

◆ Mobility: VPLEX moves applications and data between different storage installations:
  ◆ Within the same data center or across a campus (VPLEX Local),
• Within a geographical region (VPLEX Metro),
• Across even greater distances (VPLEX Geo).
◆ Availability: VPLEX creates high-availability storage infrastructure across these same varied geographies with unmatched resiliency.
◆ Collaboration: VPLEX provides efficient real-time data collaboration over distance for big data applications.

Note: For more unique innovations and advantages, refer to the EMC VPLEX GeoSynchrony Product Guide, located at EMC Online Support at https://support.emc.com.

SAN switches

ALL EMC-recommended FC SAN switches are supported, including Brocade, Cisco, and QLogic.

VPLEX limitations

Always refer to the VPLEX Simple Support Matrix for the most up-to-date support information. Refer to the EMC VPLEX Release Notes for the most up-to-date capacity limitations.
The VPLEX family consists of the following, each briefly described in this section.

- “VPLEX Local” on page 20
- “VPLEX Metro” on page 21
- “VPLEX Geo” on page 24

Figure 1 shows the VPLEX product offerings.

VPLEX Local

VPLEX Local consists of a single cluster and is deployed within a single data center.

For more details about VPLEX Local, refer to the *EMC VPLEX GeoSynchrony Product Guide*, located at EMC Online Support at [https://support.emc.com](https://support.emc.com).
VPLEX Metro consists of two VPLEX clusters connected by inter-cluster links with not more than 5 ms RTT (round-trip time).

**Note:** Refer to VPLEX and vendor-specific White Papers for confirmation of latency limitations.

For more details about VPLEX Metro, refer to the *EMC VPLEX GeoSynchrony Product Guide*, located at EMC Online Support at [https://support.emc.com](https://support.emc.com).

**VPLEX Metro topology for DWDM and FCIP**

Figure 2 shows an example of a basic VPLEX Metro topology for DWDM.

![VPLEX Metro topology for DWDM and FCIP](image)
**Figure 3** shows an example of a basic VPLEX Metro topology for FCIP.

![Basic VPLEX Metro FCIP configuration example](image)

**FCIP SCSI write command spoofing, Brocade fast-write, and Cisco write acceleration technologies**

In Geosynchrony version 5.2.1 and later, VPLEX introduced a short-write feature that is not compatible with Brocade "fast-write" nor Cisco "write-acceleration" FCIP features.

VPLEX short-write is enabled by default. Therefore, you must disable Brocade fast-write or Cisco write-acceleration features prior to upgrading to Geosynchonry 5.2.1 or later. To enable or disable the VPLEX short-write feature, issue the following command from the VPLEX CLI:

```
configuration short-write -status on | off
```
For more detailed information on the VPLEX short-write feature, refer to the EMC VPLEX 5.2.1 release notes available at http://support.emc.com.

FCIP switches introduce compression features that allow saving the bandwidth and throughput for WANcom. Due to the nature of FCIP compression and the synchronous transaction for VPLEX Metro, there is an expected minor impact to the bandwidth and throughput for the hosts connected to VPLEX distributed devices. It is required that you disable FCIP compression for both Cisco and Brocade.


For more information about DWDM and FCIP technologies, refer to the Extended Distance Technologies TechBook, available at http://elabnavigator.EMC.com.

For more details about VPLEX Metro, refer to the EMC VPLEX GeoSynchrony Product Guide, located at EMC Online Support at https://support.emc.com.
VPLEX Geo

VPLEX Geo consists of two VPLEX clusters connected by inter-cluster links with no more than 50ms RTT.

**Note:** VPLEX Geo implements asynchronous data transfer between the two sites.

**VPLEX Geo topology over 1/10 GbE and Distance Extension Gear**

*Figure 4* shows a VPLEX Geo topology over 1/10 GbE and Distance Extension Gear.

For more details about VPLEX Geo, refer to the *EMC VPLEX GeoSynchrony Product Guide*, located at EMC Online Support at [https://support.emc.com](https://support.emc.com).
VPLEX hardware

For complete details about VPLEX hardware, including the engine, directors, power supplies, and best practices, refer to the *EMC VPLEX GeoSynchrony Product Guide*, located at EMC Online Support at [https://support.emc.com](https://support.emc.com). Also refer to the VPLEX online help, available on the Management Console GUI.

For VPLEX hardware VS1 and VS2 hardware configurations, refer to the *EMC VPLEX Configuration Guide*, located at EMC Online Support at [https://support.emc.com](https://support.emc.com).

This section contains the following information:

- “VPLEX cluster” on page 25

VPLEX cluster

There are two generations of VS hardware: VS1 and VS2. A VPLEX cluster (either VS1 or VS2) consists of:

- 1, 2, or 4 VPLEX engines.
  - Each engine contains two directors.
  - Dual-engine or quad-engine clusters contain:
    - 1 pair of Fibre Channel switches for communication between directors.
    - 2 uninterruptible power sources (UPS) for battery power backup of the Fibre Channel switches and the management server.
- A management server.
- Ethernet or Fibre Channel cabling and respective switching hardware connect the distributed VPLEX hardware components.
- I/O modules provide front-end and back-end connectivity between SANs and to remote VPLEX clusters in VPLEX Metro or VPLEX Geo configurations.

**Note:** In the current release of EMC GeoSynchrony™, VS1 and VS2 hardware cannot co-exist in a cluster, except in a VPLEX Local cluster during a non disruptive hardware upgrade from VS1 to VS2.
For more details about the VPLEX cluster and architecture, refer to the *EMC VPLEX GeoSynchrony Product Guide*, located at EMC Online Support at [https://support.emc.com](https://support.emc.com).

An example of the architectural highlights is shown Figure 5.

![Architecture highlights](image)

**Figure 5**  
Architecture highlights

For more information and interoperability details, refer to the *EMC Simple Support Matrix, EMC VPLEX and GeoSynchrony*, available at [http://elabnavigator.EMC.com](http://elabnavigator.EMC.com) under the Simple Support Matrix tab.

**Management server**  
Both clusters in either VPLEX Metro or VPLEX Geo configuration can be managed from a single management server.

For more details about the management server, refer to the *EMC VPLEX GeoSynchrony Product Guide*, located at EMC Online Support at [https://support.emc.com](https://support.emc.com).
The Fibre Channel switches provide high availability and redundant connectivity between directors and engines in a dual-engine or quad-engine cluster.

For more details, refer to the *EMC VPLEX GeoSynchrony Product Guide*, located at EMC Online Support at [https://support.emc.com](https://support.emc.com).

To begin using the VPLEX cluster, you must provision and export storage so that hosts and applications can use the storage. For more details, refer to the *VPLEX Installation and Setup Guide*, located at EMC Online Support at [https://support.emc.com](https://support.emc.com).
VPLEX software

This section contains the following information:

- “GeoSynchrony,” on page 28
- “VPLEX management” on page 28
- “Provisioning with VPLEX” on page 29
- “Consistency groups” on page 30
- “Cache vaulting” on page 30

For complete details about VPLEX software, including EMC GeoSynchrony, management interfaces, provisioning with VPLEX consistency groups, and cache vaulting, refer to the EMC VPLEX GeoSynchrony Product Guide and the EMC VLEX GeoSynchrony Administration Guide, located at EMC Online Support at https://support.emc.com. Also refer to the VPLEX online help, available on the Management Console GUI.

GeoSynchrony,

EMC GeoSynchrony is the operating system running on VPLEX directors on both VS1 and VS2 hardware.

Note: For more information, refer to the EMC VPLEX GeoSynchrony Product Guide and the EMC VLEX GeoSynchrony Administration Guide, located at EMC Online Support at https://support.emc.com.

VPLEX management

VPLEX includes a selection of management interfaces.

- Web-based GUI
  Provides easy-to-use point-and-click management interface.

- VPLEX CLI
  VPLEX command line interface (CLI) supports all VPLEX operations.

- VPLEX Element Manager API
  Software developers and other users use the API to create scripts to run VPLEX CLI commands.
SNMP Support for performance statistics:
Supports retrieval of performance-related statistics as published in the VPLEX-MIB.mib.

LDAP/AD support
VPLEX offers Lightweight Directory Access Protocol (LDAP) or Active Directory as an authentication directory service.

Call home
Leading technology that alerts EMC support personnel of warnings in VPLEX.

In VPLEX Metro and VPLEX Geo configurations, both clusters can be managed from either management server.

Inside VPLEX clusters, management traffic traverses a TCP/IP-based private management network.

In VPLEX Metro and VPLEX Geo configurations, management traffic traverses a VPN tunnel between the management servers on both clusters.

For more information on using these interfaces, refer to the EMC VPLEX Management Console Help, the EMC VPLEX GeoSynchrony Product Guide, or the EMC VPLEX CLI Guide and the EMC VPLEX GeoSynchrony Administration Guide, available at EMC Online Support at https://support.emc.com.

Provisioning with VPLEX
VPLEX allows easy storage provisioning among heterogeneous storage arrays. Use the web-based GUI to simplify everyday provisioning or create complex devices.

There are three ways to provision storage in VPLEX:

- Integrated storage provisioning (VPLEX integrated array services based provisioning)
- EZ provisioning
- Advanced provisioning

All provisioning features are available in the Unisphere for VPLEX GUI.
For more information on provisioning with VPLEX, refer to the EMC VPLEX GeoSynchrony Product Guide and the EMC VLEX GeoSynchrony Administration Guide, located at EMC Online Support at https://support.emc.com.

**Consistency groups**

VPLEX consistency groups aggregate volumes to enable the application of a common set of properties to the entire group.

There are two types of consistency groups:

- **Synchronous**
  
  Aggregate local and distributed volumes on VPLEX Local and VPLEX Metro systems separated by 5ms or less of latency

- **Asynchronous**
  
  Aggregate distributed volumes on VPLEX Geo systems separated by 50ms or less of latency

For more information on consistency groups, refer to the EMC VPLEX GeoSynchrony Product Guide and the EMC VLEX GeoSynchrony Administration Guide, located at EMC Online Support at https://support.emc.com.

**Cache vaulting**

VPLEX uses the individual director’s memory systems to ensure durability of user data and critical system configuration data.

For more information on cache vaulting, refer to the EMC VPLEX GeoSynchrony Product Guide and the EMC VLEX GeoSynchrony Administration Guide, located at EMC Online Support at https://support.emc.com.
VPLEX configuration

For VPLEX hardware VS1 and VS2 configurations, refer to the EMC VPLEX Configuration Guide, located at EMC Online Support at https://support.emc.com.

For VPLEX cluster configurations, refer to the EMC VPLEX GeoSynchrony Product Guide, located at EMC Online Support at https://support.emc.com.
Configuring VPLEX with FCoE switches

EMC currently supports connecting EMC Fibre Channel over Ethernet (FCoE) arrays (EMC VMAX and EMC VNX) to VPLEX Back-End ports via FCoE switches, such as Nexus 5596UP/5548UP (UP = unified ports). The solution presented in this section uses the Nexus 5596 UP switch to bridge both VMAX and VNX FCoE storage ports and VPLEX FC Back-End ports. Both FC and FCoE ports are zoned together to enable the access of VMAX and VNX FCoE ports from VPLEX.

This section contains the following information:

- “FCoE goal” on page 32
- “Topology overview” on page 33
- “VPLEX with FCoE switches configuration steps” on page 35

FCoE goal

I/O consolidation has long been sought by the IT industry to unify multiple transport protocols (storage, network, managements, and heartbeats) in the data center. This section provides a basic VPLEX configuration solution to Fibre Channel over Ethernet (FCoE), which allows I/O consolidation that has been defined by the FC-BB-5 T11 work group. I/O consolidation, simply defined, is the ability to carry different types of traffic, having different traffic characteristics and handling requirements, over the same physical media.

I/O consolidation’s most difficult challenge is to satisfy the requirements of different traffic classes within a single network. Since Fibre Channel (FC) is the dominant storage protocol in the data center, any viable I/O consolidation solution for storage must allow for the FC model to be seamlessly integrated. FCoE meets this requirement in part by encapsulating each Fibre Channel frame inside an Ethernet frame and introducing Data Center Networking that guarantees low latency lossless traffic.

The goal of FCoE is to provide I/O consolidation over Ethernet, allowing Fibre Channel and Ethernet networks to share a single, integrated infrastructure, thereby reducing network complexities in the data center.
**Assumptions**

This use case assumes the Nexus 55xx is configured as a switch mode to allow the VPLEX Fibre Channel Back-End ports to connect directly via the Universal Port in Fibre Channel. Additionally, users can tie their Fibre Channel fabric infrastructures to FCoE storage ports.

**Topology overview**

This section provides a VPLEX Geo topology diagram followed by a detailed diagram showing an FCoE connection for the Back-End ports of VPLEX Cluster-2.

This example uses VPLEX Geo. However, VPLEX Metro or VPLEX Local can also be used.

The topology shown in Figure 6 is the recommended configuration for storage array FCoE ports to VPLEX.

![VPLEX Geo topology example](image)

**Figure 6** VPLEX Geo topology example

Figure 6 shows the Back-End ports on VPLEX Cluster-2 connected directly to the Cisco Nexus 5596 FCoE switch via its FC port. The Universal port must be set to FC max of 8 Gb/s. FCoE storage array ports are connected to the Cisco Nexus 5596 via Ethernet ports.
Figure 7 is a detailed diagram showing an FCoE connection for the Back-End ports of VPLEX Cluster-2.
VPLEX with FCoE switches configuration steps

This section provides steps to configure VPLEX with FCoE switches, as shown in Figure 6 on page 33 and Figure 7 on page 34. Figure 8 provides an overview of these steps.

Figure 8 Steps to configure VPLEX with FCoE switches

These steps are further detailed in this section.

Step 1 Attach VPLEX FC Back-End (BE) directly into NX5596 port

For instructions to modify the UP port to FC port, refer to the Nexus 5500 Series NX-OS SAN Switching Configuration Guide at http://www.cisco.com. In Figure 7 on page 34, the Nexus 5596 port 32 to 48 are configured as Fibre Channel. VPLEX BE FC must be connected to FC ports to support direct connecting VPLEX BE to the FCoE storage.
Step 2  Add ISLs between MDS 9148 and Nexus 5596
As shown in Figure 9, two ISLs have been added between the two switches to avoid single link failure.

Figure 9  ISLs between MDS 9148 and Nexus 5596 switches

Step 3  Create a VFC ports for each FCoE Array port
Refer to the Cisco Switch Command Reference manual at http://www.cisco.com for detailed information about how to create virtual interface.
Figure 10 shows the VFC ports on the switch.

<table>
<thead>
<tr>
<th>Interface</th>
<th>Vsan</th>
<th>Admin Mode</th>
<th>Admin Trunk Mode</th>
<th>Status</th>
<th>Bind Info</th>
<th>Oper Mode</th>
<th>Oper Speed (Gbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>vfc1</td>
<td>2</td>
<td>F</td>
<td>on</td>
<td>trunking</td>
<td>Ethernet1/1</td>
<td>TF</td>
<td>auto</td>
</tr>
<tr>
<td>vfc2</td>
<td>2</td>
<td>F</td>
<td>on</td>
<td>trunking</td>
<td>Ethernet1/2</td>
<td>TF</td>
<td>auto</td>
</tr>
<tr>
<td>vfc3</td>
<td>2</td>
<td>F</td>
<td>on</td>
<td>trunking</td>
<td>Ethernet1/3</td>
<td>TF</td>
<td>auto</td>
</tr>
<tr>
<td>vfc4</td>
<td>2</td>
<td>F</td>
<td>on</td>
<td>trunking</td>
<td>Ethernet1/4</td>
<td>TF</td>
<td>auto</td>
</tr>
<tr>
<td>vfc6</td>
<td>1</td>
<td>F</td>
<td>on</td>
<td>errdisabled</td>
<td>Ethernet1/5</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>vfc17</td>
<td>17</td>
<td>F</td>
<td>on</td>
<td>trunking</td>
<td>Ethernet1/17</td>
<td>TF</td>
<td>auto</td>
</tr>
<tr>
<td>vfc18</td>
<td>17</td>
<td>F</td>
<td>on</td>
<td>trunking</td>
<td>Ethernet1/18</td>
<td>TF</td>
<td>auto</td>
</tr>
<tr>
<td>vfc19</td>
<td>17</td>
<td>F</td>
<td>on</td>
<td>trunking</td>
<td>Ethernet1/19</td>
<td>TF</td>
<td>auto</td>
</tr>
<tr>
<td>vfc20</td>
<td>17</td>
<td>F</td>
<td>on</td>
<td>errdisabled</td>
<td>Ethernet1/20</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>vfc23</td>
<td>17</td>
<td>F</td>
<td>on</td>
<td>trunking</td>
<td>Ethernet1/23</td>
<td>TF</td>
<td>auto</td>
</tr>
<tr>
<td>vfc24</td>
<td>2</td>
<td>F</td>
<td>on</td>
<td>trunking</td>
<td>Ethernet1/24</td>
<td>TF</td>
<td>auto</td>
</tr>
<tr>
<td>vfc25</td>
<td>4094</td>
<td>F</td>
<td>on</td>
<td>errdisabled</td>
<td>Ethernet1/25</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>vfc26</td>
<td>2</td>
<td>F</td>
<td>on</td>
<td>trunking</td>
<td>Ethernet1/26</td>
<td>TF</td>
<td>auto</td>
</tr>
<tr>
<td>vfc28</td>
<td>2</td>
<td>F</td>
<td>on</td>
<td>trunking</td>
<td>Ethernet1/28</td>
<td>TF</td>
<td>auto</td>
</tr>
<tr>
<td>vfc29</td>
<td>2</td>
<td>F</td>
<td>on</td>
<td>trunking</td>
<td>Ethernet1/29</td>
<td>TF</td>
<td>auto</td>
</tr>
<tr>
<td>vfc30</td>
<td>4094</td>
<td>F</td>
<td>on</td>
<td>errdisabled</td>
<td>Ethernet1/30</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Figure 10  
VFC ports

Note that the Ethernet interface you bind the virtual Fibre Channel interface to must be configured as follows:

- It must be a trunk port (use the `switchport mode trunk` command).
- The FCoE VLAN that corresponds to virtual Fibre Channel's VSAN must be in the allowed VLAN list.
- FCoE VLAN must not be configured as the native VLAN of the trunk port.
- The Ethernet interface must be configured as PortFast (use the `spanning-tree port type edge trunk` command).

**Step 4  
Create a zone**

Zone the storage to the VPLEX Back-End ports, following the recommendations in the *Implementation and Planning Best Practices for EMC VPLEX Technical Notes* located at https://support.emc.com.

On page 40 shows zoning configuration for the VPLEX Back-End ports and storage. Note that a redundant path from VPLEX to storage is recommended.

```
zona name VPLEX_D21A_BE_A1FC00_VMAX_0382_9G0 vsan 2
  pwwn 50:00:14:42:60:12:d0:10
  pwwn 50:00:09:73:00:05:f9:a0

zona name VPLEX_D21A_BE_A1FC00_VMAX_0382_9H0 vsan 2
  pwwn 50:00:14:42:60:12:d0:10
  pwwn 50:00:09:73:00:05:f9:e0
```
zone name VPLEX_D21A_BE_A1FC01_VMAX_0382_10G0 vsan 2
  pwwn 50:00:14:42:60:12:d0:11
  pwwn 50:00:09:73:00:05:f9:a4

zone name VPLEX_D21A_BE_A1FC01_VMAX_0382_10H0 vsan 2
  pwwn 50:00:14:42:60:12:d0:11
  pwwn 50:00:09:73:00:05:f9:e4

zone name VPLEX_D21B_BE_B1FC01_VMAX_0382_10G0 vsan 2
  pwwn 50:00:14:42:70:12:d0:11
  pwwn 50:00:09:73:00:05:f9:a4

zone name VPLEX_D21B_BE_B1FC01_VMAX_0382_10H0 vsan 2
  pwwn 50:00:14:42:70:12:d0:11
  pwwn 50:00:09:73:00:05:f9:e4

zone name VPLEX_D22A_BE_A1FC00_VMAX_0382_9G0 vsan 2
  pwwn 50:00:14:42:60:12:5b:10
  pwwn 50:00:09:73:00:05:f9:a0

zone name VPLEX_D22A_BE_A1FC00_VMAX_0382_9H0 vsan 2
  pwwn 50:00:14:42:60:12:5b:10
  pwwn 50:00:09:73:00:05:f9:e0

zone name VPLEX_D22A_BE_A1FC01_VMAX_0382_10G0 vsan 2
  pwwn 50:00:14:42:60:12:5b:11
  pwwn 50:00:09:73:00:05:f9:a4

zone name VPLEX_D22A_BE_A1FC01_VMAX_0382_10H0 vsan 2
  pwwn 50:00:14:42:60:12:5b:11
  pwwn 50:00:09:73:00:05:f9:e4

zone name VPLEX_D22B_BE_B1FC00_VMAX_0382_9G0 vsan 2
  pwwn 50:00:14:42:70:12:5b:10
  pwwn 50:00:09:73:00:05:f9:a0

zone name VPLEX_D22B_BE_B1FC00_VMAX_0382_9H0 vsan 2
  pwwn 50:00:14:42:70:12:5b:10
  pwwn 50:00:09:73:00:05:f9:e0

zone name VPLEX_D21B_BE_B1FC00_VMAX_0382_9G0 vsan 2
  pwwn 50:00:14:42:70:12:d0:10
  pwwn 50:00:09:73:00:05:f9:a0

zone name VPLEX_D21B_BE_B1FC00_VMAX_0382_9H0 vsan 2
  pwwn 50:00:14:42:70:12:d0:10
  pwwn 50:00:09:73:00:05:f9:e0

zone name VPLEX_D22B_BE_B1FC01_VMAX_0382_10G0 vsan 2
  pwwn 50:00:14:42:70:12:5b:11
  pwwn 50:00:09:73:00:05:f9:a4
zone name VPLEX_D22B_BE_B1FC01_VMAX_0382_10H0 vsan 2
  pwnn 50:00:14:42:70:12:5b:11
  pwnn 50:00:09:73:00:05:f9:e4

zone name VPLEX_D21A_BE_A1FC00_VNX_13a_SPA0 vsan 2
  pwnn 50:00:14:42:60:12:d0:10
  pwnn 50:06:01:60:46:e4:01:3a

zone name VPLEX_D21A_BE_A1FC00_VNX_13a_SPB0 vsan 2
  pwnn 50:00:14:42:60:12:d0:10
  pwnn 50:06:01:68:46:e4:01:3a

zone name VPLEX_D21A_BE_A1FC01_VNX_13a_SPA1 vsan 2
  pwnn 50:00:14:42:60:12:d0:11
  pwnn 50:06:01:61:46:e4:01:3a

zone name VPLEX_D21A_BE_A1FC01_VNX_13a_SPB1 vsan 2
  pwnn 50:00:14:42:60:12:d0:11
  pwnn 50:06:01:69:46:e4:01:3a

zone name VPLEX_D21B_BE_B1FC00_VNX_13a_SPA0 vsan 2
  pwnn 50:00:14:42:70:12:d0:10
  pwnn 50:06:01:60:46:e4:01:3a

zone name VPLEX_D21B_BE_B1FC00_VNX_13a_SPB0 vsan 2
  pwnn 50:00:14:42:70:12:d0:10
  pwnn 50:06:01:68:46:e4:01:3a

zone name VPLEX_D21B_BE_B1FC01_VNX_13a_SPA1 vsan 2
  pwnn 50:00:14:42:70:12:d0:11
  pwnn 50:06:01:61:46:e4:01:3a

zone name VPLEX_D21B_BE_B1FC01_VNX_13a_SPB1 vsan 2
  pwnn 50:00:14:42:70:12:d0:11
  pwnn 50:06:01:69:46:e4:01:3a

zone name VPLEX_D22A_BE_A1FC00_VNX_13a_SPA0 vsan 2
  pwnn 50:00:14:42:60:12:5b:10
  pwnn 50:06:01:60:46:e4:01:3a

zone name VPLEX_D22A_BE_A1FC00_VNX_13a_SPB0 vsan 2
  pwnn 50:00:14:42:60:12:5b:10
  pwnn 50:06:01:68:46:e4:01:3a

zone name VPLEX_D22A_BE_A1FC01_VNX_13a_SPA1 vsan 2
  pwnn 50:00:14:42:60:12:5b:11
  pwnn 50:06:01:61:46:e4:01:3a

zone name VPLEX_D22A_BE_A1FC01_VNX_13a_SPB1 vsan 2
  pwnn 50:00:14:42:60:12:5b:11
  pwnn 50:06:01:69:46:e4:01:3a
EMC VPLEX

---

zone name VPLEX_D22B_BE_B1FC00_VNX_13a_SPA0 vsan 2
  pwn 50:00:14:42:70:12:5b:10
  pwn 50:06:01:60:46:e4:01:3a

zone name VPLEX_D22B_BE_B1FC00_VNX_13a_SPB0 vsan 2
  pwn 50:00:14:42:70:12:5b:10
  pwn 50:06:01:68:46:e4:01:3a

zone name VPLEX_D22B_BE_B1FC01_VNX_13a_SPA1 vsan 2
  pwn 50:00:14:42:70:12:5b:11
  pwn 50:06:01:61:46:e4:01:3a

zone name VPLEX_D22B_BE_B1FC01_VNX_13a_SPB1 vsan 2
  pwn 50:00:14:42:70:12:5b:11
  pwn 50:06:01:69:46:e4:01:3a

---

**Step 5**  Provision LUNS via FCoE

*Figure 11 on page 41* shows the VMAX Masking View. Devices mapped to the storage FCoE ports would be discovered by VPLEX.

Refer to the *EMC Solutions Enabler Symmetrix CLI Command Reference* manual, located at [https://support.emc.com](https://support.emc.com), for detailed information on how to create a Masking View on VMAX.
Configuring VPLEX with FCoE switches

Figure 11  Symmetrix VMAX Masking View

C:\>synaccess -sid 82 show vplex_sg_fcoe -type storage
Symmetrix ID : 000195700382
Storage Group Name : vplex_sg_fcoe
Last updated at : 03:01:51 AM on Mon Nov 12, 2012
   Number of Storage Groups : 0
   Storage Group Names : None
   Devices : 0005:0058 0729:07A8
   Masking View Names
      < vplex_mv_fcoe
      >

C:\>synaccess -sid 82 show vplex_pg_fcoe -type port
Symmetrix ID : 000195700382
Port Group Name : vplex_pg_fcoe
Last updated at : 03:01:51 AM on Mon Nov 12, 2012
   Director Identification
      <
      FA-9G:0
      FA-10G:0
      FA-9H:0
      FA-10H:0
      >
   Masking View Names
      < vplex_mv_fcoe
      >

C:\>synaccess -sid 82 show vplex_ig -type init
Symmetrix ID : 000195700382
Initiator Group Name : vplex_ig
Last updated at : 03:01:51 AM on Mon Nov 12, 2012
   Host Initiators
      <
      WWN : 500014426012d010 [alias: 500014426012d010/500014426012d010]
      WWN : 500014426012d011 [alias: 500014426012d011/500014426012d011]
      WWN : 500014427012d010 [alias: 500014427012d010/500014427012d010]
      WWN : 500014427012d011 [alias: 500014427012d011/500014427012d011]
      WWN : 500014426012b010 [alias: 500014426012b010/500014426012b010]
      WWN : 500014426012b011 [alias: 500014426012b011/500014426012b011]
      WWN : 500014427012b010 [alias: 500014427012b010/500014427012b010]
      WWN : 500014427012b011 [alias: 500014427012b011/500014427012b011]
      >
   Masking View Names
      < vplex_view
               vplex_mv_fcoe *
      >
   Parent Initiator Groups
      < vplex_ig_fcoe
      >
* Denotes Masking Views through a cascaded group
Step 6  Expose virtual volumes to hosts

The virtual volume from VPLEX is the logical storage construct presented to hosts. A virtual volume can be created with restricted access to specified users or applications, providing additional security.

Figure 12 illustrates the virtual volume provisioning and exporting process. Provisioning and exporting storage refers to taking storage from a storage array and making it visible to a host.

Figure 12  Virtual volume provisioning and exporting process

For more detailed configuration information, refer to the VPLEX 5.1 documentation portfolio, located at https://support.emc.com.
There are numerous VPLEX documentation, technical notes, and white papers available, some listed below, which can be found at EMC Online Support at https://support.emc.com, including:

- **EMC VPLEX GeoSynchrony Product Guide**
- **EMC VPLEX GeoSynchrony CLI Guide**
- **EMC VPLEX GeoSynchrony Configuration Guide**
- **EMC VPLEX GeoSynchrony Administration Guide**
- **EMC VPLEX Hardware Installation Guide**
- **EMC VPLEX with GeoSynchrony Release Notes**
- **VPLEX online help, available on the Management Console GUI**
- **VPLEX Procedure Generator, available at EMC Online Support at https://support.emc.com**
- **EMC Simple Support Matrix, EMC VPLEX and GeoSynchrony, available at http://elabnavigator.EMC.com**

For host-specific VPLEX information, see the appropriate Host Connectivity Guides available at EMC Online Support at https://support.emc.com

For the most up-to-date support information, you should always refer to the *EMC Support Matrix.*
This chapter contains the following information on EMC RecoverPoint:

- RecoverPoint architecture ................................................................. 46
- RecoverPoint components ............................................................... 48
- Logical topology .............................................................................. 49
- Local and remote replication ......................................................... 51
- Intelligent switches ....................................................................... 52
- EMC RecoverPoint with intelligent switch splitters .................... 53
- RecoverPoint documentation ......................................................... 54

**Note:** For detailed information on RecoverPoint with Fibre Channel over Ethernet (FCoE), refer to the “Solutions” chapter in the *Fibre Channel over Ethernet (FCoE): Data Center Bridging (DCB) Concepts and Protocols* TechBook, available through the E-Lab Interoperability Navigator at [http://elabnavigator.EMC.com](http://elabnavigator.EMC.com).
RecoverPoint architecture

RecoverPoint uses a combination of hardware appliances configured out of the direct data path “out of band” and a splitter driver to replicate data from the designated source volume to the configured target volume. RecoverPoint uses intelligent Fibre Channel switches to intercept and “split” incoming writes. The intelligent Fibre Channel switch then sends a copy of the incoming write to the RecoverPoint Appliance as well as passing the original write to the original destination. The RecoverPoint appliance then handles the sending of the “split” write to the proper destination volume, either through TCP/IP or Fibre Channel.

Traffic routed by the intelligent switch does not introduce protocol overhead. All virtualized I/O is routed through ASICs on the intelligent switch or blade. The payload (SCSI data frame) is not affected by this operation, as the ASIC does not read or modify the content but rather reads only the protocol header information to make routing decisions.

Figure 13 shows an example of RecoverPoint architecture.
The splitter residing in the intelligent switch is responsible for duplicating the write traffic and sending the additional write to the RecoverPoint appliance, as shown in Figure 14.

**Figure 14** **Intelligent switch running RecoverPoint**

RecoverPoint offers:

- Continuous remote replication (CRR) between LUNs across two SANs
- Continuous data protection (CDP) between LUNs on the same SAN
- Concurrent local and remote (CLR) data protection between LUNs across two SANs
- Heterogeneous operating system and storage array support
- The server's I/O adapters can be FC (HBA) or FCoE (CNA)
- The storage array can be FC- or FCoE-connected, depending on the splitter strategy
- Integrated with intelligent fabric
RecoverPoint components

There are five major components in a RecoverPoint installation:

- **Virtual Target (VT)** — This is the virtual representation of the physical storage that is used as either source or destination for replicated data.

- **Virtual Initiator (VI)** — This is the virtual representation of the physical host that is issuing I/O to the source volume.

- **Intelligent Fabric Splitter** — This is the intelligent-switch hardware that contains specialized port-level processors (ASICs) to perform virtualization operations on I/O at line speed. This functionality is available from two vendors: Brocade and Cisco.
  Brocade resides on the intelligent blade, AP4-18, which can be installed in a Brocade DCX or Brocade 48000 chassis. It can also be installed directly on the intelligent switch, AP-7600.
  
  Cisco resides on the intelligent blades Storage Services Module (SSM) or Multiservice Module, which can be installed in an MDS 9513, 9509, 9506, 9216i, 9216A, or 9222i. It can also be installed directly on an MDS 9222i without an intelligent blade.

- **RecoverPoint Appliances (RPA)** — These appliances are Linux-based boxes that accept the “split” data and route the data to the appropriate destination volume, either using IP or Fibre Channel. The RPA also acts as the sole management interface to the RecoverPoint installation.

- **Remote Replication** — Two RecoverPoint Appliance (RPA) clusters can be connected via TCP/IP or FC in order to perform replication to a remote location. RPA clusters connected via TCP/IP for remote communication will transfer "split" data via IP to the remote cluster. The target cluster's distance from the source is only limited by the physical limitations of TCP/IP.
  
  RPA clusters can also be connected remotely via Fibre Channel. They can reside on the same fabric or on different fabrics, as long as the two clusters can be zoned together. The target cluster's distance from the source is again only limited by the physical limitations of FC. RPA clusters can support distance extension hardware (such as, DWDM) to extend the distance between clusters.
Logical topology

There are Virtual Initiators (VI) and Virtual Targets (VT). A host (initiator) or storage (target) is physically connected to the fabric. The VI and VT are logical entities that are accessible from any port on the chassis or in the fabric, as shown in Figure 15.

The exact method of this virtualization differs between the Cisco SANTap solution and the Brocade FAP solution.

The SANTap architecture uses VSANs to physically separate the physical host from the physical storage and bridges the VSANs via virtualization internal to the intelligent switch. When a virtual target (DVT) is created, a duplicate WWN is created and placed in the “Front End” VSAN, that is the VSAN that encompasses the physical hosts. The physical hosts then communicate with the virtual target. SANTap then also creates virtual initiators (VI) and duplicates the host WWNs and places them in the “Back End” VSAN, which is the VSAN that encompasses the physical storage. The VIs then communicate to the physical storage. SANTap also creates virtual entries representing the splitter itself and communication between the RPAs and the intelligent switch happens via these virtual entries.
Figure 16 on page 50 shows example “Back End” and “Front End” VSANs. and shows the duplicate WWNs in both VSANs.

**Example “Back End” VSAN**  
VSAN 150:

<table>
<thead>
<tr>
<th>PCID</th>
<th>TYPE</th>
<th>PWWN</th>
<th>(VENDOR)</th>
<th>FC4-TYPE: FEATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x320000</td>
<td>N</td>
<td>50:06:04:82:35:2e:87:52 (EMC)</td>
<td>sseri-fcp: both 253 ← Physical Storage</td>
<td></td>
</tr>
<tr>
<td>0x320000</td>
<td>N</td>
<td>22:30:00:00:5:30:00:32:e0 (Cisco)</td>
<td>sseri-fcp: init vir...t</td>
<td></td>
</tr>
<tr>
<td>0x320000</td>
<td>N</td>
<td>22:36:00:05:30:00:32:e0 (Cisco)</td>
<td>sseri-fcp: init vir...t</td>
<td></td>
</tr>
<tr>
<td>0x320000</td>
<td>N</td>
<td>22:37:00:05:30:00:32:e0 (Cisco)</td>
<td>sseri-fcp: init vir...t</td>
<td></td>
</tr>
<tr>
<td>0x320000</td>
<td>N</td>
<td>22:38:00:05:30:00:32:e0 (Cisco)</td>
<td>sseri-fcp: init vir...t</td>
<td></td>
</tr>
<tr>
<td>0x320000</td>
<td>N</td>
<td>22:39:00:05:30:00:32:e0 (Cisco)</td>
<td>sseri-fcp: init vir...t</td>
<td></td>
</tr>
<tr>
<td>0x320010</td>
<td>N</td>
<td>22:3a:00:05:30:00:32:e0 (Cisco)</td>
<td>sseri-fcp: init vir...t</td>
<td></td>
</tr>
<tr>
<td>0x320011</td>
<td>N</td>
<td>22:3b:00:05:30:00:32:e0 (Cisco)</td>
<td>sseri-fcp: init vir...t</td>
<td></td>
</tr>
<tr>
<td>0x320012</td>
<td>N</td>
<td>22:3c:00:05:30:00:32:e0 (Cisco)</td>
<td>sseri-fcp: init vir...t</td>
<td></td>
</tr>
<tr>
<td>0x320013</td>
<td>N</td>
<td>22:3d:00:05:30:00:32:e0 (Cisco)</td>
<td>sseri-fcp: init vir...t</td>
<td></td>
</tr>
<tr>
<td>0x320020</td>
<td>N</td>
<td>21:01:00:e0:0b:af:fd:cc (Qlogic)</td>
<td>sseri-fcp: init vir...t ← Virtual Initiator</td>
<td></td>
</tr>
</tbody>
</table>

**Corresponding “Front End” VSAN**  
VSAN 151:

<table>
<thead>
<tr>
<th>PCID</th>
<th>TYPE</th>
<th>PWWN</th>
<th>(VENDOR)</th>
<th>FC4-TYPE: FEATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xa0100</td>
<td>N</td>
<td>50:06:04:82:35:2e:87:52 (EMC)</td>
<td>sseri-fcp: target vir... ← Virtual Storage (IVT)</td>
<td></td>
</tr>
<tr>
<td>0xa0200</td>
<td>N</td>
<td>21:01:00:e0:0b:af:fd:cc (Qlogic)</td>
<td>sseri-fcp: init ← Physical Initiator</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 16** Example Back End and Front End VSAN

The Brocade FAP architecture uses Frame Redirect to channel all host I/O through the corresponding bound VI. When a host is bound to a particular physical target, a virtual target is created with a new WWN. The separation in this case is handled internally by the switch. The physical target remains zoned with the physical storage. Data would flow from the physical host to the virtual target, then from the bound VI to the physical storage.
Local and remote replication

Replication by RecoverPoint is based on a logical entity called a consistency group. SAN-attached storage volumes at the primary and secondary sites, called replication volumes, are assigned to a consistency group to define the set of data to be replicated. An application, such as Microsoft Exchange, typically has its storage resources defined in a single consistency group so there is a mapping between an application and a consistency group.

EMC RecoverPoint replicates data over any distance:

◆ Within the same site or to a local bunker site some distance away

**Note:** Refer to “CDP configurations” in the *EMC RecoverPoint Administrator’s Guide*, located at EMC Online Support at [https://support.emc.com](https://support.emc.com).

◆ To a remote site, see CRR configurations

**Note:** Refer to “CRR configurations” in the *EMC RecoverPoint Administrator’s Guide*, located at EMC Online Support at [https://support.emc.com](https://support.emc.com).

◆ To both a local and a remote site simultaneously

**Note:** Refer to “CLR configurations” in the *MC RecoverPoint Administrator’s Guide*, located at EMC Online Support at [https://support.emc.com](https://support.emc.com).

RecoverPoint replication phases

The three major phases performed by RecoverPoint to guarantee data consistency and availability (RTO and RPO) during replication are:

◆ Write phase (the splitting phase)
◆ Transfer phase
◆ Distribution phase
Intelligent switches

There are several intelligent switches that provide fabric-level I/O splitting for the RecoverPoint instance:

- Connectrix AP-7600
- Connectrix ED-48000B
- Connectrix MDS Storage Services Module (SSM)

For more information on the intelligent switches, refer to the product data information in the *EMC Connectrix Products Data TechBook*, through the E-Lab Interoperability Navigator at [http://elabnavigator.EMC.com](http://elabnavigator.EMC.com).
EMC RecoverPoint with intelligent switch splitters

EMC RecoverPoint is an enterprise-scale solution designed to protect application data on heterogeneous SAN-attached servers and storage arrays. RecoverPoint runs on an out-of-path appliance and combines industry-leading continuous data protection technology with a bandwidth-efficient no data loss replication technology that protects data on local and remote sites. EMC RecoverPoint provides local and remote data protection, enabling reliable replication of data over any distance; that is, locally within the same site or remotely to another site using Fibre Channel or an IP network to send the data over a WAN. For long distances, RecoverPoint uses either Fibre Channel or IP network to send data over a WAN.

RecoverPoint uses existing Fibre Channel and Fibre Channel over Ethernet (FCoE) infrastructure to integrate seamlessly with existing host application and data storage subsystems. For detailed information on RecoverPoint with Fibre Channel over Ethernet (FCoE), refer to the “Solutions” chapter in the Fibre Channel over Ethernet (FCoE): Data Center Bridging (DCB) Concepts and Protocols TechBook, available through the E-Lab Interoperability Navigator at http://elabnavigator.EMC.com.

RecoverPoint’s fabric splitter leverages intelligent SAN-switch hardware from EMC’s Connectrix partners. This section focuses on topology considerations where the data splitter resides on an intelligent SAN switch.

To locate more detailed information about RecoverPoint, refer to “RecoverPoint documentation” on page 54.
RecoverPoint documentation

There are a number of documents for RecoverPoint related information, all which can be found at EMC Online Support at https://support.emc.com, including:

- **Release notes**
  
  Information in the release notes include:
  
  - Support parameters
  - Supported configurations
  - New features and functions
  - SAN compatibility
  - Bug fixes
  - Expected behaviors
  - Technical notes
  - Documentation issues
  - Upgrade information

- **EMC RecoverPoint Administrator’s Guide**

- **RecoverPoint maintenance and administration documents**

- **RecoverPoint installation and configuration documents**

- **RecoverPoint-related white papers**

- **EMC Support Matrix**, located at http://elabnavigator.emc.com

For detailed information on RecoverPoint with Fibre Channel over Ethernet (FCoE), refer to the “Solutions” chapter in the Fibre Channel over Ethernet (FCoE): Data Center Bridging (DCB) Concepts and Protocols TechBook, available through the E-Lab Interoperability Navigator at http://elabnavigator.EMC.com.
This chapter includes SAN connectivity information and describes how RecoverPoint can be integrated into the design of a simple or complex topology.

- SAN connectivity overview .............................................................. 56
- Simple SAN topologies ................................................................. 57
- Complex SAN topologies .............................................................. 62
- Interswitch link hops ................................................................. 72
SAN connectivity overview

RecoverPoint use intelligent switches, which allows for seamless connectivity into a Fibre Channel switched fabric.

There are a number of different SAN topologies, classified in two categories: simple and complex topologies, which this chapter will further discuss.

RecoverPoint can be integrated into the design of either topology type.

◆ “Simple SAN topologies” on page 57

Note: For more detailed information on simple SAN topologies, refer to the “Simple Fibre Channel SAN topologies” chapter in the Fibre Channel SAN Technologies TechBook, available through the E-Lab Interoperability Navigator at http://elabnavigator.EMC.com.

◆ “Complex SAN topologies” on page 62

Note: For more detailed information on complex SAN topologies, refer to the “Complex Fibre Channel SAN topologies” chapter in the Fibre Channel SAN Technologies TechBook, available through the E-Lab Interoperability Navigator at http://elabnavigator.EMC.com.
Simple SAN topologies

RecoverPoint is dependent on the intelligent switches to handle data splitting to the RecoverPoint Appliance.

The intelligent switches can act as stand-alone FC switches as well as Layer 2 FC switches. In small SANs, or with small virtualization implementations, this is one possible topology. There are a few configurations based on the choice in FC switch vendors, each discussed further in this section:

- “Connectrix B AP-7600B simple SAN topology” on page 57
- “Storage Services Module (SSM) blade in a simple SAN topology” on page 58
- “Node placement in a simple SAN topology—Connectrix B” on page 60
- “Node placement in a simple SAN topology—Connectrix MDS” on page 61

Connectrix B AP-7600B simple SAN topology

The Connectrix B AP-7600B, when operating as a platform for the RecoverPoint instance, supports F_Port connections. That is, FC-SW nodes, such as hosts and storage, can be connected directly to any one of the 16 ports on the AP-7600B, as shown in Figure 17 on page 58. There is no need to connect through a Layer 2 switch, such as an ED-48000B or DS-4900B, for example.
Note: Figure 17 does not show the CPCs or the AT switches. It only displays the FC connectivity.

**Figure 17** Connectrix B AP-7600B simple SAN topology

### Storage Services Module (SSM) blade in a simple SAN topology

The Connectrix MDS Storage Services Module (SSM) can be installed in any MDS switch or director with open slots. This includes the MDS 9513, 9509, 9506, and 9216. In Figure 18 on page 59, hosts are connected to the SSM ports and storage is connected to the fixed ports on the MDS 9216i. Hosts may be also be connected to the fixed ports; however, since the SSM ports are oversubscribed, they are best suited for host connectivity.

Since the fixed ports are line rate mode (2 Gb on the MDS 9216), storage ports should be connected there to ensure maximum bandwidth.
Figure 18  **Connectrix MDS SSM blade in simple SAN topology**

Figure 19 on page 60 shows an MDS 9513 with a 24-port line card and an SSM blade. Hosts are connected to the SSM ports and storage is connected to the 24-port line card. The SSM ports are oversubscribed so they are best suited for host connectivity. The 24-port line card ports are line rate mode (4 Gb), so storage ports should be connected there to ensure maximum bandwidth.
**SAN Connectivity and Interswitch Link Hops**

**Figure 19**  
MDS 9513 with a 24-port line card and an SSM blade

*Note: Figure 18 on page 59 and Figure 19 do not show the CPCs or the AT switches. They only display the FC connectivity.*

**Node placement in a simple SAN topology—Connectrix B**

The AP-7600B, when used as a single switch, may have both hosts and storage nodes connected directly to any of the ports. It is unlikely that the AP-7600B will be used in this manner because it does not make effective use of the available ports. Since there are only 16 ports, only a mixture of 16 hosts and storage ports are possible. It is more likely that this intelligent switch will be used with more complex designs.
Node placement in a simple SAN topology—Connectrix MDS

The Connectrix MDS single switch/director model is sometimes known as a collapsed core/edge design. There is a mixture of line rate mode (LRM) and oversubscribed mode ports (OSM). The external ports on an SSM blade are oversubscribed (same ratio as the standard 32-port line card). The Cisco switch/director can support virtualized and non-virtualized storage simultaneously. Hosts may be connected to any port in the chassis. Storage may be connected to any port in the chassis.

**Note:** Hosts accessing virtualized storage, and physical storage supplying RecoverPoint, do not have to be connected to the SSM.

The same best practice holds true for host and storage connectivity with or without RecoverPoint. Hosts should be connected to OSM ports whenever possible unless they have high I/O throughput requirements. Storage should be connected to LRM ports whenever possible because a storage port is a shared resource with multiple hosts requiring access.

If there are hosts using solely virtualized storage, then they require the SSM. Therefore, because a dependency exists, connect the host (whenever possible) directly to the SSM. As previously stated, host and storage nodes may be connected to any port on the switch/director.
Complex SAN topologies

Complex SAN topologies derive their complexity from several possible conditions:

- Domain count
- Heterogeneous switch vendors in a single SAN infrastructure
- Distance extension
- Multi-protocol configurations

For the purposes of RecoverPoint, only the first two conditions will be discussed in this section.

Domain count

SANs come in various sizes and configurations. Customers with hundreds of host and storage ports require several FC switches to be linked together through ISLs. Although the size of director class FC switches has significantly increased, core/edge topologies (as discussed in “Compound core edge switches” section in the Fibre Channel SAN Technologies TechBook, available through the E-Lab Interoperability Navigator at http://elabnavigator.EMC.com) are common because legacy switches are used in combination with the new high-density directors. These switches can be all departmental switches, all directors, or a combination of both.

A topology with numerous switches will most likely be in one of two designs, each discussed in the next sections:

- Core/edge (hosts on an edge switch and storage on a core switch). (See Figure 20 on page 64.)
- Edge/core/edge (hosts and storage on an edge switch but on different tiers). (See Figure 21 on page 65.)
Core/edge

Figure 20 on page 64 shows a core/edge design. In this model, hosts are connected to the MDS 9506s (edge tier) and storage is connected to MDS 9513s (core tier). The core tier is the centralized location and connection point for all physical storage in this model. All I/O between the host and storage must flow over the ISLs between the edge and core. It is a one-hop logical infrastructure. (An ISL hop is the link between two switches.)

The SSM blade is located in the core. To minimize latency and increase fabric efficiency, the SSM should be co-located with the storage that it is virtualizing, just as one would do in a Layer 2 SAN.

**Note:** Physical placement of the RecoverPoint Appliances can be anywhere within the fabric and need not be connected directly to the intelligent switch.

**Note:** Direct connections to the SSM are not required.

- ISLs between the switches do not have to be connected to the SSM blade
- Hosts do not have to be connected to the SSM blade
- Storage should not be connected to the SSM blade

Since the SSM is located inside the MDS 9513 core, internal routing between blades in the chassis is not considered an ISL hop. There is additional latency with the virtualization ASICs; however, there is no protocol overhead associated with routing between blades in a chassis.
Figure 21 on page 65 shows a core/edge design with a Connectrix B or RecoverPoint implementation. The AP-7600B is an external intelligent switch; therefore, it must be linked through ISLs to the core switch.

**Note:** Physical placement of the RecoverPoint Appliances can be anywhere within the fabric and need not be connected directly to the intelligent switch.

In this model, hosts are connected to the DS-32B2 (edge tier) and storage is connected to ED-48000B (core tier). The core tier is the centralized location and connection point for all physical storage in this model. All I/O between the host and storage must flow over the ISLs between the edge and core. It is a one-hop infrastructure for
Complex SAN topologies. However, all virtualized storage traffic must pass through at least one of the ports on the AP-7600B. Therefore, the I/O from the host must traverse an ISL between the DS-32B2 and the ED-48000B. Then, it must traverse an ISL between the ED-48000B and the AP-7600B. Finally, it must traverse an ISL back from the AP-7600B to the ED-48000B where the I/O is terminated. This is a three-hop logical topology.

Figure 21  Core/edge design with a Connectrix B
Figure 22 on page 67 shows an edge/core/edge design. In this model, hosts are connected to the Connectrix MDS 9506s (edge tier) and storage is connected to MDS 9506 (storage tier). The MDS 9513s act as a connectivity layer. The core tier is the centralized location and connection point for edge and storage tiers. All I/O between the host and storage must flow over the ISLs between. This is a two-hop logical topology.

Within the fabric, hosts can access virtualized and non-virtualized storage. The location of the physical storage to be virtualized will determine the location of the SSM blade. There are two possibilities:

- Storage to be virtualized is located on a single switch
- Storage to be virtualized is located on multiple switches on the storage tier

**Note:** Physical placement of the RecoverPoint Appliances can be anywhere within the fabric and need not be connected directly to the intelligent switch.

If the physical storage is located on one edge switch, place the SSM on the same switch. See the red box in Figure 22 on page 67.

To minimize latency and increase fabric efficiency, the SSM is co-located with the storage that it is virtualizing.

**Note:** Connections to the SSM are *not* required.

- ISLs between the switches do not have to be connected to the SSM blade
- Hosts do not have to be connected to the SSM blade
- Storage should *not* be connected to the SSM blade

Since the SSM is located inside the edge MDS 9506, internal routing between blades in the chassis is *not* considered an ISL hop. There is additional latency with the virtualization ASICs; however, there is no protocol overhead associated with routing between blades in a chassis.
Figure 22  **Storage on a single switch**

Figure 23 on page 68 shows a core/edge/core design with Connectrix B. The AP-7600Bs are linked via ISLs to the edge ED-48000B.

**Note:** Physical placement of the RecoverPoint Appliances can be anywhere within the fabric and need not be connected directly to the intelligent switch.

In this model, hosts are connected to the DS-32B2 (edge tier) and storage is connected to a ED-48000B, which is the other edge tier. The
SAN Connectivity and Interswitch Link Hops

core ED-48000Bs are for connectivity only. All I/O between the host and storage must flow over the ISLs in the core. It is a two-hop infrastructure for non-virtualized storage. However, all virtualized storage traffic must pass through at least one of the ports on the AP-7600B. Therefore, the I/O from the host must traverse an ISL between the DS-32B2 and the ED-48000B. It must then traverse an ISL between the ED-48000B and the next ED-48000B. Then, it must traverse the ISL between the ED-48000B and the AP-7600B. Finally, it must traverse an ISL back from the AP-7600B to the ED-48000B where the I/O is terminated. This is a four-hop design that would require an RPQ.

Figure 23  Core/edge/core design with Brocade
Storage on multiple switches

If the physical storage is spread amongst several edge switches, a single SSM must be located in a centralized location in the fabric. By doing this, one will achieve the highest possible efficiencies. In Figure 24 on page 70, only one side of the dual fabric configuration is shown. Because the physical storage ports are divided among multiple edge switches in the storage tier, the SSM has been placed in the connectivity layer in the core.

Note: Physical placement of the RecoverPoint Appliances can be anywhere within the fabric and need not be connected directly to the intelligent switch.

For RecoverPoint

Just as with the core/edge design (or any design), all virtualized traffic must flow through the virtualization ASICs. By locating the SSM in the connectivity layer, RecoverPoint’s VIs will only need to traverse a single ISL in order to access physical storage. If the SSM was placed in one of the storage tier switches, most or some of the traffic between the SSM and storage would traverse two or more ISLs.

Note: Connections to the SSM are not required.

- ISLs between the switches do not have to be connected to the SSM blade
- Hosts do not have to be connected to the SSM blade
- Storage should not be connected to the SSM blade

Since the SSM is located inside the MDS 9513, internal routing between blades in the chassis is not considered an ISL hop. There is additional latency with the virtualization ASICs; however, there is no protocol overhead associated with routing between blades in a chassis.
Similarly in the RecoverPoint solution, the physical storage may be spread amongst several edge switches. An AP-7600B must be located in a centralized location in the fabric. This will achieve the highest possible efficiencies.

In Figure 25 on page 71, only one side of the dual fabric configuration is shown. Because the physical storage ports are divided among multiple edge switches in the storage tier, the AP-7600B has been placed in the connectivity layer in the core.
**Note:** When RecoverPoint is added to a SAN, not all physical storage has to be virtualized. Multiple storage ports may have LUNs to be virtualized. However, if more than 75% of the LUNs to be virtualized reside on a single switch (for example, Figure 22 on page 67, then locate the AP-7600B on that switch, as in Figure 22).

![Diagram of SAN Connectivity and Interswitch Link Hops]

**Figure 25** Storage on multiple switches with Connectrix B
Interswitch link hops

This section contains the following information on interswitch link hops:

- “Overview” on page 72
- “Example 1 — Two-hop solution” on page 73
- “Example 2 — Preferred one-hop solution” on page 74
- “Example 3 — Three-hop solution” on page 75
- “Example 4 — One-hop solution” on page 77

**Overview**

An interswitch link hop is the physical link between two switches. The Fibre Channel switch itself is not considered a hop. The number of hops specified in the Switched Fabric Topology table of *EMC Support Matrix* states the maximum supported number of hops in a fabric under no fault conditions. For Class 3 traffic from initiator port to target port, and for Class F traffic among switches, there could be between three and five ISL hops, depending on the vendor. The physical link between host and switch as well as storage and switch is not counted as a hop. If there is a fault in the fabric, more than the *EMC Support Matrix* specified number of hops will be supported temporarily until the fault is resolved. In excess of maximum specified hops are not supported under normal operating conditions.

**Note:** In a fabric topology with RecoverPoint, all virtualized traffic must flow through an ASIC on the AP-7600B or the SSM blade.

In the previous chapters, recommendations were provided for placement in simple and complex fabrics. When including an intelligent switch into a fabric, traffic patterns across ISLs may change and hop counts may increase depending on the vendor and switch type used. The diagrams used in this section display hop counts in various fabric configurations.
In a Cisco MDS design, the SSM blade can be inserted in any MDS chassis with a slot. This includes the MDS 9513, 9509, 9506, and 9216. If the SSM is added to an existing fabric, the addition of the blade does not add any hops within the chassis itself. However, depending on the placement of the SSM in the environment, there may be a direct impact on the number of ISL hops.

**Note:** All virtualized traffic must pass through the SSM. All non-virtualized traffic does not have to pass through the SSM.

**Example 1 — Two-hop solution**

*Figure 26 on page 74 and Figure 27 on page 75, show an example of a four-switch mesh design using MDS 9506s. (Fabric ‘B’ is not shown for simplicity of the diagram. Fabric ‘B’ would be a mirror of Fabric ‘A’.) Figure 26 shows a host attached to *sw1* and physical storage attached to *sw4*. The SSM module has been placed in *sw3*. The host I/O must follow a path from *sw1* to *sw3* (first hop) because of the fabric shortest path first (FSPF) algorithm inherent to FC switches. The SSM then re-maps the I/O and sends it to its physical target on *sw4* (second hop). This is a two-hop solution.*
SAN Connectivity and Interswitch Link Hops

Figure 26 Four-switch mesh design using MDS 9506s (Example 1)

Example 2 — Preferred one-hop solution

Figure 27 shows the same host attached to \textit{sw1} and the same physical storage attached to \textit{sw4}. The SSM module has been moved to \textit{sw4}. The host I/O must follow a path from \textit{sw1} to \textit{sw4}. The SSM then re-maps the I/O and sends it to its physical target on the same switch. There is no hop increase when I/O passes between blades in the MDS chassis. This is a preferred one-hop solution.
Example 3 — Three-hop solution

Figure 28 on page 76 shows a four-switch mesh of ED-48000Bs with an AP-7600B as the intelligent switch. Because the AP-7600B is an external switch, it must be linked via an ISL to the existing fabric. Again, the host is attached to sw1 and physical storage attached to sw4. The AP-7600B has been linked via an ISL to sw4. The host I/O must follow a path from sw1 to sw4 (first hop) because of the FSPF (fabric shortest path first) algorithm inherent to FC switches. The I/O is then passed from sw4 to the AP-7600B (second hop).

The virtualization ASIC re-maps the I/O and passes it from the AP-7600B to sw4 where the physical storage resides (third hop). This is a three-hop solution.
Note: The number of hops and traffic patterns would be identical in an MDS configuration if an MDS 9216 with an SSM blade which is hosting the RecoverPoint instance is attached to an existing fabric of MDS directors.

Figure 28 Four-switch mesh of ED-48000Bs with an AP-7600B as the intelligent switch (Example 3)
With both mesh and complex fabric designs, it is not always possible to maintain a one-hop solution. With higher domain-count fabrics, there is a likelihood of increased hops. This is true of a virtualized and non-virtualized environment. It is also likely with the addition of intelligent switches or blades that some hosts will have more hops than others due to the placement of the physical storage in relation to the location of the intelligent switch.

**Example 4 — One-hop solution**

Figure 29 on page 78 shows a four-switch mesh of MDS 9506s. Storage has been spread across sw2, sw3, and sw4 switches. The SSM blade is located in sw4. (Again, Fabric ‘B’ is not shown for simplicity). Both Host A and Host B are accessing virtualized storage.

All I/O must pass through the SSM. I/O initially passes from sw1 to sw4 (first hop) because of the fabric shortest path first (FSPF) algorithm inherent to FC switches. The SSM re-maps the I/O. The final destination of the I/O may be the EMC storage on sw4.

If the I/O terminates there, it is considered a one-hop solution. However, the final destination may be the EMC storage on sw2 or the non-EMC storage on sw3. In this case, it is a two-hop solution. Host C is not accessing virtualized storage. Its physical target is the EMC storage array on sw2. The I/O passes from sw1 to sw2 because of the FSPF algorithm inherent to FC switches. This is always a one-hop solution.
SAN Connectivity and Interswitch Link Hops

Figure 29 Four-switch mesh of MDS 9506s (Example 4)
This glossary contains terms related to EMC products and EMC networked storage concepts.

**A**

**access control**
A service that allows or prohibits access to a resource. Storage management products implement access control to allow or prohibit specific users. Storage platform products implement access control, often called LUN Masking, to allow or prohibit access to volumes by Initiators (HBAs). *See also “persistent binding” and “zoning.”*

**active domain ID**
The domain ID actively being used by a switch. It is assigned to a switch by the principal switch.

**active zone set**
The active zone set is the zone set definition currently in effect and enforced by the fabric or other entity (for example, the name server). Only one zone set at a time can be active.

**agent**
An autonomous agent is a system situated within (and is part of) an environment that senses that environment, and acts on it over time in pursuit of its own agenda. Storage management software centralizes the control and monitoring of highly distributed storage infrastructure. The centralizing part of the software management system can depend on agents that are installed on the distributed parts of the infrastructure. For example, an agent (software component) can be installed on each of the hosts (servers) in an environment to allow the centralizing software to control and monitor the hosts.
| **alarm** | An SNMP message notifying an operator of a network problem. |
| **any-to-any port connectivity** | A characteristic of a Fibre Channel switch that allows any port on the switch to communicate with any other port on the same switch. |
| **application** | Application software is a defined subclass of computer software that employs the capabilities of a computer directly to a task that users want to perform. This is in contrast to system software that participates with integration of various capabilities of a computer, and typically does not directly apply these capabilities to performing tasks that benefit users. The term application refers to both the application software and its implementation which often refers to the use of an information processing system. (For example, a payroll application, an airline reservation application, or a network application.) Typically an application is installed “on top of” an operating system like Windows or Linux, and contains a user interface. |
| **application-specific integrated circuit (ASIC)** | A circuit designed for a specific purpose, such as implementing lower-layer Fibre Channel protocols (FC-1 and FC-0). ASICs contrast with general-purpose devices such as memory chips or microprocessors, which can be used in many different applications. |
| **arbitration** | The process of selecting one respondent from a collection of several candidates that request service concurrently. |
| **ASIC family** | Different switch hardware platforms that utilize the same port ASIC can be grouped into collections known as an ASIC family. For example, the Fuji ASIC family which consists of the ED-64M and ED-140M run different microprocessors, but both utilize the same port ASIC to provide Fibre Channel connectivity, and are therefore in the same ASIC family. For interoperability concerns, it is useful to understand to which ASIC family a switch belongs. |
| **ASCII** | ASCII (American Standard Code for Information Interchange), generally pronounced [aeski], is a character encoding based on the English alphabet. ASCII codes represent text in computers, communications equipment, and other devices that work with text. Most modern character encodings, which support many more characters, have a historical basis in ASCII. |
| **audit log** | A log containing summaries of actions taken by a Connectrix Management software user that creates an audit trail of changes. Adding, modifying, or deleting user or product administration... |
values, creates a record in the audit log that includes the date and time.

**authentication** Verification of the identity of a process or person.

**B**

**backpressure** The effect on the environment leading up to the point of restriction. See “congestion.”

**BB_Credit** See “buffer-to-buffer credit.”

**beaconing** Repeated transmission of a beacon light and message until an error is corrected or bypassed. Typically used by a piece of equipment when an individual Field Replaceable Unit (FRU) needs replacement. Beaconing helps the field engineer locate the specific defective component. Some equipment management software systems such as Connectrix Manager offer beaconing capability.

**BER** See “bit error rate.”

**bidirectional** In Fibre Channel, the capability to simultaneously communicate at maximum speeds in both directions over a link.

**bit error rate** Ratio of received bits that contain errors to total of all bits transmitted.

**blade server** A consolidation of independent servers and switch technology in the same chassis.

**blocked port** Devices communicating with a blocked port are prevented from logging in to the Fibre Channel switch containing the port or communicating with other devices attached to the switch. A blocked port continuously transmits the off-line sequence (OLS).

**bridge** A device that provides a translation service between two network segments utilizing different communication protocols. EMC supports and sells bridges that convert iSCSI storage commands from a NIC-attached server to Fibre Channel commands for a storage platform.

**broadcast** Sends a transmission to all ports in a network. Typically used in IP networks. Not typically used in Fibre Channel networks.
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<td><strong>default</strong></td>
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<td><strong>default zone</strong></td>
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<td><strong>Dense Wavelength Division Multiplexing (DWDM)</strong></td>
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<td><strong>destination ID</strong></td>
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<td><strong>device</strong></td>
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<td><strong>dialog box</strong></td>
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</table>
DID  An acronym used to refer to either Domain ID or Destination ID. This ambiguity can create confusion. As a result E-Lab recommends this acronym be used to apply to Domain ID. Destination ID can be abbreviated to FCID.

director  An enterprise-class Fibre Channel switch, such as the Connectrix ED-140M, MDS 9509, or ED-48000B. Directors deliver high availability, failure ride-through, and repair under power to insure maximum uptime for business critical applications. Major assemblies, such as power supplies, fan modules, switch controller cards, switching elements, and port modules, are all hot-swappable.

The term director may also refer to a board-level module in the Symmetrix that provides the interface between host channels (through an associated adapter module in the Symmetrix) and Symmetrix disk devices. (This description is presented here only to clarify a term used in other EMC documents.)

DNS  See “domain name service name.”

domain ID  A byte-wide field in the three byte Fibre Channel address that uniquely identifies a switch in a fabric. The three fields in a FCID are domain, area, and port. A distinct Domain ID is requested from the principal switch. The principal switch allocates one Domain ID to each switch in the fabric. A user may be able to set a Preferred ID which can be requested of the Principal switch, or set an Insistent Domain ID. If two switches insist on the same DID one or both switches will segment from the fabric.

domain name service name  Host or node name for a system that is translated to an IP address through a name server. All DNS names have a host name component and, if fully qualified, a domain component, such as host1.abcd.com. In this example, host1 is the host name.

dual-attached host  A host that has two (or more) connections to a set of devices.

E  A time-out period within which each data frame in a Fibre Channel sequence transmits. This avoids time-out errors at the destination Nx_Port. This function facilitates high speed recovery from dropped frames. Typically this value is 2 seconds.
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<tr>
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<tr>
<td><strong>E_Port</strong></td>
<td>Expansion Port, a port type in a Fibre Channel switch that attaches to another E_Port on a second Fibre Channel switch forming an Interswitch Link (ISL). This link typically conforms to the FC-SW standards developed by the T11 committee, but might not support heterogeneous interoperability.</td>
</tr>
<tr>
<td><strong>edge switch</strong></td>
<td>Occupies the periphery of the fabric, generally providing the direct connections to host servers and management workstations. No two edge switches can be connected by interswitch links (ISLs). Connectrix departmental switches are typically installed as edge switches in a multiswitch fabric, but may be located anywhere in the fabric.</td>
</tr>
<tr>
<td><strong>Embedded Web Server</strong></td>
<td>A management interface embedded on the switch’s code that offers features similar to (but not as robust as) the Connectrix Manager and Product Manager.</td>
</tr>
<tr>
<td><strong>error detect time out value</strong></td>
<td>Defines the time the switch waits for an expected response before declaring an error condition. The error detect time out value (E_D_TOV) can be set within a range of two-tenths of a second to one second using the Connectrix switch Product Manager.</td>
</tr>
<tr>
<td><strong>error message</strong></td>
<td>An indication that an error has been detected. See also “information message” and “warning message.”</td>
</tr>
<tr>
<td><strong>Ethernet</strong></td>
<td>A baseband LAN that allows multiple station access to the transmission medium at will without prior coordination and which avoids or resolves contention.</td>
</tr>
<tr>
<td><strong>event log</strong></td>
<td>A record of significant events that have occurred on a Connectrix switch, such as FRU failures, degraded operation, and port problems.</td>
</tr>
<tr>
<td><strong>expansion port</strong></td>
<td>See “E_Port.”</td>
</tr>
<tr>
<td><strong>explicit fabric login</strong></td>
<td>In order to join a fabric, an Nport must login to the fabric (an operation referred to as an FLOGI). Typically this is an explicit operation performed by the Nport communicating with the F_port of the switch, and is called an explicit fabric login. Some legacy Fibre Channel ports do not perform explicit login, and switch vendors perform login for ports creating an implicit login. Typically logins are explicit.</td>
</tr>
</tbody>
</table>
Glossary

F

FA  Fibre Adapter, another name for a Symmetrix Fibre Channel director.

F_Port  Fabric Port, a port type on a Fibre Channel switch. An F_Port attaches to an N_Port through a point-to-point full-duplex link connection. A G_Port automatically becomes an F_port or an E-Port depending on the port initialization process.

fabric  One or more switching devices that interconnect Fibre Channel N_Ports, and route Fibre Channel frames based on destination IDs in the frame headers. A fabric provides discovery, path provisioning, and state change management services for a Fibre Channel environment.

fabric element  Any active switch or director in the fabric.

fabric login  Process used by N_Ports to establish their operating parameters including class of service, speed, and buffer-to-buffer credit value.

fabric port  A port type (F_Port) on a Fibre Channel switch that attaches to an N_Port through a point-to-point full-duplex link connection. An N_Port is typically a host (HBA) or a storage device like Symmetrix, VNX series, or CLARiiON.

fabric shortest path first (FSPF)  A routing algorithm implemented by Fibre Channel switches in a fabric. The algorithm seeks to minimize the number of hops traversed as a Fibre Channel frame travels from its source to its destination.

fabric tree  A hierarchical list in Connectrix Manager of all fabrics currently known to the Connectrix service processor. The tree includes all members of the fabrics, listed by WWN or nickname.

failover  The process of detecting a failure on an active Connectrix switch FRU and the automatic transition of functions to a backup FRU.

fan-in/fan-out  Term used to describe the server:storage ratio, where a graphic representation of a 1:n (fan-in) or n:1 (fan-out) logical topology looks like a hand-held fan, with the wide end toward n. By convention fan-out refers to the number of server ports that share a single storage port. Fan-out consolidates a large number of server ports on a fewer number of storage ports. Fan-in refers to the number of storage ports that a single server port uses. Fan-in enlarges the storage capacity used by a server. A fan-in or fan-out rate is often referred to as just the
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<td>FCP</td>
<td>See “Fibre Channel Protocol.”</td>
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<tr>
<td>FC-SW</td>
<td>The Fibre Channel fabric standard. The standard is developed by the T11 organization whose documentation can be found at T11.org. EMC actively participates in T11. T11 is a committee within the InterNational Committee for Information Technology (INCITS).</td>
</tr>
<tr>
<td>fiber optics</td>
<td>The branch of optical technology concerned with the transmission of radiant power through fibers made of transparent materials such as glass, fused silica, and plastic. Either a single discrete fiber or a non spatially aligned fiber bundle can be used for each information channel. Such fibers are often called optical fibers to differentiate them from fibers used in non-communication applications.</td>
</tr>
<tr>
<td>fibre</td>
<td>A general term used to cover all physical media types supported by the Fibre Channel specification, such as optical fiber, twisted pair, and coaxial cable.</td>
</tr>
<tr>
<td>Fibre Channel</td>
<td>The general name of an integrated set of ANSI standards that define new protocols for flexible information transfer. Logically, Fibre Channel is a high-performance serial data channel.</td>
</tr>
<tr>
<td>Fibre Channel Protocol</td>
<td>A standard Fibre Channel FC-4 level protocol used to run SCSI over Fibre Channel.</td>
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<tr>
<td>Fibre Channel switch modules</td>
<td>The embedded switch modules in the back plane of the blade server. See “blade server” on page 81.</td>
</tr>
<tr>
<td>firmware</td>
<td>The program code (embedded software) that resides and executes on a connectivity device, such as a Connectrix switch, a Symmetrix Fibre Channel director, or a host bus adapter (HBA).</td>
</tr>
<tr>
<td>F_Port</td>
<td>Fabric Port, a physical interface within the fabric. An F_Port attaches to an N_Port through a point-to-point full-duplex link connection.</td>
</tr>
<tr>
<td>frame</td>
<td>A set of fields making up a unit of transmission. Each field is made of bytes. The typical Fibre Channel frame consists of fields: Start-of-frame, header, data-field, CRC, end-of-frame. The maximum frame size is 2148 bytes.</td>
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</table>
frame header  Control information placed before the data-field when encapsulating data for network transmission. The header provides the source and destination IDs of the frame.

FRU  Field-replaceable unit, a hardware component that can be replaced as an entire unit. The Connectrix switch Product Manager can display status for the FRUs installed in the unit.

FSPF  Fabric Shortest Path First, an algorithm used for routing traffic. This means that, between the source and destination, only the paths that have the least amount of physical hops will be used for frame delivery.

gateway address  In TCP/IP, a device that connects two systems that use the same or different protocols.

gigabyte (GB)  A unit of measure for storage size, loosely one billion ($10^9$) bytes. One gigabyte actually equals 1,073,741,824 bytes.

G_Port  A port type on a Fibre Channel switch capable of acting either as an F_Port or an E_Port, depending on the port type at the other end of the link.

GUI  Graphical user interface.

H  

HBA  See “host bus adapter.”

hexadecimal  Pertaining to a numbering system with base of 16; valid numbers use the digits 0 through 9 and characters A through F (which represent the numbers 10 through 15).

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

hop  A hop refers to the number of InterSwitch Links (ISLs) a Fibre Channel frame must traverse to go from its source to its destination.
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**inter-switch link (ISL)**

Interswitch link, a physical E_Port connection between any two switches in a Fibre Channel fabric. An ISL forms a hop in a fabric.

**IP**

Internet Protocol, the TCP/IP standard protocol that defines the datagram as the unit of information passed across an internet and provides the basis for connectionless, best-effort packet delivery service. IP includes the ICMP control and error message protocol as an integral part.

**IP address**

A unique string of numbers that identifies a device on a network. The address consists of four groups (quadrants) of numbers delimited by periods. (This is called **dotted-decimal notation**.) All resources on the network must have an IP address. A valid IP address is in the form `nnn.nnn.nnn.nnn`, where each `nnn` is a decimal in the range 0 to 255.

**ISL**

Interswitch link, a physical E_Port connection between any two switches in a Fibre Channel fabric.

**K**

**kilobyte (K)**

A unit of measure for storage size, loosely one thousand bytes. One kilobyte actually equals 1,024 bytes.

**L**

**laser**

A device that produces optical radiation using a population inversion to provide light amplification by stimulated emission of radiation and (generally) an optical resonant cavity to provide positive feedback. Laser radiation can be highly coherent temporally, spatially, or both.

**LED**

Light-emitting diode.

**link**

The physical connection between two devices on a switched fabric.

**link incident**

A problem detected on a fiber-optic link; for example, loss of light, or invalid sequences.

**load balancing**

The ability to distribute traffic over all network ports that are the same distance from the destination address by assigning different paths to different messages. Increases effective network bandwidth. EMC PowerPath software provides load-balancing services for server I/O.
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<td>logical volume</td>
<td>A named unit of storage consisting of a logically contiguous set of disk sectors.</td>
</tr>
<tr>
<td>Logical Unit Number (LUN)</td>
<td>A number, assigned to a storage volume, that (in combination with the storage device node’s World Wide Port Name (WWPN)) represents a unique identifier for a logical volume on a storage area network.</td>
</tr>
<tr>
<td>MAC address</td>
<td>Media Access Control address, the hardware address of a device connected to a shared network.</td>
</tr>
<tr>
<td>managed product</td>
<td>A hardware product that can be managed using the Connectrix Product Manager. For example, a Connectrix switch is a managed product.</td>
</tr>
<tr>
<td>management session</td>
<td>Exists when a user logs in to the Connectrix Management software and successfully connects to the product server. The user must specify the network address of the product server at login time.</td>
</tr>
<tr>
<td>media</td>
<td>The disk surface on which data is stored.</td>
</tr>
<tr>
<td>media access control</td>
<td>See “MAC address.”</td>
</tr>
<tr>
<td>megabyte (MB)</td>
<td>A unit of measure for storage size, loosely one million (10^6) bytes. One megabyte actually equals 1,048,576 bytes.</td>
</tr>
<tr>
<td>MIB</td>
<td>Management Information Base, a related set of objects (variables) containing information about a managed device and accessed through SNMP from a network management station.</td>
</tr>
<tr>
<td>multicast</td>
<td>Multicast is used when multiple copies of data are to be sent to designated, multiple, destinations.</td>
</tr>
<tr>
<td>multiswitch fabric</td>
<td>Fibre Channel fabric created by linking more than one switch or director together to allow communication. See also “ISL.”</td>
</tr>
<tr>
<td>multiswitch linking</td>
<td>Port-to-port connections between two switches.</td>
</tr>
<tr>
<td>name server (dNS)</td>
<td>A service known as the distributed Name Server provided by a Fibre Channel fabric that provides device discovery, path provisioning, and</td>
</tr>
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</table>

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state change notification services to the N_Ports in the fabric. The service is implemented in a distributed fashion, for example, each switch in a fabric participates in providing the service. The service is addressed by the N_Ports through a Well Known Address.

**network address**

A name or address that identifies a managed product, such as a Connectrix switch, or a Connectrix service processor on a TCP/IP network. The network address can be either an IP address in dotted decimal notation, or a Domain Name Service (DNS) name as administered on a customer network. All DNS names have a host name component and (if fully qualified) a domain component, such as `host1.emc.com`. In this example, `host1` is the host name and `EMC.com` is the domain component.

**nickname**

A user-defined name representing a specific WWxN, typically used in a Connectrix -M management environment. The analog in the Connectrix -B and MDS environments is alias.

**node**

The point at which one or more functional units connect to the network.

**N_Port**

Node Port, a Fibre Channel port implemented by an end device (node) that can attach to an F_Port or directly to another N_Port through a point-to-point link connection. HBAs and storage systems implement N_Ports that connect to the fabric.

**NVRAM**

Nonvolatile random access memory.

**offline sequence (OLS)**

The OLS Primitive Sequence is transmitted to indicate that the FC_Port transmitting the Sequence is:

a. initiating the Link Initialization Protocol  
b. receiving and recognizing NOS  
c. or entering the offline state

**OLS**

See “offline sequence (OLS)”.

**operating mode**

Regulates what other types of switches can share a multiswitch fabric with the switch under consideration.
**operating system**  Software that controls the execution of programs and that may provide such services as resource allocation, scheduling, input/output control, and data management. Although operating systems are predominantly software, partial hardware implementations are possible.

**optical cable**  A fiber, multiple fibers, or a fiber bundle in a structure built to meet optical, mechanical, and environmental specifications.

**OS**  See “operating system.”

**out-of-band management**  Transmission of monitoring/control functions outside of the Fibre Channel interface, typically over ethernet.

**oversubscription**  The ratio of bandwidth required to bandwidth available. When all ports, associated pair-wise, in any random fashion, cannot sustain full duplex at full line-rate, the switch is oversubscribed.

**P**

**parameter**  A characteristic element with a variable value that is given a constant value for a specified application. Also, a user-specified value for an item in a menu; a value that the system provides when a menu is interpreted; data passed between programs or procedures.

**password**  (1) A value used in authentication or a value used to establish membership in a group having specific privileges. (2) A unique string of characters known to the computer system and to a user who must specify it to gain full or limited access to a system and to the information stored within it.

**path**  In a network, any route between any two nodes.

**persistent binding**  Use of server-level access control configuration information to persistently bind a server device name to a specific Fibre Channel storage volume or logical unit number, through a specific HBA and storage port WWN. The address of a persistently bound device does not shift if a storage target fails to recover during a power cycle. This function is the responsibility of the HBA device driver.

**port**  (1) An access point for data entry or exit. (2) A receptacle on a device to which a cable for another device is attached.
**port card**  Field replaceable hardware component that provides the connection for fiber cables and performs specific device-dependent logic functions.

**port name**  A symbolic name that the user defines for a particular port through the Product Manager.

**preferred domain ID**  An ID configured by the fabric administrator. During the fabric build process a switch requests permission from the principal switch to use its preferred domain ID. The principal switch can deny this request by providing an alternate domain ID only if there is a conflict for the requested Domain ID. Typically a principal switch grants the non-principal switch its requested Preferred Domain ID.

**principal downstream ISL**  The ISL to which each switch will forward frames originating from the principal switch.

**principal ISL**  The principal ISL is the ISL that frames destined to, or coming from, the principal switch in the fabric will use. An example is an RDI frame.

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

**principal upstream ISL**  The ISL to which each switch will forward frames destined for the principal switch. The principal switch does not have any upstream ISLs.

**product**  (1) Connectivity Product, a generic name for a switch, director, or any other Fibre Channel product. (2) Managed Product, a generic hardware product that can be managed by the Product Manager (a Connectrix switch is a managed product). Note distinction from the definition for “device.”

**Product Manager**  A software component of Connectrix Manager software such as a Connectrix switch product manager, that implements the management user interface for a specific product. When a product instance is opened from the Connectrix Manager software products view, the corresponding product manager is invoked. The product manager is also known as an Element Manager.
<p>| <strong>product name</strong> | A user configurable identifier assigned to a Managed Product. Typically, this name is stored on the product itself. For a Connectrix switch, the Product Name can also be accessed by an SNMP Manager as the System Name. The Product Name should align with the host name component of a Network Address. |
| <strong>products view</strong> | The top-level display in the Connectrix Management software user interface that displays icons of Managed Products. |
| <strong>protocol</strong> | (1) A set of semantic and syntactic rules that determines the behavior of functional units in achieving communication. (2) A specification for the format and relative timing of information exchanged between communicating parties. |
| <strong>R</strong> | |
| <strong>R_A_TOV</strong> | See “resource allocation time out value.” |
| <strong>remote access link</strong> | The ability to communicate with a data processing facility through a remote data link. |
| <strong>remote notification</strong> | The system can be programmed to notify remote sites of certain classes of events. |
| <strong>remote user workstation</strong> | A workstation, such as a PC, using Connectrix Management software and Product Manager software that can access the Connectrix service processor over a LAN connection. A user at a remote workstation can perform all of the management and monitoring tasks available to a local user on the Connectrix service processor. |
| <strong>resource allocation time out value</strong> | A value used to time-out operations that depend on a maximum time that an exchange can be delayed in a fabric and still be delivered. The resource allocation time-out value of (R_A_TOV) can be set within a range of two-tenths of a second to 120 seconds using the Connectrix switch product manager. The typical value is 10 seconds. |
| <strong>S</strong> | |
| <strong>SAN</strong> | See “storage area network (SAN).” |
| <strong>segmentation</strong> | A non-connection between two switches. Numerous reasons exist for an operational ISL to segment, including interop mode incompatibility, zoning conflicts, and domain overlaps. |</p>
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<td>segmented E_Port</td>
<td>E_Port that has ceased to function as an E_Port within a multiswitch fabric due to an incompatibility between the fabrics that it joins.</td>
</tr>
<tr>
<td>service processor</td>
<td>See “Connectrix service processor.”</td>
</tr>
<tr>
<td>session</td>
<td>See “management session.”</td>
</tr>
<tr>
<td>single attached host</td>
<td>A host that only has a single connection to a set of devices.</td>
</tr>
<tr>
<td>small form factor pluggable (SFP)</td>
<td>An optical module implementing a shortwave or long wave optical transceiver.</td>
</tr>
<tr>
<td>SMTP</td>
<td>Simple Mail Transfer Protocol, a TCP/IP protocol that allows users to create, send, and receive text messages. SMTP protocols specify how messages are passed across a link from one system to another. They do not specify how the mail application accepts, presents or stores the mail.</td>
</tr>
<tr>
<td>SNMP</td>
<td>Simple Network Management Protocol, a TCP/IP protocol that generally uses the User Datagram Protocol (UDP) to exchange messages between a management information base (MIB) and a management client residing on a network.</td>
</tr>
<tr>
<td>storage area network (SAN)</td>
<td>A network linking servers or workstations to disk arrays, tape backup systems, and other devices, typically over Fibre Channel and consisting of multiple fabrics.</td>
</tr>
<tr>
<td>subnet mask</td>
<td>Used by a computer to determine whether another computer with which it needs to communicate is located on a local or remote network. The network mask depends upon the class of networks to which the computer is connecting. The mask indicates which digits to look at in a longer network address and allows the router to avoid handling the entire address. Subnet masking allows routers to move the packets more quickly. Typically, a subnet may represent all the machines at one geographic location, in one building, or on the same local area network.</td>
</tr>
<tr>
<td>switch priority</td>
<td>Value configured into each switch in a fabric that determines its relative likelihood of becoming the fabric’s principal switch.</td>
</tr>
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T

TCP/IP Transmission Control Protocol/Internet Protocol. TCP/IP refers to the protocols that are used on the Internet and most computer networks. TCP refers to the Transport layer that provides flow control and connection services. IP refers to the Internet Protocol level where addressing and routing are implemented.

toggle To change the state of a feature/function that has only two states. For example, if a feature/function is enabled, toggling changes the state to disabled.

topology Logical and/or physical arrangement of switches on a network.

trap An asynchronous (unsolicited) notification of an event originating on an SNMP-managed device and directed to a centralized SNMP Network Management Station.

U

unblocked port Devices communicating with an unblocked port can log in to a Connectrix switch or a similar product and communicate with devices attached to any other unblocked port if the devices are in the same zone.

Unicast Unicast routing provides one or more optimal path(s) between any of two switches that make up the fabric. (This is used to send a single copy of the data to designated destinations.)

upper layer protocol (ULP) The protocol user of FC-4 including IPI, SCSI, IP, and SBCCS. In a device driver ULP typically refers to the operations that are managed by the class level of the driver, not the port level.

URL Uniform Resource Locator, the addressing system used by the World Wide Web. It describes the location of a file or server anywhere on the Internet.

V

virtual switch A Fibre Channel switch function that allows users to subdivide a physical switch into multiple virtual switches. Each virtual switch consists of a subset of ports on the physical switch, and has all the properties of a Fibre Channel switch. Multiple virtual switches can be connected through ISL to form a virtual fabric or VSAN.
| **virtual storage area network (VSAN)** | An allocation of switch ports that can span multiple physical switches, and forms a virtual fabric. A single physical switch can sometimes host more than one VSAN. |
| **volume** | A general term referring to an addressable logically contiguous storage space providing block I/O services. |
| **VSAN** | Virtual Storage Area Network. |
| **warning message** | An indication that a possible error has been detected. See also “error message” and “information message.” |
| **World Wide Name (WWN)** | A unique identifier, even on global networks. The WWN is a 64-bit number (XX:XX:XX:XX:XX:XX:XX:XX). The WWN contains an OUI which uniquely determines the equipment manufacturer. OUIs are administered by the Institute of Electronic and Electrical Engineers (IEEE). The Fibre Channel environment uses two types of WWNs; a World Wide Node Name (WWNN) and a World Wide Port Name (WWPN). Typically the WWPN is used for zoning (path provisioning function). |
| **zone** | An information object implemented by the distributed Nameserver (dNS) of a Fibre Channel switch. A zone contains a set of members which are permitted to discover and communicate with one another. The members can be identified by a WWPN or port ID. EMC recommends the use of WWPNs in zone management. |
| **zone set** | An information object implemented by the distributed Nameserver (dNS) of a Fibre Channel switch. A Zone Set contains a set of Zones. A Zone Set is activated against a fabric, and only one Zone Set can be active in a fabric. |
| **zonie** | A storage administrator who spends a large percentage of his workday zoning a Fibre Channel network and provisioning storage. |
| **zoning** | Zoning allows an administrator to group several devices by function or by location. All devices connected to a connectivity product, such as a Connectrix switch, may be configured into one or more zones. |