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Welcome to Symmetrix Host Connectivity Foundations

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Symmetrix Host Connectivity Foundations

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Symmetrix Host Connectivity Foundations - IMPACT

Course Description



This foundation level course provides participants with an understanding of host connectivity options as part of EMC's offering.

This course is part of the EMC Technology Foundations curriculum and is a pre-requisite to other learning paths.

Course Number:	MR-5WP-SMHCFD		
Method:	IMPACT	Duration:	1 hour

Audience

This course is intended for any person who presently or plans to:

- Educate partners and/or customers on EMC host connectivity options in a Symmetrix and CLARiiON-based storage infrastructure
- Provide technical consulting skills and support for EMC products
- Analyze a Customer's business technology requirements
- Qualify the value of EMC's products
- Collaborate with customers as a storage solutions advisor

Prerequisites

Prior to taking this course, participants should have completed the following Courses:

- None

Course Objectives

Upon successful completion of this course, participants should be able to:

- Discuss the difference between file level and block level access
- Define DAS, SAN, NAS, and CAS storage
- Explain the evolution of Symmetrix connectivity
- List the types and characteristics of available Symmetrix front-end directors
- Illustrate how Symmetrix Logical Volumes are presented to a host

Modules Covered

This course includes one module:

- Host Connectivity

Assessments

This course includes a self-assessment quiz, to be conducted on-line via KnowledgeLink, EMC's Learning Management System.

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Symmetrix Host Connectivity Foundations



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Welcome to Symmetrix Host Connectivity Foundations. This course will introduce host connectivity options. It starts at a high level with a discussion of the various access methods including DAS, SAN, and CAS. It then focuses on the Symmetric and CLARiiON connectivity options and how a Logical Volume, or LUN, appears to the hosts. SAN connectivity and the Connectrix family of products, NAS with Celerra and CAS with Centera, are discussed in more detail under separate training.

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EMC Technology Foundations

- EMC Technology Foundations consists of AutoIS, **SAN products, NAS products, and Storage Platforms**, as well as advanced storage management software.
- EMC Technology supports the portfolio of end-to-end services designed to help accelerate the implementation of Information Lifecycle Management (ILM).
- ILM uses EMC Technology to enable organizations to better and more cost-effectively manage, properly protect, achieve compliance and improve the availability of their business information in a way that ties varying information usefulness to business goals and service levels.

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In prior courses, we discussed the storage platforms that are designed to optimize networked storage. This session discusses the different networking technologies used to connect a host to the storage.

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Course Objectives

After completing this course, you will be able to:

- Discuss the difference between file level and block level access
- Define DAS, SAN, NAS, and CAS storage
- Explain the evolution of Symmetrix connectivity
- List the types and characteristics of available Symmetrix front-end directors
- Illustrate how Symmetrix Logical Volumes are presented to a host
- Explain how a host views a Symmetrix Logical Volume

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These are the learning objectives for this training. This training is focused on Symmetrix based connectivity; however, for the Symmetrix, EMC offers a wide variety of connectivity options for connecting both Open Systems and Mainframe to connect the host to the storage. For the CLARiiON, we offer Open Systems connectivity using Fibre Channel only.

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Block Level vs File Level Access

- Host typically accesses storage in one of three ways
 - Block level
 - Traditional access method for disk storage
 - Storage system presents Logical Volumes or LUNs to the hosts
 - Logical Volume consists of n-number of disk blocks – typically 512 bytes
 - Host sees Logical Volume as physical volumes
 - Typically hosts has exclusive access to Logical Volume
 - File level
 - Files and file system hierarchies are presented to the hosts
 - Hosts typically storage using an IP network
 - Client Server model – Hosts are clients to file servers
 - NFS and Windows Network Shares are examples
 - Performance is less predictable
 - Allows sharing of information among multiple hosts
 - Fixed content objects
 - Static data

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EMC offers highbred solutions such as Celerra HighRoad, where data is seen by the host as a networked file system. In this case, data is accessed directly from disk, at a block level, over a storage area network. Also keep in mind that a single storage system may present both file and block level data to attached hosts.

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ABC's of Storage Connectivity

- DAS – Direct Attached Storage
 - Captive storage
 - ESCON, Parallel SCSI or direct attached Fibre Channel are examples
 - Limited distance and sharing capabilities
- SAN – Storage Area Network
 - Application of network technology to solve channel limitations
 - Hubs and switches
 - Greater distances and more flexibility in sharing storage system
- NAS – Network Attached Storage
 - Unlimited distance
 - NFS and Windows network “shares” are typical applications
- CAS – Content Addressable Storage
 - Fixed content data
 - Data is accessed using uniquely calculated Content Address (CA)
 - Client applications access using API over IP network

Note: EMC storage systems can simultaneously support multiple connectivity options

Direct Attached Storage is the legacy approach to connect a host to disk. Parallel SCSI is an example of this approach; however, Fibre Channel can also be directly connected. With the exception of a multi-initiator configuration that you might see in a cluster environment, disks are never shared. To make a disk available to another host, re-cabling is required.

Today networking technologies are most often used to connect host to storage. EMC uses the term Network Storage to refer to SAN, NAS, and CAS. The greater flexibility, connectivity, and unlimited distances allow the customer to connect more of the enterprise to enterprise storage.

Storage Area Networks provide greater flexibility than DAS and by applying networking technology, allow more host to share a storage system over greater distances. While SANs allow sharing of a storage subsystem, logical volumes within the storage system are not typically shared and SANs use access control methodologies such as zoning and LUN Masking so that a host has exclusive access to the assigned volumes. SANs are typically dedicated networks for the purpose of storage access only.

Network attached storage has been around for almost 20 years. Today we see a lot of attention given to NAS because of the economies of server consolidation and the benefits of Enterprise Storage. NAS allow effectively unlimited distances and multiple hosts can share access to the same files. Applications that use NAS are written in such a manner to coordinate access to shared files in order to maintain data integrity. IP network are often shared with other applications, bandwidth and access time is less predictable than SANs so application requirements must be carefully considered.

CAS or Content Addressable Storage is the latest technique for storing and retrieving fixed content data.

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Networked Storage Technologies

	SAN <i>Storage Area Networks</i>	NAS <i>Network-Attached Storage</i>	CAS <i>Content Addressed Storage</i>
Type of Transport	Fibre Channel IP (emerging)	IP	IP
Type of Data	Block	File	Object, fixed content
Key Requirement	Deterministic performance	Multi-protocol Sharing	Longevity, integrity assurance
Typical Applications	OLTP, data warehousing, ERP	Software and product development, file server consolidation	Content management

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EMC offers networked storage solutions for every business need:

- SAN for business and technical applications requiring optimized transaction performance
- NAS for high-availability file sharing and collaboration
- CAS for storage and retrieval of fixed content (information in its final form like archived (e-mails and MRIs).

SAN, NAS, and now content addressed storage (CAS) are all purpose-built solutions:

- SANs for transactions (OLTP and data warehousing)
- NAS for file sharing (applications such as Decision Support Systems and e-mail)
- CAS for fixed content applications - a purpose-built solution to meet the storing and retrieval needs for very large quantities of fixed content. CAS solutions are online, disk-based repositories that are greatly enhanced through software.

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Application Considerations

- It is not just about physical access to data, it all about how the data is to be used
 - How often does the data change
 - Performance considerations
 - Sharing considerations
 - Capacity requirements
 - Availability requirements
 - Distance between host and storage
 - Skill level of administration team

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It is really the application that determines the appropriate connectivity technology. Here are just a few of the questions that should be asked when assessing an environment when architecting a storage infrastructure.



Symmetrix Enterprise Storage Evolution

- In the 1980's the Data Center was dominated by mainframes
- In EMC offers plug compatible storage
- In the late 1980's early 1990's departmental servers emerged
- In Mid 1990's EMC offers heterogeneous systems attach
 - Storage Consolidation
 - Enterprise Storage
- In 1998 Fibre Channel increases connectivity and distance
 - Enterprise Storage Network
- 2003 – iSCSI support on DMX!

•Data Center

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In the 1980's, the data center was dominated by the mainframe. EMC offered plug compatible storage that was very attractive to the customer. The primary channel interconnection was initially bus and tag cables and later ESCON.

In the late 80's and early 90's we started to see an explosion of application servers inside and outside of the data center. Initially, these were UNIX servers and, then later, Windows based servers. These servers brought with them a wide variety of storage devices including captive disks, JBOD, and RAID subsystems. Each brought with them management challenges and inconsistency in data protection and backup practices.

In mid 1990's, EMC introduced A SCSI front-end director allowing Open System connect. This allowed the application servers in the data center to be connected to the Symmetrix and avail themselves to the benefits of Enterprise Storage. While the benefits were outstanding, limitations on the number of available ports and the distance limitations of SCSI prevented wide scale displacement of direct attached storage.

In 1998, EMC introduced a Fibre Channel Front-end director. Using fiber optical cables, fibre channel allowed distances of up 500 meters. For the first time, application servers outside the data center could be connected to the Symmetrix. Support for hubs and switches immediately followed, allowing servers to share a single port on the Symmetrix and allowing even greater storage consolidation. This was the beginning of Networked Storage. Today, advances in Fibre channel technology have resulted in even greater connectivity over extended distances.

And the evolution continues with today's announcement of iSCSI on the DMX, where even more servers will be able to connect to the Symmetrix.

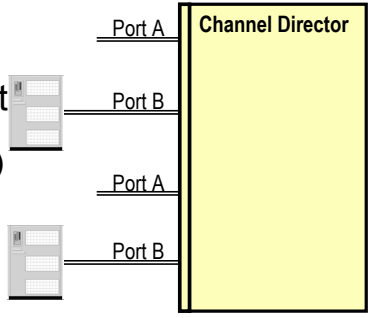
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Symmetrix Front End

- Channel Directors allow Symmetrix to connect to the host environment
 - Minimum of 2 directors per frame (redundancy)
 - Maximum of 4, 6 or 8 directors per frame (depending upon model and configuration)
- Type(s) of Channel Director cards determined by the type of host and the selected protocol for communication with Symmetrix
- Cards are Field Replaceable Units (FRUs) and “hot swappable”
- Open Systems and Windows hosts connect to Symmetrix using either:
 - SCSI (Small Computer System Interface)
 - Fibre Channel (SCSI protocol to be sent over greater distances via Fibre Channel protocol and fiber optic cable)
- Mainframe hosts will typically connect to Symmetrix using ESCON or FICON (IBM-based protocols that allows mainframe hosts to connect to storage using fiber optic cables)



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Normally, Channel Directors are installed in pairs, providing redundancy and continuous availability in the event of repair or replacement to any one Channel Director. Each Channel Director has multiple microprocessors and supports multiple independent data paths to the global memory to and from the host system.

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Flexible Connectivity Options



- DMX supports eight-port, four processor Fibre Channel Directors
 - 2GB/sec (can be configured for 1GB/sec)
 - Single-mode and multi-mode configurations:
 - Eight multi-mode ports
 - Seven multi-mode ports and one single-mode port
 - Six multi-mode ports and two single-mode ports
 - 8,192 Logical Volumes per director (2048 per port)
- SCSI Channel Directors supported on Symm 8000
 - 4 ports, 4 concurrent I/Os (Ultra 40MB/sec)
 - 4 ports, 4 concurrent I/Os (Ultra LVD 80MB/sec)
- iSCSI support using Multi-Protocol Channel Director
 - Low cost connectivity using existing IP network infrastructure

Enterprise Connectivity

Extensive SAN / NAS integration

Extended mainframe functionality

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In addition to existing 2 Gb Fibre Channel and ESCON directors for host connectivity and SRDF links, the DMX introduces the new Multi-Protocol Channel Director for unmatched connectivity flexibility.

The Multi-Protocol Channel Director is available with a 4-port version for DMX1000/DMX2000/DMX3000 (no DMX800 support) and a 2-port version for all Symmetrix DMX Series systems (including the DMX800).

The Multi-Protocol Channel Director allows customers to mix and match the following connectivity options:

- High performance 2 Gb FICON
- Gigabit Ethernet for SRDF
- The industry's first high-end storage attachment for iSCSI

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SCSI Overview

- Open Systems hosts typically use the SCSI (Small Computer Systems Interface) protocols to connect external disks and other peripheral devices
- SCSI standard defines command set, communications protocol, and physical characteristics of the media and connectors
- Traditionally SCSI is implemented using bus topologies
- SCSI is also implemented using Fibre Channel to increase distance and connectivity options
 - Arbitrated Loop
 - Switched fabric
- Each SCSI device is assigned a unique address that includes the TID(Target ID) and LUN (Logical Unit Number)
 - Typical Parallel SCSI bus configurations typically use 16 targets (0-15) with one reserved for HBA
 - Each TID can have one or more LUNs (typically 0 - 15)
 - Fibre Channel maps the SCSI address to LUN
- Today SCSI can also be implemented over IP networks using iSCSI

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The SCSI specification includes extensive options for both physical and operational characteristics. For this reason, it is supported on nearly every open systems platform.

For physical connectivity, EMC offers parallel SCSI on non-DMX Symmetrix, and SCSI over fibre channel and SCSI over IP networks on the DMX.

At a protocol level, the SCSI standard a wide variety of command sets and operational parameters.

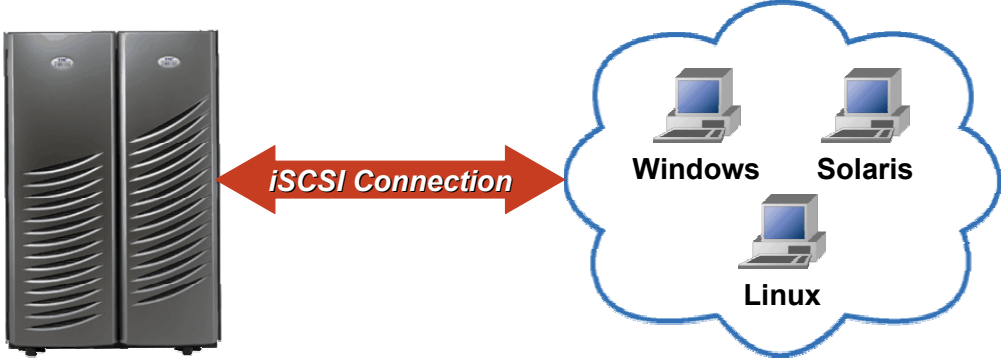
You know what they say about standards: “I like standards because there are so many of them!” SCSI includes provisions to operate with a number of different device type in many different environments. The Symmetrix intelligent front-end directors can be configured on a port-by-port basis to support any specific set of operational parameters as required by a host. Port flag configuration is part of the bin-file and can also be configured using EMC ControlCenter.

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Industry's First High-End iSCSI Implementation



- A method for block level data access using the TCP/IP network
 - Consolidate storage for distributed servers
 - Leverage existing IP network and lower connectivity costs

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The Internet Small Computer Systems Interface (iSCSI) protocol provides a means of transporting SCSI packets over TCP/IP. iSCSI works by wrapping SCSI commands into TCP and transporting them over an IP network. Since iSCSI is IP based traffic, it can be routed or switched on standard Ethernet equipment.

iSCSI offers a cost-effective way of consolidating storage from stranded servers. Symmetrix DMX is the first high-end storage system to support this emerging industry standard. The Symmetrix Multi-Protocol Channel Director supports native iSCSI channel connectivity between Symmetrix DMX systems and open systems servers in lieu of Fibre Channel, and enables Symmetrix DMX systems to connect servers that can use Ethernet for SAN connectivity, which can potentially save thousands of dollars over an equivalent Fibre Channel SAN solution. The iSCSI services on the Multi-Protocol Channel Director support the following host environments:

- All Windows 2000 and Windows 2003 servers listed on the EMC Support Matrix
- All generic 10/100 and Gigabit Ethernet NICs using Windows as above
- Microsoft iSCSI device driver (no TOE or iSCSI HBA)

Other operating system and driver combinations are being qualified, and will be announced as available. Please see the latest EMC Support Matrix for details and updates.

The native iSCSI connectivity eliminates the need for iSCSI to Fibre Channel bridging typically provided through external boxes or through blades found in intelligent multi-protocol switches. By eliminating the need for bridging, customers can save thousands of dollars in hardware costs, reduced protocol processing overhead, and simplify network connectivity, management, and problem determination.

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Mainframe Connectivity Options

- **ESCON - eight-port, four Processor Director**
 - Supports data transfer rates up to 17 MB/s per port
 - Single-mode and multi-mode configurations:
 - Eight multi-mode ports
 - Seven multi-mode ports and one single-mode port
 - Six multi-mode ports and two single-mode ports
 - 8,192 Logical Volumes per director (2048 per port)
- **FICON support using Multi-Protocol Channel Director**
 - Supports data transfer rates up to 2GB/Sec
 - Point-to-point
 - Switched point-to-point
 - Single FICON Fibre Channel Director between server and storage
 - No mixing FICON and FC Open Systems on the same Switch

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Today mainframe connectivity is through either ESCON or FICON serial channels. The original mainframe connectivity was through parallel interfaces with bus and tag cables. Except for a few legacy systems, this bus and tag has been replaced with ESCON because of increased speed and flexibility.

FICON is Fibre Channel for mainframes. It offers superior performance and extended distance as compared to its predecessor, ESCON. As such, most mainframe customers will adopt FICON as their primary mainframe channel connectivity over the next few years.

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ESCON Characteristics

- IBM Mainframe data transmission protocol
- Serial data transmission using frames
 - Duplex 62.5 micron optical cables with ESCON connectors
 - Half-Duplex communication (1 I/O operation per physical channel at any given time)
- For practical purposes, ESCON is capable of 17 MB/sec
 - 20MB/sec theoretical maximum transmission speed based on protocol characteristics
 - Approximately 17MB/sec possible given unavoidable protocol latency
 - Depends upon distance, configuration, equipment, etc.
- Maximum transmission distance is 3km without repeaters
 - 66km using 3 x McData 9191 repeaters
- Switched topologies are possible with ESCON directors



ESCON duplex connector



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ESCON was first made available by IBM in 1990 as a replacement for parallel channel attachment for mainframes. Other mainframe manufacturers, such as Amdahl and Hitachi, support ESCON as well.

It is important to note that even though ESCON cables are “duplex,” meaning that they have separate transmit and receive leads, ESCON data traffic is limited to 1 I/O from 1 LPAR (mainframe partition) at a time per physical channel.

A typical figure for ESCON’s maximum transfer rate is 17MB/sec. You may hear lower figures, such as 14MB/sec. 17MB/sec reflects the maximum speed of the protocol once unavoidable hardware and protocol latency is accounted for, although the physical ESCON “pipe” can support 20MB/sec. Real-world variables typically result in realized transfer rates lower than the stated maximum (a typical figure would be the aforementioned 14MB/sec), but the burst rate is 17MB/sec. Also, when ESCON is transmitted over distances greater than 9Km, “data droop” occurs. This results from the fact that there are not enough data buffers at either end of the ESCON link to support constant throughput.

The McData 9191 (also badged as the IBM ESCON Channel Director 9032 Model 005) is an ESCON channel extender. ESCON directors can provide both static and dynamic connections and are typically used to allow multiple ESCON host channels to access a smaller number of control unit (storage) ports. Extension of ESCON beyond 66Km is possible for SRDF traffic. In fact, using products such as the CNT UltraNet Storage Director (USD), it is even possible to transmit ESCON-based SRDF using Ethernet over WANs, with no real distance limit. However, such transmission is limited to non-synchronous data mirroring, not real-time I/O.

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FICON Characteristics

- IBM Mainframe data transmission protocol
- Serial data transmission using Fibre Channel frames
 - Duplex optical cables
 - Full duplex communication (multiple simultaneous I/O operations per cable)
- For practical purposes, FICON is capable of 70MB/sec
 - 100MB/sec theoretical maximum transmission speed
 - Approximately 70MB/sec possible given unavoidable latency
 - Depends upon distance, configuration, equipment, etc.
- Maximum transmission distance is 10km without switches
 - 100Km using switches and DWDM



- Switched topologies are possible with Fibre Channel switches

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FICON includes many improvements over ESCON and relieves many ESCON architectural limitations. FICON employs ESCON protocols that have been mapped to the FC-4 Upper Level Protocol Layer of the Fibre Channel architecture. The major benefit of using Fibre Channel to transmit ESCON data is performance. Greater performance coupled, with the ability to multiplex I/O operations, means that fewer FICON cables and ports are typically needed to replace ESCON cables and ports, meaning that consolidation is an important benefit as well. Distance is also greatly increased. Some existing Fibre Channel switches (including the Connectrix Enterprise Directors) may be capable of transmitting FICON data. The maximum bandwidth of Fibre Channel is currently 200MB/sec, but FICON is currently based on the 100MB/sec specifications. Because there is ESCON-specific overhead included in the FICON frames that are transported via Fibre Channel, FICON bandwidth can be approximately 60 to 80MB/sec. 70MB/sec is an oft-published maximum performance number for FICON.

The most important thing to remember when comparing FICON to ESCON is that FICON is full-duplex. Both protocols use duplex cables with a transmit and receive lead, but only FICON can utilize a single cable for multiple I/Os from different LPARs at the same time. FICON can therefore “talk” and “listen” at the same time, whereas ESCON can “talk” down a cable and must “listen” for the reply for the same I/O operation in order to let other LPARs transmit and receive their own data.

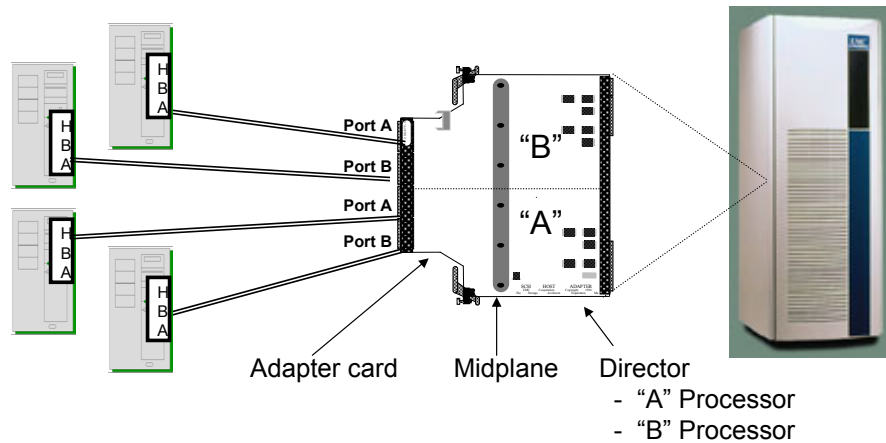
With extenders such as (but not limited to) DWDMs, FICON can be transmitted up to 100Km without “data droop,” since the buffering scheme of Fibre Channel is more robust than that of ESCON.

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Connecting a Symmetrix Using SCSI

- Each SA Director has four ports. The 68 pin SCSI cable connects the HBA (Host Bus Adapter) to the SA port.



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A limitation to SCSI connectivity is each port typically connects only to a single host.

Each port is configured independently and operational parameters can be configured as appropriate for various hosts.

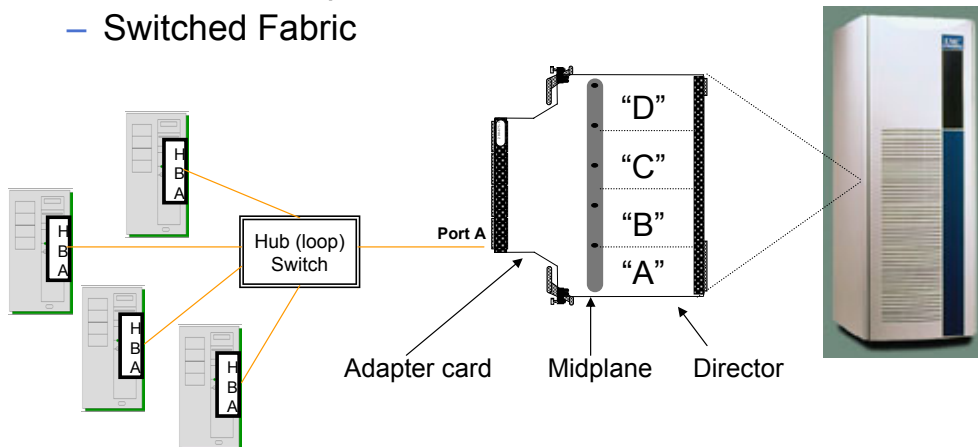
Parallel SCSI is not supported on the DMX.

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Connecting a Symmetrix Using Fibre Channel

- Depending on the model, a FA Director may have up to four processors and (8) 100-200MB/s ports
 - Direct Connect
 - Arbitrated Loop
 - Switched Fabric

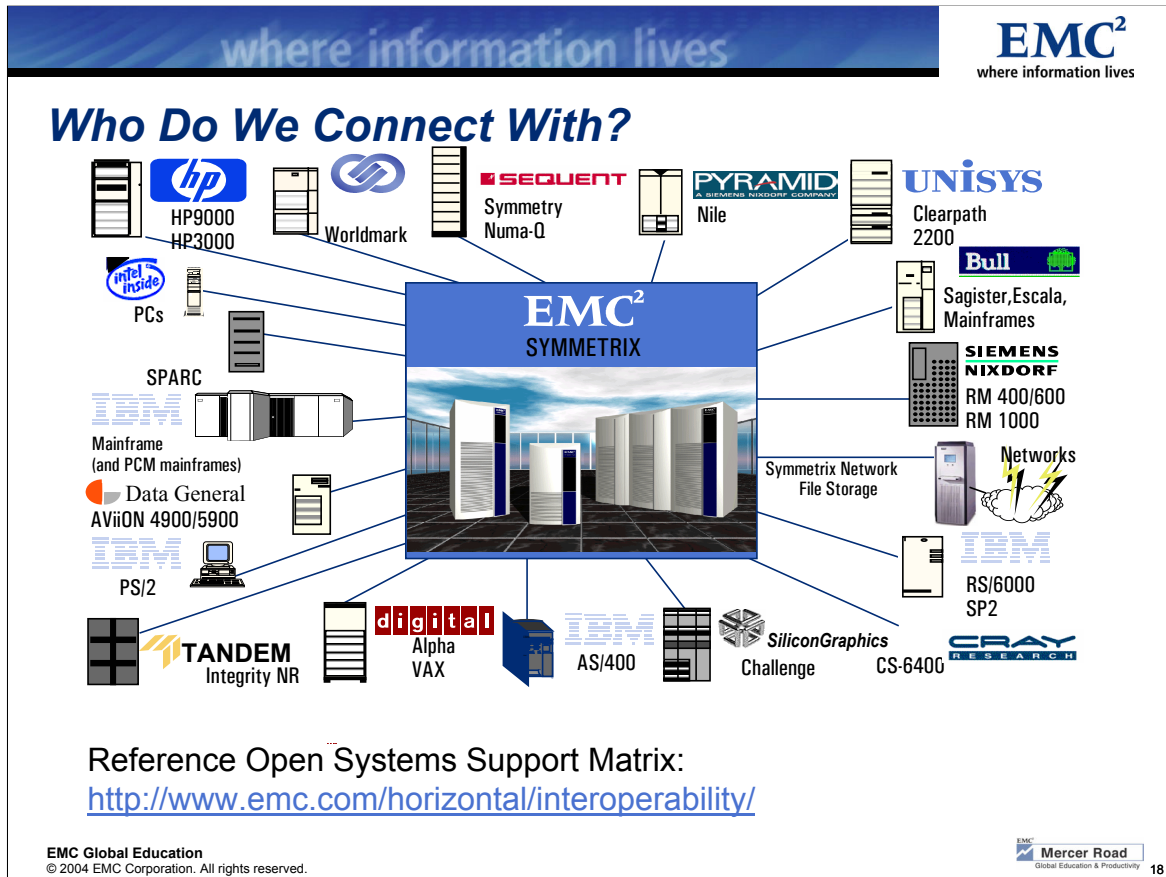


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Each port is configured independently and operational parameters can be configured as appropriate for various hosts.



Who do we connect to? Everybody! We cannot even begin to discuss each vendor we can connect to. However the good news is EMC publishes an extensive support matrix that provides specific detail on who we connect with and under what environments. The document is now over 900 pages long but don't let the size intimidate you as it is well organized.

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How Symmetrix Logical Volumes Appear to a Host

- Symmetrix Logical Volumes are viewed by the hosts as a disk device
- Host is unaware of protection or other Symmetrix attributes
- Unix hosts access disk through device special files
 - Many hosts use CTD format
 - Example: /dev/rdisk/c1t1d2



- Other UNIX hosts assign logical names to disk devices
 - Example: IBM-AIX uses hdisks (/dev/hdisk2)
 - NT accesses disk devices through a PHYSICALDRIVE name
 - Example: \\.\PHYSICALDRIVE2

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A host views a Symmetrix Logical Volume in the same manner as it sees any other disk device. The host is unaware how the volume is configured in the Symmetrix, its protection scheme, or any other special attributes such as BCV or remote replication using SRDF.

Hosts assign Disk Devices a logical device file. Many UNIX hosts such as HP-UX and Solaris use CTD device naming conventions. Note that Solaris calculates the Controller-Target-LUN name differently. The T portion is an actual assigned number, and the D portion is the hex representation of the Target ID and LUN together.

Other operating systems such as NT and IBM AIX assign Logical names that do not map directly to the SCSI ID.

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Course Summary

Key points covered in this course:

- Mainframe systems initially connected to the Symmetrix using Bus & Tag Parallel Channel connection, today ESCON or FICON is typically used
- Open Systems typically use parallel SCSI or Fibre Channel to connect to the Symmetrix
- Fibre Channel provides greater flexibility in connecting hosts to storage and allows for increased performance, greater connectivity, and longer distances
 - Allows corporate computing resources the full advantages of Enterprise Storage
- Logical volumes are presented to front-end channel director when the “bin file” is created, or interactively using ECC
- Hosts view Symmetrix Logical Volumes as disk drives

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These are the key points covered in this training. Please take a moment to review them.

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Thanks for your attention. This ends our training on Symmetrix Host Connectivity Foundations.