OVERVIEW

To cope with the storage challenges of rapid data growth and inefficient data storage and management, companies are rethinking how they design and manage their storage infrastructure. The traditional strategy of deploying servers with direct-attached storage has become an ineffective way to store and manage the information and data that is so essential to the company's business.
Storage Area Networks (SANs) have appeared as the industry-preferred solution to satisfy business requirements. SANs enable organizations to uncouple the application (server) side from the information (data storage) side, providing tremendous flexibility and increased performance to satisfy enterprise needs. SANs provide higher availability, true scalability, and simplified management at a lower total cost of ownership (TCO).
The HP StorageWorks SAN QuickSpec provides an overview of StorageWorks architectures and designs for enterprise deployments. In particular, it describes the three approaches to SAN design, the major SAN design considerations, and a quick reference to the specific hardware components and operating systems supported. For direct access to the documents that provide more in-depth information on SAN design, please visit our website at: http://www. hp StorageWorks SAN.com

For in-depth information on the hp StorageWorks SAN, consult our website at:
http://www.hp StorageWorks SAN.com

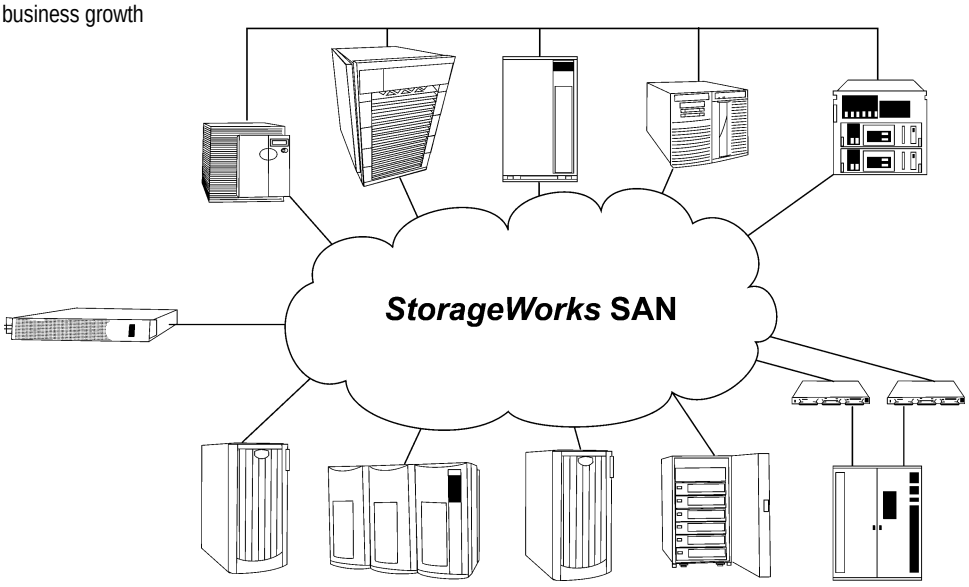
Documents available at the website include:

- The Heterogeneous SAN Design Guide
- The Operating System Support Matrix
- SAN White Papers
- Product Announcements
- Press Releases

BENEFITS OF SANS

StorageWorks SAN's technology provides answers to the challenges facing businesses today. This well-designed SAN architectures and designs:

- Reduce costs through server and storage consolidation, and more efficient data management
- Support today's heterogeneous corporate computing environments
- Allow pools of data, potentially a company's most valuable resource, to be shared over the enterprise and across distances
- Create a more flexible IT infrastructure
- Support business growth



KEY DESIGN CONSIDERATIONS

StorageWorks SANs can be configured to meet the needs of the business today as well as charting a course for the solutions of tomorrow. The flexibility of the StorageWorks SAN allows the needs of the business to shape the SAN solution. Careful attention to several key business needs allows the enterprise to develop a SAN architecture as unique as the business itself.

Factors that need to be considered when designing a SAN include:

- Connectivity levels
- Scalability levels
- Performance levels
- Disaster tolerance
- Backup and restore needs
- Manageability needs
- Physical layout of the enterprise
- Availability levels
- Type of data access required
- Platform and Operating System support needed

STORAGEWORKS SAN DESIGN APPROACHES

StorageWorks SAN architectures allow the IT professional to design a SAN that can meet any demand by providing three approaches to SAN Design and implementation:

- **HP Standard SAN Topologies.** They specify the arrangement of the Fibre Channel Switches within the SAN fabric and are optimized for specific data access needs
- **Custom SAN Topologies** based on qualified design rules. These design rules specify maximum limits and provide guidelines for developing custom design topologies that can be tailored to meet the unique and specific storage and access needs of the enterprise
- **Variations of Standard SAN Topologies.** Using the SAN design rules, IT professionals can modify the standard designs to satisfy specific needs. Standard designs provide an efficient starting point for the overall design

STORAGEWORKS SAN DESIGN RULES THE ADVANTAGE OF FLEXIBILITY

The flexibility of the StorageWorks SAN is unparalleled, placing the power to build a storage infrastructure around the needs of the business directly in the hands of the business. The StorageWorks "Heterogeneous SAN DesignGuide" describes fabric design configuration rules for heterogeneous SANs. These design rules allow the IT professional to create and modify a base configuration to fit the needs of the enterprise. With these design rules, IT professional can create SANs that:

- Support the existing IT infrastructure, preserving investments in existing servers and storage
- Allow for non-disruptive integration into existing IT environments
- Provide the ideal mix of data access, fault tolerance, scalability, and performance based on the needs of the business

FABRIC DESIGN RULES

Fabric Design Rules

The Heterogeneous Design Guide provides the framework within which IT professionals can create custom configurations for the enterprise. Guidelines provided in the Heterogeneous Design Guide include:

General SAN Fabric Rules

- Number of switches supported
- Types of switches supported
- Maximum number of hops supported
- Domain IDs and Worldwide Names needed
- Number of ISLs supported

FABRIC DESIGN RULES *(continued)*

General Fabric Performance Recommendations

Device connection recommendations to maximize performance

SAN Appliance Rules and Recommendations

SAN Fabric Zoning Rules:

- Zoning rules addressing different devices in a SAN
- Zoning rules addressing different hardware platforms in a SAN
- Zoning rules addressing different operating systems in a SAN
- Number of nodes or ports allowed in a SAN

SAN Component Interconnect Rules:

- E-Port interface for switch to switch connectivity
- F-Port interface for fabric attached devices like HBAs and storage devices
- Fibre Optic Interconnects/Distance rules
- Minimum allowable bend radius of fibre optic cable
- Maximum distance per cable segment between devices and switches
- Maximum distance per cable segment between devices and switches or switches and switches

Fibre Optical Cable Loss Budgets

Platform and Operating System Rules:

- Rules on mixing platforms on a single shared storage system
- Rules on zoning for different platforms in a heterogeneous SAN
- Rules on specific platform and operating systems

Storage System Rules:

Rules on configuring storage connected to multiple different platforms and operating systems in a heterogeneous SAN

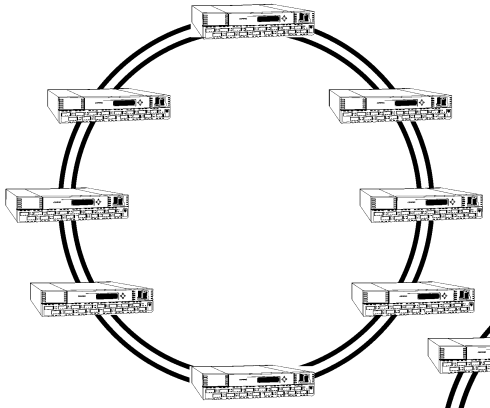
HP "DEFINED" SAN TOPOLOGIES: THE ADVANTAGE OF SIMPLICITY

The StorageWorks SAN also provides the power of simplicity with four defined topologies. Based on the design rules outlined in the Heterogeneous SAN Design Guide, HP has developed four different SAN topologies that can be implemented to provide the ideal levels of data access and connectivity. The four defined SAN topologies are:

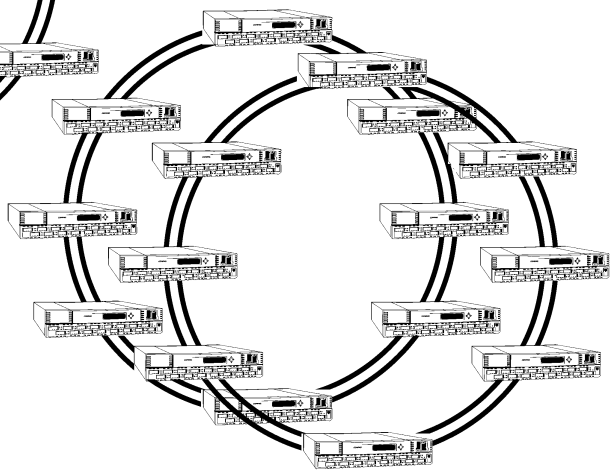
- Ring
- Cascaded
- Meshed
- Core-to-Edge backbones

RING SAN:OPTIMAL FOR LOCAL ACCESS NEEDS

Description: This topology is characterized by a continuous ring of switches connected together into a single fabric. Each switch is connected to the next switch on either side with the last switch in the ring connected back to the first.



8 Switch Ring



8x2 Switch Ring - 2 Fabrics

RING SAN:OPTIMAL FOR LOCAL ACCESS NEEDS *(continued)*

Maximum Switches	Eight in the ring, up to 20 with the branches (check the on-line SAN Design Guide for latest update)	
Available F-Ports	200 to 400	
Maximum hop count	Seven	
Data Access	Local (One to One)	Highest data access
	Centralized (Many to One)	Medium data access
	Distributed (Many to Many)	Not recommended
Physical Layout	Inter-switch distances of up to 10 km	
Availability Levels	Levels one through four	

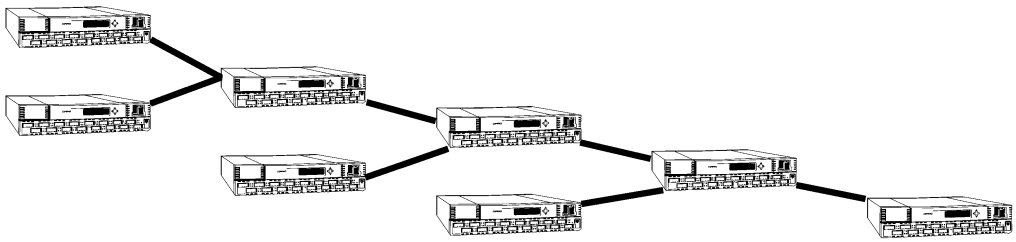
Key Design Strengths:

- Offers the same level of fabric resiliency as the mesh design with full fabric connectivity and at least two internal fabric paths or routes
- Well suited for situations where data access is localized, yet provides the benefits of SAN integration to the whole organization
- Scaling is easy and logical
- Centralized management and backup is supported
- Shared backup is supported
- Non-disruptive expansion is possible due to modular design
- Ring fabric can be pre-configured and installed before the server requirements are known
- Supports multiple fabrics for higher availabilities

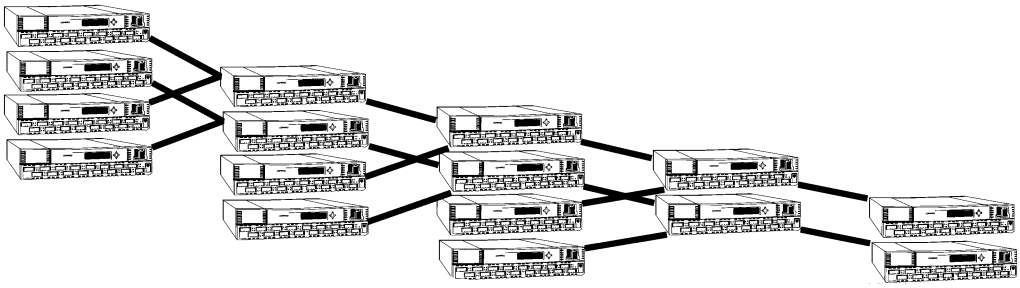
CASCADED SAN:ACCOMMODATING GEOGRAPHICAL CONDITIONS

Description: A string of switches or levels of switches connected together by one or more Inter–switch links (ISL). The switches are arranged in a linear array, each one connected to the switch that is next in line, or arranged in a vertical cascade with multiple levels off a single top switch.

8 Switch Cascaded



8x2 Switch Cascaded – 2 Fabrics



CASCADED SAN:ACCOMMODATING GEOGRAPHICAL CONDITIONS *(continued)*

Maximum Switches	20 (Check on-line Design Guide for latest limit)	
Available F-Ports	200 to 400	
Maximum hop count	Seven	
Data Access	Optimal for local access	
	Local (One to One)	Highest data access
	Centralized (Many to One)	Not recommended
	Distributed (Many to Many)	Medium data access
Physical Layout	Inter-switch distances of up to 10 km	
Availability Levels	Levels one through four	

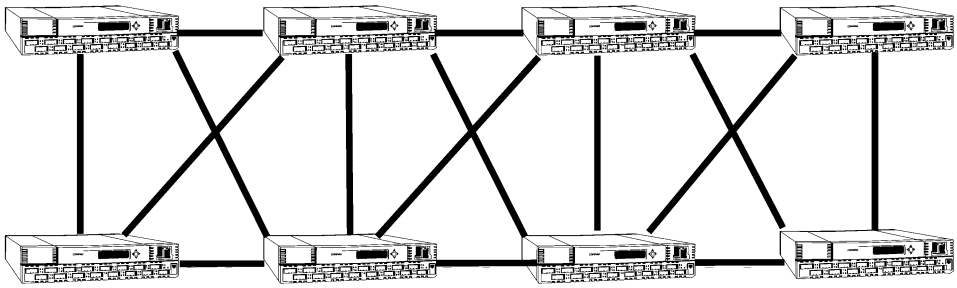
Key Design Strengths:

- Well suited for applications where data access is local, yet provides the benefits of an integrated SAN across the organization
- Scales easily for additional connectivity
- Supports centralized management and backup
- Supports shared backup
- Provides highest performance when groups of servers and the
- storage being accessed can be connected to the same switches
- Supports multiple fabrics for higher availability
- Accommodates diverse geographic conditions

MESHED SAN:SATISFYING LOCAL AND REMOTE DATA ACCESS NEEDS

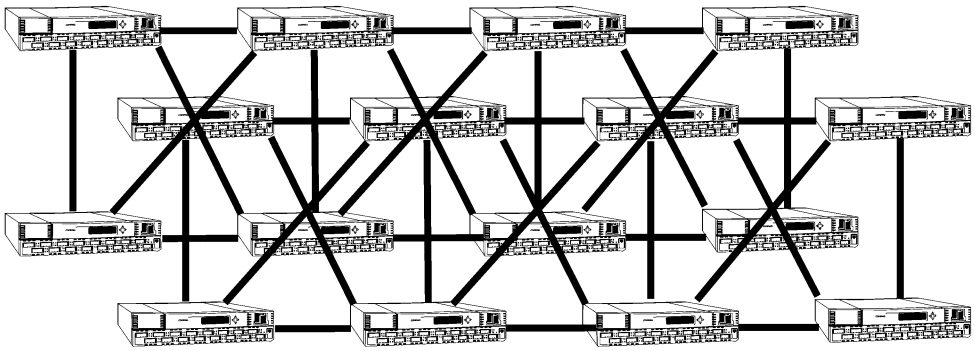
Description: Similar to a cascaded fabric, in a meshed fabric all switches are interconnected. However, this topology provides at least two paths or routes from any one switch to another switch in the fabric.

8 Switch Meshed



MESHED SAN:SATISFYING LOCAL AND REMOTE DATA ACCESS NEEDS *(continued)*

8 Switch Meshed – 2 Fabrics



Maximum Switches	20 (Check the on-line SAN Design Guide for the latest update)
Available F-Ports	200 to 400
Maximum hop count	Seven
Data Access	Can be configured for many to many, local data access, or a mix. This topology is best suited to applications where the data access is a mix of local and distributed. Local (One to One) — High data access Centralized (Many to One) — Medium data access Distributed (Many to Many) — High data access
Physical Layout	Inter-switch distances of up to 10 km
Availability Levels	Levels one through four

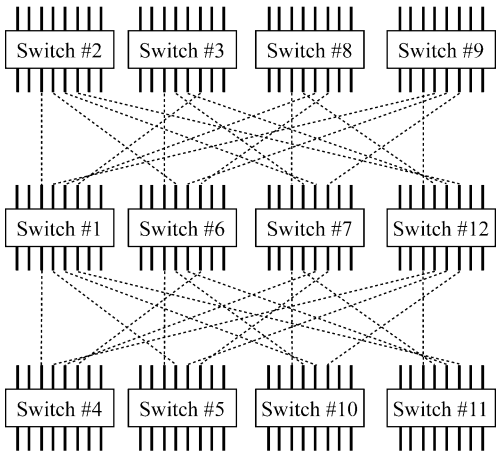
Key Design Strengths

- Provides protection against link and switch port failures
- Ideal for situations where data access requirements are a mix of local and distributed
- Scales easily
- Supports centralized management and backup
- Supports shared backup
- Provides a level of fabric resiliency such that if a single ISL or ISL switch port interface fails, the fabric can automatically re-route data through an alternate path through other switches in the fabric.
- Supports multiple fabrics for higher availability

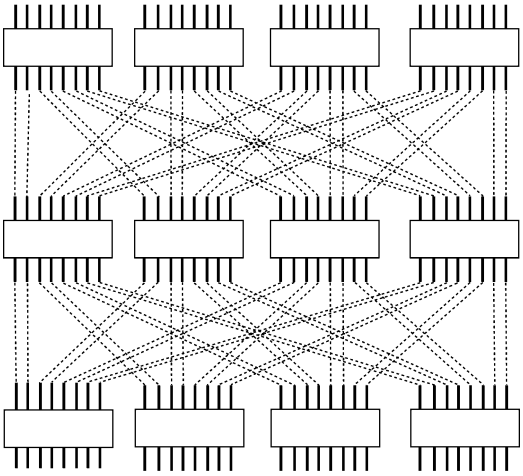
"CORE-TO-EDGE"BACKBONE SAN:HIGHEST PERFORMANCE AND DISTRIBUTED ACCESS

Description: A Tree Backbone SAN fabric is a three-level configuration of switches where the center level switches are dedicated as core or backbone switches. These core or backbone switches connect the edge switches on the upper and lower tiers in the fabric. Servers and storage subsystems can be connected to and intermixed with any of the edge switches.

Fat trees and skinny trees are two forms of backbone topologies. The primary difference between them is the ratio of end ports to ISL connections. In a fat tree configuration this ratio is one, while skinny trees have a ratio greater then one. For the SAN fabric design, there is a trade off between cross sectional bandwidth (more ISLs) and connectivity (# of ports). Fat trees provide the many-to-many connectivity needed in virtualization implementations. Skinny trees on the other hand, allow device connectivity at the core and are popular designs: the 4 x 24 skinny tree is an example of this type of architecture.



128-Port Skinny Tree – High Connectivity



64-Port Fat Tree – High Bandwidth

"CORE-TO-EDGE" BACKBONE SAN:HIGHEST PERFORMANCE AND DISTRIBUTED ACCESS *(continued)*

Maximum Switches	20 with up to four switches dedicated as backbones (check the on-line SAN Design Guide for the latest update)	
Available F-Ports	192 to 384	
Maximum hop count	Seven	
Data Access	Backbone topologies offer maximum flexibility for implementing mixed access types: local, distributed, centralized. It also offers the best many to many connectivity with evenly distributed bandwidth and redundant connectivity	
	Local (One to One)	Medium data access
	Centralized (Many to One)	Highest data access
	Distributed (Many to Many)	Highest data access
Physical Layout	Inter-switch distances of up to 10 km	
Availability Levels	Levels one through four	

Key Design Strengths:

- Highest fabric performance
- Best for "many-to-many" connectivity and evenly distributed bandwidth throughout the fabric
- Offers maximum flexibility for implementing mixed access types (local, distributed, and centralized)
- Supports centralized management and backup
- Well suited for situations where data traffic patterns may vary and may even be random at times but the underlying need is for full network many-to-many connectivity with high performance
- Supports all availability levels
- Provides an easy upgrade path from other SAN designs
- Efficient port expansion since new switches need only be connected to backbone switches
- When implemented with 2 backbone switches, provides a level of switch redundancy in a single fabric
- Well suited to take full advantage of expected future technological developments such as storage virtualization

HPSAN PLATFORM AND OPERATING SYSTEM SUPPORT

All of the HP SAN topologies support a heterogeneous mix of HP and Multi-vendor hardware platforms and operating systems.

The platforms and operating systems supported in the HP SAN are:

- HP Tru64 UNIX®
- Microsoft® Windows® NT®, Windows 2000, Datacenter
- HP OpenVMS
- SUN™ Solaris™
- HP-UX
- Novell® NetWare®
- Red Hat® Linux®
- SuSE® Linux
- SGI IRIX
- IBM AIX

SUPPORTED CLUSTER PRODUCTS

The HP SAN also supports a range of cluster products including:

- HP Tru64 TruCluster
- HP MC/ServiceGuard
- VMS Clusters
- Microsoft Cluster Server (MSCS)
- Novell NetWare Clusters
- SUN Clusters
- VERITAS Clusters

INTERCONNECTS AND COMPONENTS

Host Bus Adapters

The Fibre Channel Host Bus Adapters (HBA) supported in the Compaq heterogeneous open SAN are:

Host Bus Adapter	Operating System
HP 380574-001/KGPSA-BC	Windows NT, Windows 2000, Tru64 UNIX, OpenVMS
HP 168794-B21/KGPSA-CA	Tru64 UNIX, OpenVMS
HP 176479-B21/KGPSA-CB	Windows NT, Windows 2000
HP 120186-B21/291 (64 bit), 223180-B21/291 (32 bit)	Novell NetWare
HP 380575-001/SWSA4-SB (JNI FC-1063) 32-bit Sbus	SUN Solaris
HP 380576-001/SWSA4-PC (JNI FCI-1063) 32-bit PCI	SUN Solaris
HP 123503-001/SWSA4-SC (JNI FC64-1063) 64-bit Sbus	SUN Solaris
HP 254457-B21 (QCP2202F cPCI)	SUN Solaris
HP 254456-B21 (QLA2310F PCI)	SUN Solaris
HP 254458-B21 QLA2202FS Sbus)	SUN Solaris
HP 167433-B21	Redhat, SUSE Linux x86/Alpha
HP 218409-B21	HP-UX
HP A3404A FC-AL HSC Bus, K Class	HP-UX
HP A3591A FC-AL HSC Bus, D Class	HP-UX
HP A3636A FC-AL HSC Bus, T Class	HP-UX
HP A3740A FC-AL PCI, L Class	HP-UX
HP A5158A FC-AL PCI A/L/V/N Class	HP-UX
HP A5158A (PCI)	HP-UX
HP A6685A, K class	HP-UX
QLogic 2200F/66SGI PCI-FC-1POPT PCI	IRIX
QLogic 2200F/66SGI XT-FC-1POPT XIO	IRIX

NOTE: The HP branded HBAs listed above are supplied with HP specific drivers and firmware. These are the only HBAs supported for the specified operating systems.

Fibre Channel Switches

The StorageWorks Fibre Channel Switches supported in the Compaq heterogeneous open SAN are:

Product Name	6 – 3
Fibre Channel SAN Switch 8 Port	158222-B21
Fibre Channel SAN Switch 16 Port	158223-B21
Fibre Channel SAN Switch 8 Port-EL	176219-B21
Multiport upgrade for 8 Port-EL	207104-B21
StorageWorks SAN Switch 16 Port-EL	212776-B21
StorageWorks SAN Switch *Integrated*/32	230616-B21
StorageWorks SAN Switch *Integrated*/64	230617-B21

INTERCONNECTS AND COMPONENTS *(continued)*

StorageWorks SAN Switch 2/16 Port	240602-B21
StorageWorks SAN Director 64	254512-B21
StorageWorks SAN Switch 2/16 EL	283056-B21
StorageWorks SAN Switch 2/8 EL	258707-B21
StorageWorks Core Switch 2/64	254508-B21

Gigabit Interface Converters (GBIC)	Distance	Part Number
Short Wavelength	850 nm	380561-B21
Long Wavelength	1310 nm	127508-B21
Very Long Distance	1550 nm	230800-B21

Fiber Optical Cables	Length	Part Number
50/125 Multi-Mode	2m	234457-B21
50/125 Multi-Mode	5m	234457-B22
50/125 Multi-Mode	15m	234457-B23
50/125 Multi-Mode	30m	234457-B24
50/125 Multi-Mode	50m	234457-B25
62.5/125 Multi-Mode		
9/125 Single-Mode		

Gigabit Link Modules (GLM)

- Short wavelength (850 nm) 30-50124-01

Data Replication Manager (DRM) Interfaces/Transports

- Fibre channel connection via 50, 62.5 micron multi-mode, or 9 micron single-mode fibre optic cable
- Fibre channel connection via Wave Division Multiplexing (WDM) and Dense Wave Division Multiplexing (DWDM)
- ATM over a single T1/E1 Wide Area Network
- ATM over multiple T1/E1 Wide Area Network (Inverse Multiplexing)
- ATM over T3/E3 Wide Area Network
- ATM over fractional and/or shared T3/E3 and OC3 Wide Area Network

SAN Management Tools

SAN Management Application	OSM Based	Fabric Based	Server Based	Storage Based
SAN Fabric Management				
StorageWorks Fabric Watch User Guide	No	Yes	No	No
SAN/Fibre Channel Switch Management	No	Yes	No	No
SANworks Network View	Yes	No	No	No
SAN Storage Management				
HP OpenView Storage Element Manager for HSG	Yes	No	No	No
HP OpenVIew Storage Element Manager for HSV	Yes	No	No	No
HP SANworks Network View	Yes	No	No	No
HP StorageWorks Command Console	No	No	Yes	No
HP Storage System Array Controller Software (ACS) Command Line Interface (CLI)	No	No	No	Yes
HP OpenView Storage SANscript	No	No	Yes	No
RA4000/4100 Array Configuration Utility (ACU)	No	No	Yes	Yes
MSA1000 (ACU, ACU-XE, ACU-XE(Offline)	No	No	Yes	Yes
HP StorageWorks Secure Path	No[1]	No	Yes	No
SAN Data Management				
HP OpenView Storage Enterprise Volume Manager (EVM)	No	No	Yes	No[2]
HP OpenView HP OpenView Storage virtual replicator	No	No	Yes	No
HP OpenView Storage Data Replication Manager (DRM)	No	No	No	Yes[3]
HP OpenView Storage Command Scripter	No	No	Yes	No[2]

INTERCONNECTS AND COMPONENTS *(continued)*

SAN/Storage Usage & Monitoring				
HP SANworks Network View	Yes	No	No	No
HP OpenView Storage Open SAN Manager (OSM)	Yes	No	No	No
HP OpenVIew Storage Resource Manager (SRM)	No	Yes	Yes	No
HP OpenView Storage Resource Manager for Exchange	No	Yes	Yes	No
HP OpenView Resource Monitor	Yes	No	No	No
HP OpenView Storage Allocation Reporter	Yes	No	No	No

1. This product is a character cell interface to configure and control an Enterprise Virtual Array.
2. This product is a front-end to the Storage System's CLI.
3. DRM requires ACS Version 8.xP Software.

Storage Arrays

- HP StorageWorks Enterprise Virtual Array
- HP RAID Array 4000 (RA4000)
- HPRAID Array 4100 (RA4100)
- HP StorageWorks Modular SAN Array 1000 (MSA1000)
- HP StorageWorks Modular Array 6000 (MA6000)
- HP StorageWorks Modular Array 8000 (MA8000)
- HP RAID Array 8000 (ra8000)
- HP StorageWorks Enterprise Modular Array 12000 (ema12000)
- HP StorageWorks Enterprise Modular Array 16000 (ema16000)
- HP StorageWorks Enterprise Storage Array 12000 (esa12000)

SAN GLOSSARY

Arbitrated loop topology: A Fibre Channel topology that provides a (FC-AL) lower cost solution to attach multiple communicating ports in a loop.

Cascade: Connecting one switch to another switch for an inter-switch link.

Dynamic load sharing: Automatically distributes traffic among multiple paths.

Fabric: Single or Multiple Fibre Channel switches interconnected which use Fibre Channel methodology for linking nodes and routing frames in a Fibre Channel network.

Fibre Channel: A high-speed serial transmission network technology. Three topologies: point to point, arbitrated loop, and switched.

ISL (Inter Switch Link)**:** Connection between two switches.

Mesh: A cascading subset that defines the physical connections between switches where multiple switches are all connected to each other.

Node: The basic definition of a Fibre Channel device. A node may have one or two ports.

Port: The hardware entity within a node that performs data communications over the Fibre Channel link.

Storage Pool: A centralized resource of disk devices that can be allocated in an on-demand fashion.

Topology: The logical and/or physical arrangement of switches in a network.

Zone: A logical or physical blockage creating a grouping of ports in a switch that is allowed to communicate with each other. Other elements not in the zone cannot communicate.

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