Storage Area Network Configurations for RA8000/ESA12000 on Novell NetWare

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Introduction

This application note describes fibre channel switch based Storage Area Network (SAN) configurations for RA8000/ESA12000 storage systems on Novell NetWare platforms. For mixed platform heterogeneous SAN configurations, refer to the "Heterogeneous Storage Area Networks" application note and the applicable platform-specific application notes listed in Table 3.

Enterprise Network Storage Architecture (ENSA)

The Compaq Enterprise Network Storage Architecture is key to supporting Compaq's NonStop eBusiness strategy; through ENSA, Compaq leverages industry standards to allow deployment of storage where applications need it. ENSA uses the Compaq StorageWorks product family to deliver the storage solutions that address non-stop computing requirements like availability, reliability, performance, scalability, manageability, and data backup/restore capabilities. ENSA addresses the storage issues that our customers expect to face now and in the future. Compaq SANs address today's issues including:

- Data protection
- High availability
- Increased distance
- High connectivity
- High bandwidth
- Multi-vendor platform support
- Economical capacity growth
- Scalability
- Investment protection

With the addition of multi-switch fibre channel Fabric support in the RA8000/ESA12000 FC storage products and the integration of Enterprise Backup Solutions (EBS) into the SAN, Compaq has taken the next evolutionary step in delivery of the ENSA vision. Our customers can now realize the full benefits of a scalable Storage Area Network providing the robust backbone needed to address dispersed server operation with shared storage access and backup across the enterprise.

Product Overview

The RA8000 and ESA12000 FC storage systems are based on a common architecture and offer customers centralized management, high availability, and exceptional performance and scalability in open systems environments. These products provide a Fibre Channel storage solution with industry leading SAN support utilizing both FC-Fabric (switch) and FC-AL (arbitrated loop) technology.

The RA8000 FC is a mid-range storage system available in a pedestal enclosure for departmental use in the office. It can also be installed in server racks for small data centers. An easy-to-deploy, flexible solution for open systems, the RA8000 supports up to 2.6 TB of storage.

The ESA12000 FC, designed for the data center, is available in three easy-to-order building blocks; each optimized for specific, high-capacity customer requirements. The ESA12000 FC offers unprecedented levels of storage, scaling in performance and capacity as user requirements increase.

These storage systems incorporate the latest RAID technology providing RAID levels 0, 1, 0+1, adaptive 3/5, and non-RAID disks. Compaq's implementation of RAID capability assures that data availability will be maintained despite hardware failure. Features such as read ahead cache and mirrored write back cache improve or minimize the effect on performance while preserving data availability and supporting high availability.

The RA8000/ESA12000 FC platform kits contain the necessary operating system specific software and documentation needed to install, configure, and monitor your storage system. All platform kits include the StorageWorks Command Console (SWCC) for storage management operations including configuring, status inquiry and notification facilities. SWCC provides a user oriented graphical user interface (GUI) simplifying the most complex of storage management operations.

NetWare Cluster Services

NetWare Cluster Services (NCS) is the clustering software system implemented on servers to ensure high availability and manageability of critical network resources, including data (volumes), applications, server licenses, and services. It is a multinode, NDS-enabled clustering product of NetWare 5 that supports failover, failback, and migration (load balancing) of individually managed cluster resources. NCS provides important features to help you ensure and manage the availability of your network resources. These features include:

- Support for shared disk configurations or local disk configurations.
- Multinode all-active cluster. Any server in the cluster can restart resources (applications, services, IP addresses, and volumes) from a failed server in the cluster.
- Single point of administration through a Java-based ConsoleOne cluster configuration and monitoring graphical user interface.
- The ability to tailor a cluster to the specific applications and hardware infrastructure that fit your organization.
- Dynamic assignment and reassignment of server storage on an as-needed basis.

> Novell Cluster server requires that the shared storage devices be accessible from all servers in the cluster.

For Novell Cluster Server in a large heterogeneous SAN, either Selective Storage Presentation or switch zoning will need to be used to ensure that only the servers in the cluster can access the storage used by that cluster.

SAN Concepts

A Storage Area Network interconnects multiple shared storage environments and servers into a storage network. All storage can be managed from a single location or from multiple locations. All of the storage becomes available to any server, regardless of physical location.

SAN Management

SAN management tools and product features provided with the RA8000/ESA12000 storage systems include the following:

- SAN Storage and Switch Management
    SWCC – Utilized to manage and monitor storage systems, storagesets, and SAN fibre channel switches including configuration, status inquiry, and notification facilities.

- SAN Access Management
    Switch Fabric Zoning – The FC switch Zoning feature provides a means to control SAN access at the node port level. Zoning can be used to separate one physical Fabric into many virtual Fabrics consisting of selected server and storage ports. This capability allows you to set up barriers between different operating environments, to deploy logical Fabric subsets by creating defined server and/or storage groups, or to create temporary server and storage zones for tape backup. Zones may be configured dynamically, and the number of zones and zone membership are effectively unlimited. Nodes can be in multiple zones to allow for overlapping depending on the desired access control. Use of Zoning is supported in both homogeneous NetWare SAN configurations and heterogeneous mixed platform SAN configurations.

    Selective Storage Presentation (SSP) – The RAID Array SSP feature provides a means to control access at the storageset level. SSP is an exclusive RA8000/ESA12000 storage system feature that allows multiple servers or host bus adapters (HBA) to share access to the same RAID array reliably, with each server or the HBAs storagesets (LUNs) presented exclusively to those that are allowed access. Additionally, SSP allows the setting of host modes and LUN offsets for each HBA connected to the array. The host mode is specially tailored to the storage communication techniques of the operating system. The LUN (logical unit) offset feature allows higher numbered LUNs in a RAID Array to be presented in a range required by specific operating systems. The SSP feature also provides a means to track the numerous FC HBAs within servers attached to a SAN by identifying each by Worldwide ID (WWID).

Additional information about these products and features is available in the documentation listed in Table 3.

SAN Performance Considerations

Many different components of the system and the configuration of the SAN can limit the performance of an application on a system using RA8000 or ESA12000 FC storage. Some of the possible component limiting factors include the host CPU(s), memory size, FC HBA, RAID controllers, or the specific configuration of disks used behind the controllers. At the SAN level, performance can be limited by the number and arrangement of FC switches and inter-switch links (ISL) in the Fabric, and the way servers and storage systems are connected to the Fabric. The limiting factor can move to any of these areas depending on the workload. Identifying the limits will assist in determining the best configuration for a given application.

SAN Configuration Guidelines

The following sections provide information about configuring SANs including the base Fabric design selection, fibre channel Fabric rules, platform and disk storage connectivity rules. The configuration information is presented in the form of rules to provide for flexibility and customization depending on the specific customer need. In addition to the listed rules, also shown are examples of recommended SAN configurations based on the number and arrangement of fibre channel switches in a Fabric. The example "SAN Fabric Configurations" illustrates proper application of the listed rules with regard to fibre channel switch arrangement, switch interconnection in a Fabric, and platform/storage connections. The exact SAN Fabric configuration used for your specific application should begin with one of the base SAN configurations shown. In choosing a Fabric configuration you should consider capacity, connectivity, availability, distance, backup, and performance needs as well as future growth requirements.

It is not required that you configure server and storage in the SAN exactly as depicted in the illustrations, however it is strongly recommended that the switch interconnection rules and platform connectivity rules be strictly adhered to.

This application note describes homogeneous NetWare SAN configurations. It is expected that customers may desire to implement a heterogeneous SAN consisting of many different operating system platforms. Whether implementing a homogeneous or heterogeneous SAN, it is necessary to adhere to the platform specific rules and maximums for each given platform within the SAN.

SAN Design Selection Process

It is suggested that the following general steps be followed when initially designing a SAN.

1. Considering capacity, connectivity, availability, distance, performance, and backup requirements, select the SAN Fabric configuration that best fits your needs. Refer to the configuration illustrations, notes, Fabric rules, and platform server and storage connectivity rules. Using the maximum server and maximum storage counts shown as the upper bound limits determine the specific number of servers or storage required number for your particular installation.

    - If you want a lower server count than the maximum listed: You may increase the storage count, but only to the upper limit indicated for maximum storage, and provided you do not exceed the platform limits listed in Table 1 for HBAs/Server and Controller Ports/HBA.

    - If you want a lower storage count than the maximum listed: You may increase the server count, but only to the upper limit indicated for maximum servers, and provided you do not exceed the platform limits listed in Table 1 for Servers/Storage System.

    - If capacity or connection needs are greater than provided in a 4 switch Fabric, consider implementing multiple 4-switch Fabrics. (Future releases will support inter-connection of multiple Fabrics into a single Fabric to provide for growth and scaling of the SAN.)

2. If you are configuring a homogeneous Novell NetWare SAN, refer to Novell NetWare Server/Storage Rules beginning on page 6 to determine how best to configure servers and storage.

    Line 1 in Table 1 lists the configuration maximums for Novell NetWare platforms in homogeneous SAN configuration.

3. If you are configuring a heterogeneous SAN, refer to the appropriate platform application note(s) and the heterogeneous SAN application note referenced in Table 1 to ensure platform interaction

    Line 2 in Table 1 lists the configuration maximums for Novell NetWare platforms in a heterogeneous SAN configuration.

4. Select the desired method(s) of SAN management and access control based on your specific needs. Use SWCC for storageset management, and use controller based SSP or switch based Zoning (or both) for disk storage access control.

SAN Configuration Rules and Maximums

The following sections list the SAN design rules as they apply to Fabric configurations and Novell NetWare platforms for servers and storage.

Fabric Rules

*   Up to 4 fibre channel switches total in a single Fabric - a SAN with all switches interconnected. NetWare supports the Compaq 16 (158223-B21) and 8 (158222-B21) port SAN switches. NetWare requires that the switch support FL-Port logins.
*   Within a single Fabric, maximum of 1 switch hop between servers and storage, maximum of 2 switch hops worst case with a single fault - a Fabric can re-route to a 2-hop path on a single link failure. A hop is defined as 1 or more connections between two FC switches, for example; 2 switches cascaded = 1 hop. Server to FC switch segments and Storage to FC switch segments are not counted as hops.
*   Within a single Fabric where switches are interconnected, each FC switch must have a unique domain number (Domain_ID).
*   Up to 16 inter-switch links (ISLs) between any 2 switches, up to 8 active to the same destination.
*   Minimum cable segment length is 2 meters.
*   Up to 200 meters per cable segment using short-wavelength laser GBICs and 62.5 micron multi-mode fiber optic cable. With multiple cable segments 600 meters total distance nominal, 800 meters worst case with a single fault re-route, between server and storage.

- Up to 500 meters per cable segment using short-wavelength laser GBICs and 50 micron multi-mode fibre optic cable. With multiple cable segments 1.5 km total distance nominal, 2.0 km worst case, with a single fault re-route between server and storage.
- Up to 10 km per ISL cable segment using long-wavelength laser GBICs and 9 micron single-mode fibre optic cable. With multiple cable segments 11 kilometers total distance nominal, 21 km worst case with a single fault re-route, between server and storage. 10 km links are only supported in switch to switch connections.

Novell NetWare Server/Storage Rules

Table 1 describes the Novell NetWare platform maximums when in a homogenous NetWare SAN and when using Novell NetWare platforms in a heterogeneous mixed platform SAN.

Table 1   Guidelines for Novell NetWare Platform Supported

Maximum Supported Number of:	Host Bus Adapters per Server [1]	Active Controller Host Ports (HBA Targets) per HBA [2]	LUNs per HBA Target [3]	HBAs per Server per Switch Zone [4]	Active Servers per Storage System [5]
Novell NetWare SAN	4	4	30	4	16
Heterogeneous SAN					8

Table Notes:
1. The actual maximum number of host bus adapters per server is dependent on the specific server model.
2. The recommended maximum number of active HSG80 controller host ports a single HBA can simultaneously access; the actual number of Targets available is 16, including the HBA.
3. The maximum number of LUNs per SCSI target. The maximum number of LUNs per target a host bus adapter can address in a SAN may be less.
4. The maximum number of HBAs per server that can be connected to the same switch zone.
5. This column gives the maximum number of active hosts for one storage system in a Homogeneous NetWare SAN. This assumes 1 FC HBA per host for non-HA Transparent Failover configurations and 2 FC HBAs per host for HA Multiple-bus Failover configurations. The Heterogeneous SAN entry is the maximum total number of active hosts when multiple different operating system types are accessing the same storage system.

- All configurations are supported under NetWare 4.2 and 5.x and Novell Cluster Server.
- For NetWare, all server connections into the SAN use a FC-Fabric FL-port based HBA. FC-AL HBA connections into the SAN are not supported for NetWare platforms.
- The maximum number of FC HBAs per server is 4, or total allowed in the server if less than 4. Use Selective Storage Presentation (see below) to assign specific LUNs exclusively to each HBA.
- The maximum number of active controller ports per FC HBA is 4.
- Any combination of NetWare Servers - standalone or clustered, and RA8000/ESA12000 storage systems is allowed per SAN configuration, provided these rules are followed:
    1. A maximum of 16 NetWare servers (assumes 1 FC HBA per server) per RA8000 or ESA12000 dual controller storage system, with a maximum of 8 servers configured on each active port.
    2. All specific SAN configuration rule limits are followed. Refer to the individual SAN Fabric configurations.
- All configurations require the *Connection Name Operating System* parameter set to "NETWARE".
- All configurations require the port topology be set to "FABRIC"
  Set this port_topology = fabric
  Set other port_topology = fabric

- When configuring HSG80 controllers for access from NetWare servers only, the controller SCSI mode should be set to "SCSI-2" and the Command Console LUN (CCL) must be disabled.
- Each active controller host port presents one SCSI Target ID that has a connected path through the Fabric to the port .
- The maximum number of LUNs per HSG80 controller pair is 30.
- Dual redundant controllers can be configured for Transparent Failover Mode.
- Each storage system can be configured using SWCC or the Command Line Interface (CLI) through either the HSG80 controller maintenance serial port or a TCP/IP interface.
- All configurations utilize ACS V8.5F (Array Controller Software) configured for FABRIC topology.
- ACS V8.5 provides for up to 64 connection name entries. For dual controllers in Transparent Failover Mode, up to 2 connection entries are created for each server HBA, thus a total of 32 server HBAs are visible to a storage system at any given time. Note: The maximum number of server HBAs supported on a storage system is 16. Each storage system in the SAN will automatically add connection name entries upon initial power up. As a result, in certain SAN configurations it is possible to exceed the number of available connection name entries in a storage system prior to the addition of entries for the specific server HBAs that you want to access. This could result in the inability of a storage system to properly connect to a desired server HBA in the SAN. To avoid this, you can configure specific server HBAs and specific storage systems into FC Switch Zones of up to 32 Servers in Transparent Failover.
- Rename connection names. By default, new connection names are automatically added to the controller connection name table by the controllers when they detect a path to an adapter from each active controller host port. The default connection name assigned by the controllers will be "!NEWCONnn", where nn is a number from 1 to 64. After the controllers detect all paths, rename each connection name to be more meaningful to the configuration, i.e., SERVER1P1, SERVER1P2, etc. (Connection names can be a maximum of 9 characters.)
- Selective Storage Presentation - for configurations with more than 1 FC HBA in a server, or more than one server accessing through the same HSG80 controller host port:

    Use the Unit *Connection Name* parameter to allow exclusive access to units from each server or HBA (using the CLI, "SET unit-number DISABLE_ACCESS_PATH = ALL ENABLE_ACCESS_PATH = *connection-name*")

> **NOTE**
>
> Shared access between different servers to the same storage unit (LUN) requires specific application software (i.e., Novell Cluster Server) to ensure proper data preservation.

- LUNs can consist of single disks (JBOD), a storageset of multiple disks, or a partition (up to 8), configured for a specific RAID level of 0, 1, 0 + 1, or 3/5.
- The maximum storage capacity stated (2.6 TB) assumes 36GB disks. Increases in disk drive capacity will increase overall storage capacity for the same enclosure footprint.

Configuration Descriptions

Table 2 lists four SAN Fabric configuration examples for RA8000 and ESA12000 storage systems when using Novell NetWare platforms. The configurations are based on the rules listed in the SAN Configuration Guidelines section. They show the limits with regard to:

- Total number and arrangement of fibre channel switches in a single Fabric, or multiple Fabrics for high availability
- Maximum number of servers and storage systems per Fabric configuration
- Recommended Fabric switch configurations optimized for general purpose, maximum capacity, maximum connectivity, highest availability, backup, or highest performance

The configurations are listed in order based on the number of switches in the Fabric. This follows a logical progression where you may desire to initially configure a small SAN containing a single FC switch, then add a second switch for high availability or increased connectivity, and additional switches as capacity and connectivity needs increase.

The maximum server counts and maximum storage counts listed for each configuration show the upper bound limits - either maximum servers or maximum storage, for that switch arrangement. Depending on your connectivity or storage capacity needs, you may choose to implement your SAN maximized for one or the other, or a lesser number of either. All configurations allow the flexibility to trade off server and storage system count based on total FC switch port availability, however you cannot exceed the upper bound limits listed or the platform limits in Table 1 for each configuration.

All configurations support a mix of both clustered and non-clustered servers. All configurations are supported with all Compaq supplied 16-port and 8-port FC switches.

Table 2   Index of RA8000/ESA 12000 SAN Fabric Configurations for Novell NetWare

| SAN Fabric Configuration #	Description	Pages
1	One FC Switch, Controller Transparent Failover Mode, Integrated EBS	9-10
2	Two FC Switches, Cascaded, Controller Transparent Failover Mode, Integrated EBS	11-13
3	Three FC Switches, Cascaded Meshed Fabric, Controller Transparent Failover Mode	14-16
4	Four FC Switches, Cascaded Meshed Fabric, Controller Transparent Failover Mode	17-19

Additional Information/References

A list of all related product documentation is included in Table 3 at the end of this application note. Refer to these documents for more details on StorageWorks product installation and configuration.

SAN Fabric Configuration 1 - One FC Switch, Controller Transparent Failover Mode

SAN Fabric Configuration 1 (Figure 1) is a general-purpose configuration that provides connectivity for multiple servers and disk storage on a single SAN. Up to 12 separate non-cooperating servers or up to 8 clustered cooperating servers can be connected through a 16-port switch providing access from all servers to a single storage system. With an 8-port FC switch, up to 4 servers can be connected to 1 storage system. With either switch type the number of storage systems can be increased if the number of servers is reduced to provide additional switch ports for storage. The HSG80 array controllers within the RA8000 or ESA12000 storage enclosure are configured in Transparent failover mode providing full controller redundancy in the unlikely event of either controller failing.

Figure 1 One Switch Fabric Configuration Example
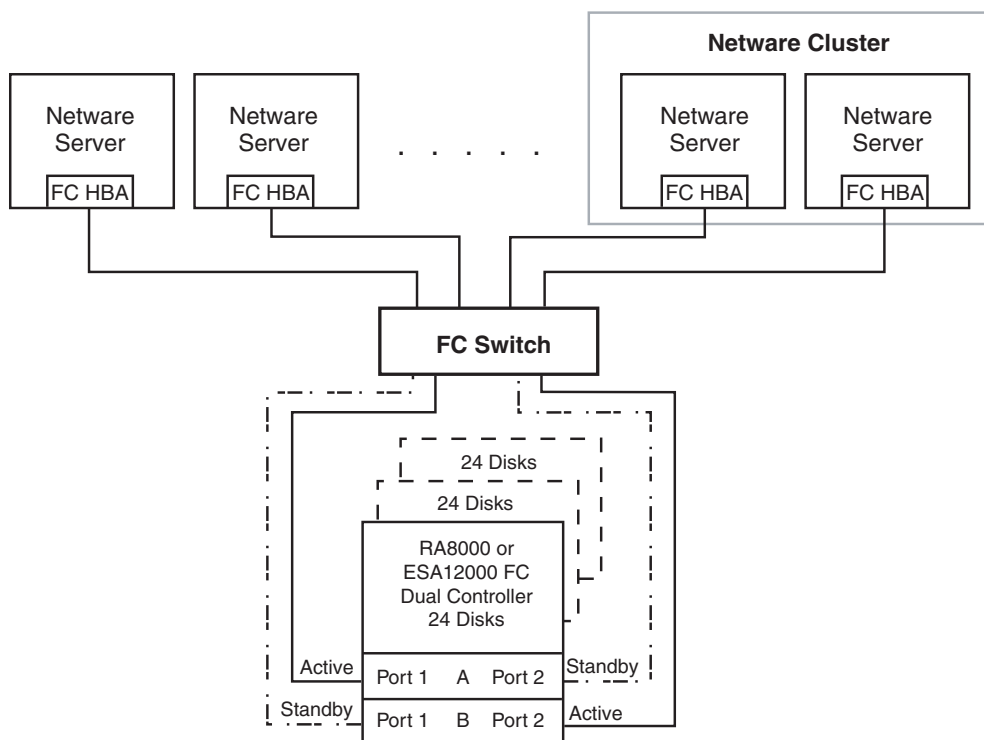
SAN Configuration 1 Server/Storage Connectivity Rules

- Any mix of Novell NetWare Servers - standalone or clustered, and storage systems using these maximums. Assumes 1 FC HBA per server and an even storage port count.
- 16-port FC Switch, total number of switch ports available for Servers and Storage is 16
  - Maximum Server Connectivity,
    - Up to 12 Servers and 1 Storage System (4 storage ports/2 Active, 2 Standby)
    - [16 – 4 storage ports = 12 server ports]
    - Maximum of 8 servers configured on any one active controller host port
  - Or Maximum Storage Capacity,
    - Up to 4 Storage Systems (14 storage ports/7 Active, 7 Standby) and 2 Servers
    - [16 – 2 server ports = 14 storage ports]
- 8-port FC Switch, total number of switch ports available for Servers and Storage is 8
  - Maximum Server Connectivity,
    - Up to 4 Servers and 1 Storage System (4 storage ports/2 Active, 2 Standby)
    - [8 – 4 storage ports = 4 server ports]
  - Or Maximum Storage Capacity,
    - Up to 2 Storage Systems (6 storage ports/3 Active, 3 Standby) and 2 Servers
    - [8 – 2 server ports = 6 storage ports]
- All HSG80 array controllers configured in Transparent Failover Mode

SAN Configuration 1 Fabric Rules

- Total Switches = 1, 16-port or 8-port
- Maximum Switch Hops (nominal) = 0
- Maximum Switch Hops (worst case) = 0
- Maximum Distances
  Up to 500 meters per FC cable segment, 1 km total server to storage using 50 micron multi-mode fibre optic cable. Refer to general Fabric rules for other cable types.

SAN Configuration 1 Notes

- When configured with greater than 1 NetWare Server or FC HBA, use SSP to assign exclusive access to units (LUNs) to specific server FC HBAs.

> **NOTE**
>
> Shared access between different servers to the same storage unit (LUN) requires specific application software (i.e., Novell Cluster Server) to ensure proper data preservation.

- For servers accessing controller host port 1, use unit number and offset values in the range 0 – 99; for controller host port 2, use number and offset values in the range 100 -199.
- Performance considerations, assuming relatively equal server load:
  If using a single storage system, for balanced performance across all servers, configure half of the servers on each of the controller port pairs. If using multiple storage systems, configure an equal number of servers on each storage system.

  The recommended maximum number of controller host ports configured per FC HBA is 2 for high bandwidth applications and 4 for high throughput applications.

SAN Fabric Configuration 2 – Two FC Switches, Cascaded, Controller Transparent Failover Mode

SAN Fabric configuration 2 (Figure 2) is a general purpose single Fabric cascaded switch configuration that provides increased server and disk storage connectivity capabilities. Up to 22 servers can be connected through a 16-port switch providing access from all servers to 2 storage systems. With an 8-port FC switch, up to 10 servers can be connected to 1 storage system. With either switch type the number of storage systems can be increased if the number of servers is reduced to provide switch ports for storage. A minimum of 1 ISL is required between the 2 switches, more may be required based on the specific server and storage configuration and count, and the applications utilized. The ISL(s) can be up to 10 km allowing connectivity between two remote sites. The HSG80 array controllers within the RA8000 or ESA12000 storage enclosure are configured in Transparent failover mode providing full controller redundancy in the unlikely event of either controller failing.

Figure 2 Two Switches, Cascaded Fabric Configuration Example
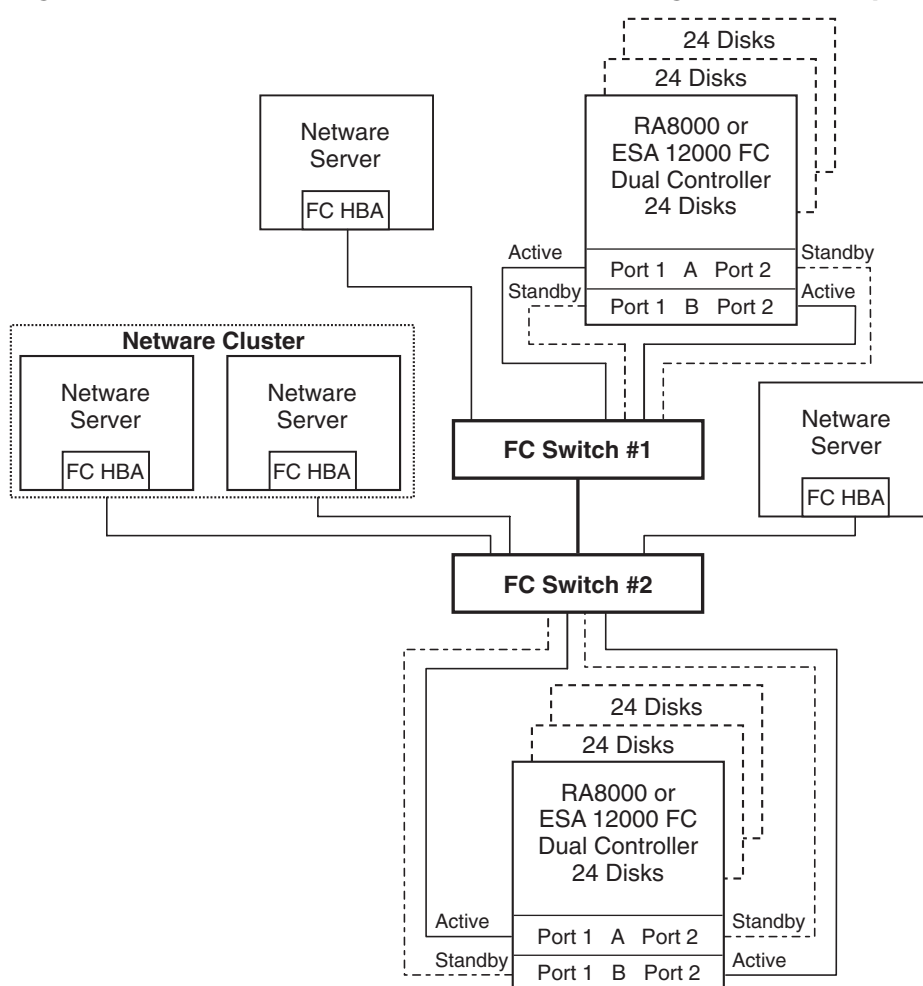
SHR-1647

SAN Configuration 2 Server/Storage Connectivity Rules

- Any mix of Novell NetWare Servers - standalone or clustered, and storage systems using these maximums. Assumes 1 FC HBA per server and an even storage port count.
- 16-port FC Switches, total number of switch ports available for Servers and Storage is 30
    - Maximum Server Connectivity,
        - Up to 22 Servers and 2 Storage Systems (8 storage ports/4 Active, 4 Standby)
        - [32 – 2 ISL ports – 8 storage ports = 22 server ports]
        - Maximum of 16 servers configured on one controller pair
        - Maximum of 8 servers configured on any one active controller host port
    - Or Maximum Storage Capacity,
        - Up to 7 Storage Systems (26 Storage Ports/13 Active, 13 Standby) and 4 Servers
        - [32 – 2 ISL ports – 4 server ports = 26 storage ports]
        - Maximum of 4 active controller host ports per FC HBA
- 8-port FC Switches total number of switch ports available for Servers and Storage is 14
    - Maximum Server Connectivity,
        - Up to 10 Servers and 1 Storage System (4 storage ports/2 Active, 2 Standby)
        - [16 – 2 ISL ports – 4 storage ports = 10 server ports]
        - Maximum of 8 servers configured on any one active controller host port
    - Or Maximum Storage Capacity,
        - Up to 3 Storage Systems (12 storage ports/6 Active, 6 Standby) and 2 Servers
        - [16 – 2 ISL ports – 2 server ports = 12 storage ports]
        - Maximum of 4 active controller host ports per FC HBA
- All HSG80 array controllers configured in Transparent Failover Mode

SAN Configuration 2 Fabric Rules

- Total Switches = 2, 16-port or 8-port
- Maximum Switch Hops (nominal) = 1
- Maximum Switch Hops (worst case) = 1
- Maximum number of ISLs between the two switches = 16, up to 8 active to the same destination
- Maximum Distances:
  Up to 500 meters per FC cable segment, 1.5 km total server to storage when using 50 micron multi-mode fibre optic cable. Refer to general Fabric rules for other cable types.
  Up to 10 km per inter-switch link, 11 km total server to storage when using 9 micron single mode fibre optic cable and long wavelength GBICs.

SAN Configuration 2 Notes

- Each FC Switch must have a unique domain number (Domain_ID).
- When configured with greater than 1 NetWare Server or FC HBA, use SSP to assign exclusive access to units (LUNs) to specific server FC HBAs.

> **NOTE**
>
> Shared access between different servers to the same storage unit (LUN) requires specific application software (i.e., NOVELL CLUSTER SERVER) to ensure proper data preservation.

- For servers accessing controller host port 1, use unit number and offset values in the range 0 – 99; for controller host port 2, use number and offset values in the range 100 -199.
- Performance considerations, assuming relatively equal server load:
  If using two storage systems, for balanced performance across all servers, configure half of the servers on each of the storage systems and equally on the controller port pairs.

  The recommended maximum number of controller host ports configured per FC HBA is 2 for high bandwidth applications and 4 for high throughput applications.

  Use these general performance rules to determine the optimum number of ISLs required between both switches:

  - For balanced SAN performance configure 1 storage system on each FC switch.
  - For the highest available performance, whenever possible, devices that exchange the highest amount of data should be connected to the same FC switch, for example, servers and the storage assigned to them should be configured on the same FC switch, otherwise:
    -- For high bandwidth applications – One ISL between switches for every 2 storage controller ports on one switch being accessed by a server on the other switch.
    -- For high throughput applications – One ISL between switches for every 6 storage controller ports on one switch being accessed by a server on the other switch.

SAN Fabric Configuration 3 – Three FC Switches, Cascaded Meshed Fabric, Controller Transparent Failover Mode

SAN Fabric configuration 3 (Figure 3) is a meshed Fabric cascaded switch configuration that provides increased server, disk, and tape storage connectivity capabilities in addition to Fabric resiliency. All of the switches in the Fabric are interconnected providing alternate paths within the Fabric. This Fabric feature automatically reconfigures a route to a good path should a component in a Fabric path fail. Up to 32 servers can be connected through 3 16-port FC switches to 2 storage systems. With 8-port FC switches up to 14 servers can be connected to 1 storage system. With either switch type, the number of storage systems can be increased if the number of servers is reduced to provide switch ports for storage. A minimum of 1 ISL is required between each of the 3 switches, more may be required based on the specific server and storage configuration and count, and the applications utilized. The ISL(s) can be up to 10 km allowing connectivity between three remote sites. The HSG80 array controllers within the RA8000 or ESA12000 storage enclosure are configured in Transparent failover mode providing full controller redundancy in the unlikely event of either controller failing.

Figure 3 Three Switches, Cascaded Meshed Fabric Configuration Example
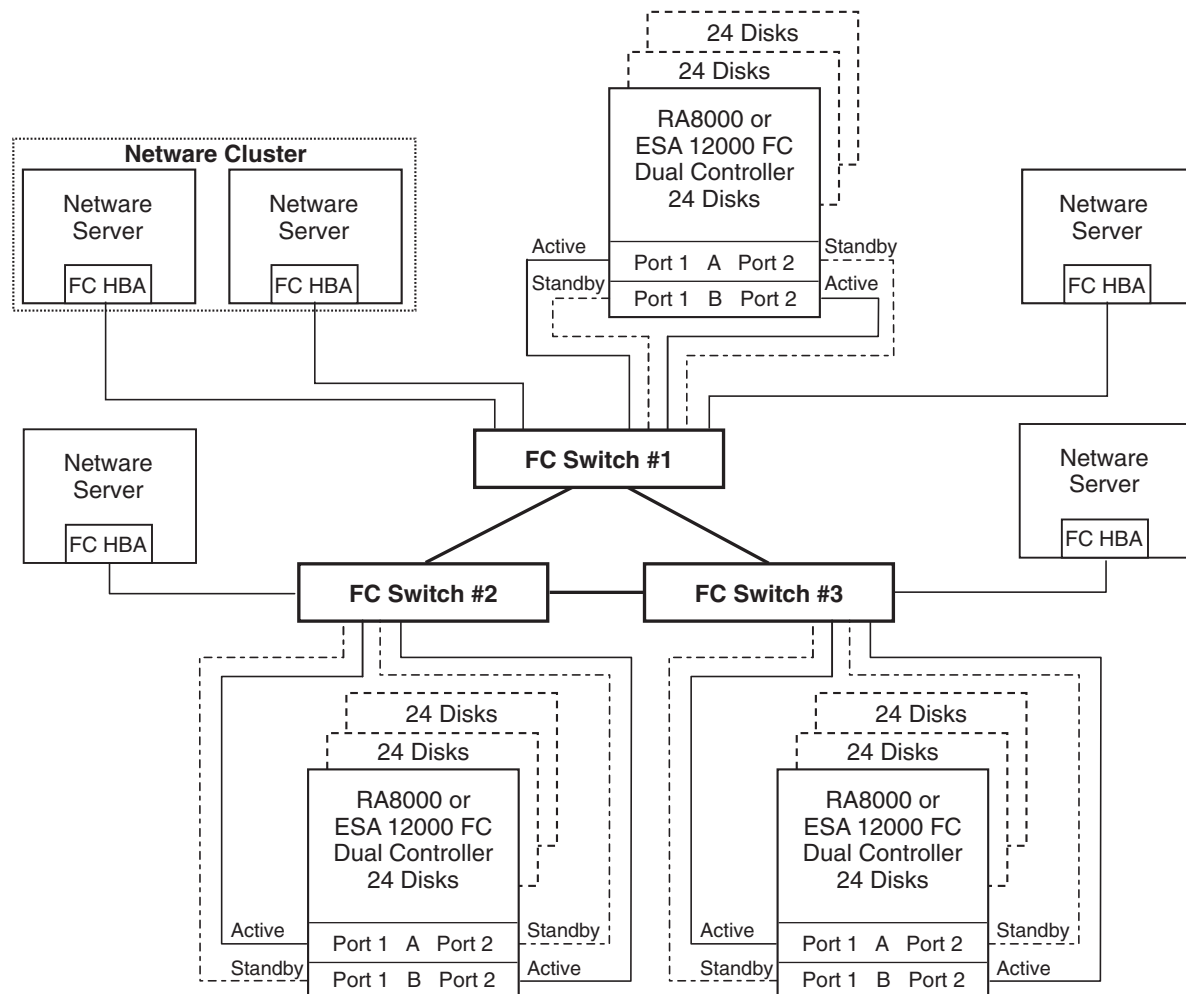
SHR-1648

SAN Configuration 3 Server/Storage Connectivity Rules

- Any mix of Novell NetWare Servers - standalone or clustered, and storage systems using these maximums. Assumes 1 FC HBA per server and an even storage port count.
- 16-port FC Switches, total number of switch ports available for Servers and Storage is 42
  - Maximum Server Connectivity,
    - Up to 32 Servers and 2 Storage Systems (8 storage ports/4 Active, 4 Standby)
    - [48 – 6 ISL ports – 8 storage ports = 34, use 32 server ports maximum, 2 unused]
    - Maximum of 16 servers configured on any one controller pair
    - Maximum of 8 servers configured on any active controller host port
  - Or Maximum Storage Capacity,
    - Up to 9 Storage Systems (36 storage ports/18 Active, 18 Standby) and 6 Servers
    - [48 – 6 ISL ports – 6 server ports = 36 storage ports]
    - Maximum of 4 active controller host ports per FC HBA
- 8-port FC Switches, total number of switch ports available for Servers and Storage is 18
  - Maximum Server Connectivity,
    - Up to 14 Servers and 1 Storage System (4 storage ports/2 Active, 2 Standby)
    - [24 – 6 ISL ports – 4 storage ports = 14 server ports]
    - Maximum of 8 servers configured on any active controller host port
  - Or Maximum Storage Capacity,
    - Up to 4 Storage Systems (16 storage ports/8 Active, 8 Standby) and 2 Servers
    - [24 – 6 ISL ports – 2 server ports = 16 storage ports]
    - Maximum of 4 active controller host ports per FC HBA
- All HSG80 array controllers configured in Transparent Failover Mode

SAN Configuration 3 Fabric Rules

- Total Switches = 3, 16-port or 8-port
- Maximum Switch Hops (nominal) = 1
- Maximum Switch Hops (worst case) = 2
- Maximum number of ISLs between any two switches = 16, up to 8 active to the same destination
- Maximum Distances:
  Up to 500 meters per FC cable segment, 1.5 km total server to storage (2.0 km worst case) when using 50 micron multi-mode fibre optic cable. Refer to general Fabric rules for other cable types. Up to 10 km per inter-switch link, 11 km total server to storage (21 km worst case) when using 9 micron single mode fibre optic cable and long wavelength GBICs.

SAN Configuration 3 Notes

- Each FC Switch must have a unique domain number (Domain_ID).
- When configured with greater than 1 NetWare Server or FC HBA, use SSP to assign exclusive access to units (LUNs) to specific server FC HBAs.

> **NOTE**
>
> Shared access between different servers to the same storage unit (LUN) requires specific application software (i.e., NOVELL CLUSTER SERVER) to ensure proper data preservation.

- For servers accessing controller host port 1, use unit number and offset values in the range 0 – 99; for controller host port 2 use number and offset values in the range 100 -199.
- Performance considerations, assuming relatively equal server load:
  If using three storage systems, for balanced performance across all servers, configure one third of the servers on each of the storage systems and equally on the controller port pairs.

- The recommended maximum number of controller host ports configured per FC HBA is 2 for high bandwidth applications and 4 for high throughput applications.

  Use these general performance rules to determine the optimum number of ISLs required between both switches:

  - For balanced SAN performance configure 1 storage system on each FC switch

  - For the highest available performance, whenever possible, devices that exchange the highest amount of data should be connected to the same FC switch, for example, servers and the storage assigned to them should be configured on the same FC switch, otherwise:

  - For high bandwidth applications – One ISL between switches for every 2 storage controller ports on one switch being accessed by a server on the other switch.
    For high throughput applications – One ISL between switches for every 6 storage controller ports on one switch being accessed by a server on the other switch.

SAN Fabric Configuration 4 – Four FC Switches, Cascaded Meshed Fabric, Controller Transparent Failover Mode

SAN Fabric configuration 4 (Figure 4) is a meshed Fabric cascaded switch configuration that provides the maximum server and storage connectivity available in a single Fabric. All of the switches in the Fabric are interconnected providing alternate paths within the Fabric. This Fabric feature automatically reconfigures a route to a good path should a component in a Fabric path fail. Up to 40 servers can be connected through 4 16-port FC switches to 3 storage systems. With 8-port FC switches up to 16 servers can be connected to 1 storage system. With either switch type the number of storage systems can be increased if the number of servers is reduced to provide switch ports for storage. A minimum of 1 ISL is required between each of the 4 switches and a minimum of 2 ISLs are required to cross couple the 4 switches as shown. Additional ISLs may be required based on the specific server and storage configuration and count, and the applications utilized The cross-coupled ISLs ensure that the hop count within the Fabric does not exceed 2 for a single path failure. The ISL(s) can be up to 10 km allowing connectivity between four remote sites. The HSG80 array controllers within the RA8000 or ESA12000 storage enclosure are configured in Transparent failover mode providing full controller redundancy in the unlikely event of either controller failing.

Figure 4 Four Switches, Cascaded Meshed Fabric Configuration Example
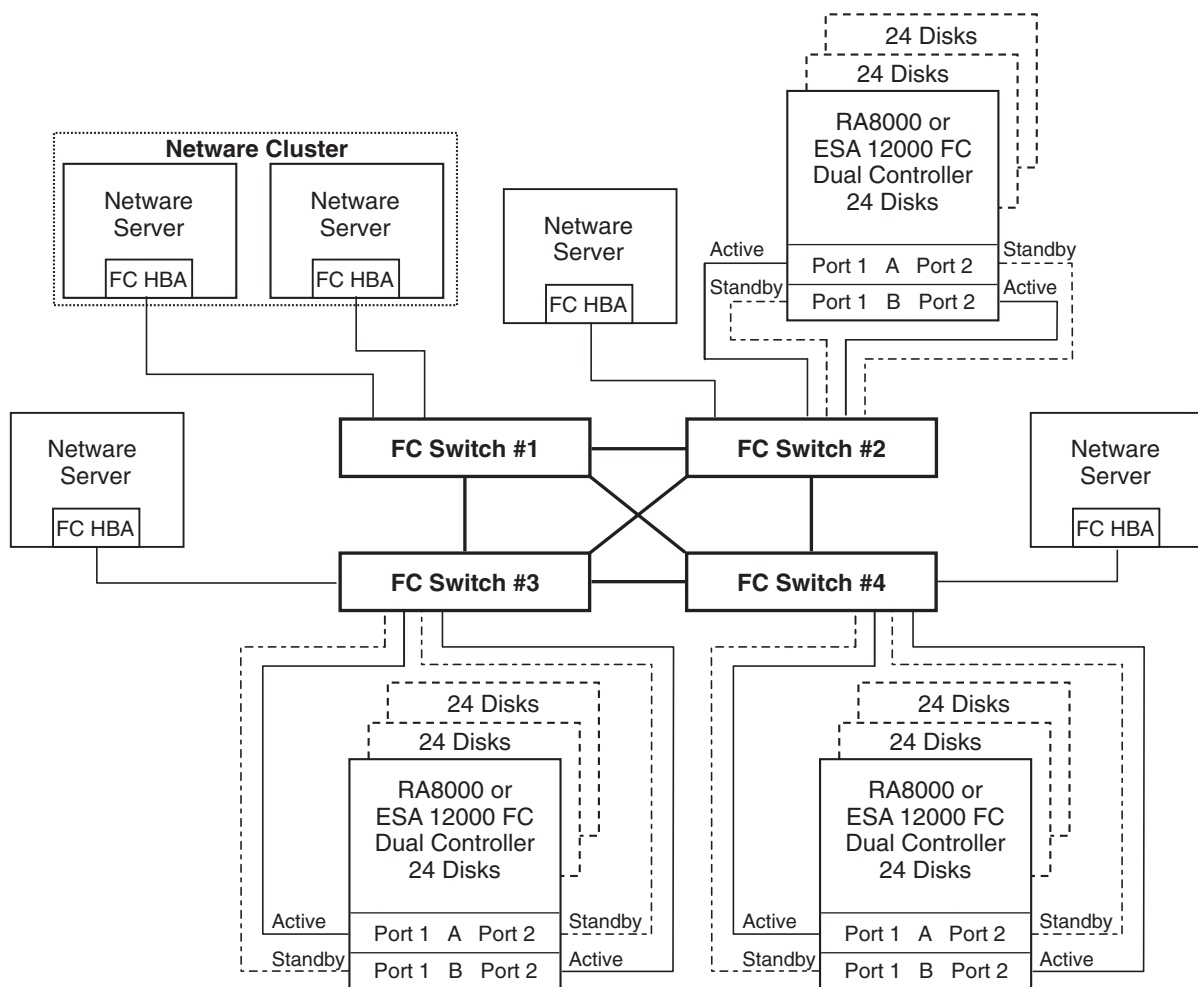
SHR-1649

SAN Configuration 4 Server/Storage Connectivity Rules

- Any mix of Novell NetWare Servers - standalone or clustered, and storage systems using these maximums. Assumes 1 FC HBA per server and an even storage port count.
- 16-port FC Switches, total number of switch ports available for Servers and Storage is 52
  - Maximum Server Connectivity,
    - Up to 40 Servers and 3 Storage Systems (12 storage ports/6 Active, 6 Standby)
    - [64 – 12 ISL ports – 12 storage ports = 40 server ports]
    - Maximum of 16 servers configured on any one controller pair
    - Maximum of 8 servers configured on any active controller host port
  - Or Maximum Storage Capacity,
    - Up to 12 Storage Systems (46 storage ports/23 Active, 23 Standby) and 6 Servers
    - [64 – 12 ISL ports – 6 server ports = 46 storage ports]
    - Maximum of 4 active controller host ports per FC HBA
- 8-port FC Switches, total number of switch ports available for Servers and Storage is 20
  - Maximum Server Connectivity,
    - Up to 16 Servers and 1 Storage System (4 storage ports/2 Active, 2 Standby)
    - [32 – 12 ISL ports – 4 storage ports = 16 server ports]
    - Maximum of 16 servers configured on any one controller pair
    - Maximum of 8 servers configured on any active controller host port
  - Or Maximum Storage Capacity,
    - Up to 4 Storage Systems (16 storage ports/8 Active, 8 Standby) and 4 Servers
    - [32 – 12 ISL ports – 4 server ports = 16 storage ports]
    - Maximum of 4 active controller host ports per FC HBA
- All HSG80 array controllers configured in Transparent Failover Mode

SAN Configuration 4 Fabric Rules

- Total Switches = 4, 16-port or 8-port
- Maximum Switch Hops (nominal) = 1
- Maximum Switch Hops (worst case) = 2
- Maximum number of ISLs between any two switches = 15
- Maximum Distances:
  - Up to 500 meters per FC cable segment, 1.5 km total server to storage (2.0 km worst case) when using 50 micron multi-mode fibre optic cable. Refer to general Fabric rules for other cable types.
  - Up to 10 km per inter-switch link, 11 km total server to storage (21 km worst case) when using 9 micron single mode fibre optic cable and long wavelength GBICs.

SAN Configuration 4 Notes

- Each FC Switch must have a unique domain number (Domain_ID).
- When configured with greater than 1 NetWare Server or FC HBA, use SSP to assign exclusive access to units (LUNs) to specific server FC HBAs.

NOTE

Shared access between different servers to the same storage unit (LUN) requires specific application software (i.e., NOVELL CLUSTER SERVER) to ensure proper data preservation.

- For servers accessing controller host port 1, use unit number and offset values in the range f 0 – 99; for controller host port 2 use number and offset values in the range 100 -199
- Depending on the specific number of servers and storage systems utilized in this SAN configuration, it is possible to exceed the available total number of connection name entries in a storage system. (See NetWare Server/Storage Rules). This situation can be avoided by using FC switch Zoning to create separate Zones for each of the server groups that you wish to configure with specific storage systems.
- Performance considerations, assuming relatively equal server load:
  If using four storage systems, for balanced performance across all servers, configure one quarter of the servers on each of the storage systems and equally on the controller port pairs.

  The recommended maximum number of controller host ports configured per FC HBA is 2 for high bandwidth applications and 4 for high throughput applications.

  Use these general performance rules to determine the optimum number of ISLs required between both switches:

  - For balanced SAN performance, configure 1 storage system on each FC switch.

  - For the highest available performance, whenever possible, devices that exchange the highest amount of data should be connected to the same FC switch, for example, servers and the storage assigned to them should be configured on the same FC switch, otherwise:
    - -- For high bandwidth applications – One ISL between switches for every 2 storage controller ports on one switch being accessed by a server on the other switch.
    - -- For high throughput applications – One ISL between switches for every 6 storage controller ports on one switch being accessed by a server on the other switch.

Product Details

The RA8000/ESA12000 storage systems utilize the Compaq HSG80 RAID controller running Array Controller Software (ACS) V8.5. The ACS software is designed to support multiple platforms providing features including: dual controller operation, two controller failover modes – Transparent and Multiple-Bus, mirrored write back cache, read ahead cache, RAID implementation, disk mirroring, and disk partitioning capabilities. In addition, ACS manages host interconnect and protocol services to provide data for event notification and status such as displayed by SWCC.

The HSG80 controller has two FC host ports providing up to a total of nearly 200 Mbytes per second of available bandwidth. Disk drives are connected to the controller through 6 UltraSCSI channels providing up to 40 Mbytes per second per channel of available bandwidth. Servers can use multiple host bus adapters (HBAs) to multiple RA8000 FC systems for unlimited storage capacity.

The RA8000 FC is supplied in two basic building blocks, a pedestal style cabinet and what has been termed a "rackable" model. The pedestal is a self-contained desk height cabinet; it is available in DIGITAL Classic Top Gun Blue and in Compaq Opal. The rackable is shipped ready to be mounted in a 19" Compaq rack or a 19"cabinet/rack using an included universal RETMA/metric mounting kit.

RA8000 FC controllers come with 64 MB of cache. Cache options allow for 128 MB, 256 MB and 512MB of cache in each controller. ESA12000 FC controllers come with 256 MB of cache. Cache options allow for 512MB of cache in each controller. Cache features include read ahead and mirrored write back cache for use in optimizing performance where redundant capabilities are required for high availability system configurations. In the rare event that a storage controller fails, the mirrored data is immediately available to the remaining controller for continuing operation.

The RA8000 FC pedestals and rackables come in both single controller and in dual controller models to allow the customer to select the level of high availability required for their application. A single controller model can be upgraded to a dual controller model when warranted by the application.

High availability is supported by the use of redundancy and hot swappable components. The RA8000 FC disk enclosures include redundant cooling, and have 5 power supplies providing N+1 redundancy. Power can be upgraded to full redundancy with the addition of 3 more supplies and a second power distribution unit for AC input redundancy. StorageWorks components are "hot" swappable including storage controllers when operating as a redundant pair.

You can configure and monitor the RA8000 and ESA12000 FC using the StorageWorks Command Console (SWCC). SWCC is included in the HSG80 Software Solutions Platform kit. Using this client/server tool, you can configure RAID sets locally or over a TCP/IP network. The Client provides an easy to use graphical user interface. It can be used to monitor your storage system and notify you of events by updating a graphical display, sending electronic mail, or alerting via a pager. The Command Console Client includes applications (or Storage Windows) that communicate with the Command Console Agent software running on the host platform.

The Command Console Client is available on Windows 95, Windows 98, and on Intel platforms running NetWare. A Storage Window for the HSG80 controller supports the Array Controller Software (ACS) V8.5 and offers integration with Compaq's Insight Manager (CIM). Insight Manager can receive SNMP traps from the Command Console Agent and Insight Manager services can directly launch SWCC for notification or configuring operations.

Parts List

Compaq Part #	Description
380558-001	RA8000/ESA12000 FC Solution Software V8.5 for Novell NetWare
128697-B21	ACS V8.5F Controller SW
120186-B21	Compaq 64-Bit 66MHZ Fibre Channel HBA
380560-B21 (Blue) 380560-B22 (Opal) 380670-B21 380580-001 (Blue) 380580-002 (Opal) 380590-B21 (Blue) 380590-B22 (Opal) 380600-001 (Blue) 380600-002 (Opal) 380610-B21 (Blue) 380610-B22 (Opal) 380620-001 (Blue) 380620-002 (Opal) 380630-B21 (Blue) 380630-B22 (Opal)	RA8000 Pedestal w/dual HSG80 RA8000 Pedestal w/dual HSG80 RA8000 Rackable w/dual HSG80 ESA12000 w/dual HSG80 24 Slot 60HZ ESA12000 w/dual HSG80 24 Slot 60HZ ESA12000 w/dual HSG80 24 Slot 50HZ ESA12000 w/dual HSG80 24 Slot 50HZ ESA12000 w/dual HSG80 48 Slot 60HZ ESA12000 w/dual HSG80 48 Slot 60HZ ESA12000 w/dual HSG80 48 Slot 50HZ ESA12000 w/dual HSG80 48 Slot 50HZ ESA12000 w/2 pairs/dual HSG80 48 Slot 60HZ ESA12000 w/2 pairs/dual HSG80 48 Slot 60HZ ESA12000 w/2 pairs/dual HSG80 48 Slot 50HZ ESA12000 w/2 pairs/dual HSG80 48 Slot 50HZ
380570-B21 (Blue) 380570-B22 (Opal) 380568-B21 380640-001 (Blue) 380640-002 (Opal) 380650-B21 (Blue) 380650-B22 (Opal)	Pedestal Expansion 24 slots Pedestal Expansion 24 slots Rackable Expansion 24 slots ESA12000 Expansion 48 Slot 60HZ ESA12000 Expansion 48 Slot 60HZ ESA12000 Expansion 48 Slot 50HZ ESA12000 Expansion 48 Slot 50HZ
158222-B21 158223-B21 167365-B21	SAN Switch 8 port (no GBICs) SAN Switch 16 port (no GBICs) Rackmount Kit
380561-B21 127508-B21	FC Optical GBIC (short wavelength laser) FC Optical GBIC (long wavelength laser)
234457-B21 234457-B22 234457-B23 234457-B24 234457-B25	FC 2 Meter Optical Cable FC 5 Meter Optical Cable FC 15 Meter Optical Cable FC 30 Meter Optical Cable FC 50 Meter Optical Cable
380691-B21 380595-B21 380694-B21 380588-B21 380589-B21 147599-001 159138-001	4GB UW 7200 RPM Disk 9GB UW 7200 RPM Disk 18GB UW 7200 RPM Disk 9GB UW 10000 RPM Disk 18GB UW 10000 RPM Disk 36GB UW 7200 RPM Disk 36GB UW 10000 RPM Disk

Configuration References

The following documents provide further information on the configuration of RA8000 and ESA12000 Fibre Channel Storage Systems:

Table 3 Configuration Reference Material

Topic	Document Title	Order Number
Heterogeneous SAN Application Note	*Heterogeneous Storage Area Networks*	*EK-SMA30-AN*
Sun SAN Application Note	*Storage Area Network Configurations for RA8000/ESA12000 on Sun Solaris*	*EK-SMA37-AN*
HP-UX SAN Application Note	*Storage Area Network Configurations for RA8000/ESA12000 on HP-UX*	*EK-SMA32-AN*
OpenVMS SAN Application Note	*Storage Area Network Configurations for RA8000/ESA12000 on OpenVMS*	*EK-SMA34-AN*
Tru64 UNIX SAN Application Note	*RA8000/ESA12000 FC-Switch Configurations for Tru64 UNIX*	*EK-SMA33-AN*
Novell NetWare Application Note	*RA8000/ESA12000 FC-AL Configurations for Novell NetWare*	*EK-FCALN-AA*
Novell NetWare – Installation Reference Guide	*RA8000/ESA12000 Fibre Channel Solution Software for Novell NetWare – Installation Reference Guide*	*AA-RFB9C-TE*
Windows NT – Intel Standard FC-AL Configurations Application Note	*RA8000/ESA12000 FC-AL Configurations for Windows NT - Intel*	**AA-RH0RB-TE*
Windows NT – Intel High Availability FC-AL Configurations Application Note	*RA8000/ESA12000 FC-AL High Availability Configurations for Windows NT - Intel*	**AA–RH0SC–TE*
Windows NT - Intel HSG80 Array Controller	*Release Notes, HSG80 Array Controller (ACS V8.5F) for Windows NT Server - Intel*	*AA–RH0QB–TE or 387393-002*
Windows NT - Intel RA8000/ESA12000 Installation	*RA8000/ESA12000 Fibre Channel Solution Software for Windows NT – Intel Installation Reference Guide*	*AA–RFA9C–TE*
Windows NT Clusters	*RAID Array 8000/ESA12000 Fibre Channel Cluster Solutions for Windows NT*	*EK-NTC8K-IG*
Secure Path Installation	*StorageWorks Secure Path v3.0 for Windows NT – Installation and Reference Guide*	*AA-RL4SA-TE*
HSG80 Array Controller Configuration	*HSG80 Array Controller ACS Version 8.5 Configuration Guide*	*EK-HSG85-CG or 165144-001*
HSG80 Array Controller Command Line Interface	*HSG80 Array Controller ACS Version 8.5 CLI Reference Guide*	*EK-HSG85-RG or 165145-001*
HSG80 Array Controller Maintenance	*HSG80 Array Controller ACS Version 8.5 Maintenance and Service Guide*	*EK-HSG84-SV or 118620-002*
StorageWorks Command Console	*Command Console V2.2 (HSG80) for RAID Array 8000/ESA12000, User's Guide*	*AA–RFA2D–TE*

* Refer to the website for the latest information.