

RA8000/ESA12000 FC-AL High Availability Configurations for Windows NT - Intel

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Application Note
AA-RH0SD-TE

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NOTE

This application note describes RA8000/ESA12000 FC-AL high availability configurations. For standard configurations refer to "RA8000/ESA12000 FC-AL Configurations for Windows NT - Intel".

Enterprise Network Storage Architecture (ENSA)

Compaq StorageWorks RAID Array 8000 (RA8000 FC) and Enterprise Storage Array 12000 (ESA12000 FC) products are the latest in fully integrated Fibre Channel RAID storage solutions. These products provide the key initial step in delivering on Compaq's ENSA vision. ENSA addresses the issues that customers expect to face now and in the future. Both products address today's issues including: economical capacity growth, data protection, high availability, increased distance, multi-vendor platform support, and investment protection by being the base for building the ENSA vision.

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 (Storage Area Network) support utilizing 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 in 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 affect 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.

Microsoft Cluster Server (MSCS)

A Windows NT MSCS cluster enables two servers to share an RA8000 or ESA12000 FC storage system through a Fibre Channel bus. If a server failure should occur, the storage I/O is re-routed through to the functioning server. This process, called cluster failover, requires no resource downtime ensuring the high availability of data.

The RA8000 and ESA12000 FC storage systems are supported in four Windows NT MSCS cluster configurations. All of the cluster configurations provide full cluster failover capabilities through a fibre channel bus connected to both cluster servers.

In addition to cluster failover, the RAID array controllers can be configured in transparent failover mode to protect against the unlikely event of a single controller failure. This feature eliminates controllers as single points of failure and is invoked without the need for server intervention.

For the highest availability, two hardware paths between the cluster servers and the RA8000 or ESA12000 FC storage system can be configured using Compaq's Secure Path for Windows NT. This configuration provides two separate physical paths between the servers and the storage.

Secure Path for Windows NT

StorageWorks Secure Path is a high availability software product providing continuous data access for RA8000 and ESA12000 FC storage products configured on Windows NT platforms. Redundant hardware, advanced RAID technology and automated failover capability are used to enhance fault tolerance and availability. Secure Path effectively eliminates controllers, interconnect hardware and host bus adapters as single points of failure in the storage system.

Key to Secure Path's functionality is the capability of RA8000/ESA12000 FC dual HSG80 controllers to operate in the active/active Multiple-Bus failover mode. This failover mode allows each controller to be configured on its own bus and to process I/O independently under normal operation. Available storage units are "preferred" to one or the other of the two controllers which determines which controller path is used for access at system boot time. During runtime, storage units may be moved between paths at anytime through use of the management utility.

Controllers in Multiple-Bus failover mode monitor each other and automatically failover storage units from the failed member of a controller pair. The Secure Path software detects the failure of I/O operations to complete on a failed path and automatically re-routes all traffic to the surviving path. Controller and path failover is completed seamlessly, without process disruption or data loss.

The Secure Path management utility provides continuous monitoring capability and identifies failed paths and failed-over storage units. To facilitate static load balancing, storage units can be moved between paths using simple "drag-and-drop" operations.

The integration of Secure Path, Windows NT Clustering, and StorageWorks RAID Array Fibre Channel technology provides the maximum level of fault-tolerance, data availability, and performance required for mission-critical environments.

Performance Considerations

The performance of an application on a system that includes RA8000 or ESA12000 FC storage can be limited by many different components of the system. Some of the possible component limitations include the host CPU(s), memory size, the host bus adapter(s) (HBA), the fibre channel bus, the RAID controller, or the specific configuration of disks used behind the controller. The limiting factor can move to any of these components depending on the workload. Identifying the limits will assist in determining the best configuration for a given application.

Table 1 lists the upper limit performance specifications for the components of the RA8000 and ESA12000 FC storage systems based on testing using standard storage performance tests and methodologies. These numbers should be used to compare component level performance as a means to determine the best configuration from a performance perspective. User application tests may not necessarily reach these levels of performance as applications may perform additional levels of processing for each I/O. The controller specifications listed show both cache (no disk access) and media (with disk access) limitations.

To further aid in evaluating the performance aspects of specific configurations, additional information is included within each configuration section. The configurations are rated based on I/O performance (I/Os per second) - typical of small transfer applications such as databases and mail, and bandwidth performance (MBs per second) - typical of large transfer applications such as video and graphics. Note that other factors, such as connectivity needs, may require tradeoffs be made such that performance is a secondary consideration.

Table 1 Performance Maximums of FC-AL Components

Transfer Size	IO/sec (small transfer sizes, random access)		MB/sec (large transfer sizes, sequential access)	
	Read	Write	Read	Write
FC HBA - KGPSA-BC	15,500	14,250	86	51
FC Hub	25,000	25,000	100	100
Single HSG80 Controller (1 Active Port)	12,000 Cache 4,100 Media	9,000 Cache 4,000 Media	77 Cache 54 Media	50 Cache 44 Media
Single HSG80 Controller (2 Active Ports)	12,000 Cache 4,100 Media	9,000 Cache 4,000 Media	98 Cache 54 Media	100 Cache 47 Media
Dual HSG80 Controllers (2 Active/2 Standby Ports)	24,000 Cache 8,200 Media	18,000 Cache 8,000 Media	154 Cache 102 Media	101 Cache 88 Media
Dual HSG80 Controllers (4 Active Ports)	24,000 Cache 8,200 Media	18,000 Cache 8,000 Media	195 Cache 102 Media	178 Cache 88 Media

NOTE

FC Hub performance limits are theoretical. Actual measured performance is lower due to limits unrelated to the hub.

General Configuration Guidelines

Fibre Channel storage technology offers more configuration flexibility than parallel SCSI storage. This application note describes typical RA8000/ESA12000 FC Windows NT High Availability configurations based on the configuration maximums listed. This document is not intended to describe all possible configurations. For configurations not shown here, the configuration maximums should be used to determine the viability of a proposed configuration. It is strongly recommended that you not exceed the maximums listed. The maximums and notes listed apply to all configurations, additional information specific to particular configurations is provided in each configuration section.

Configuration Maximums

- 500 meters per optical cable segment, 1 kilometer total distance between server and storage
- The maximum number of FC HBAs per server is 4 or the total allowed in the server if less than 4. When configuring more than one FC HBA in a single server, each must be connected to a different fibre channel hub (i.e., different loop)
- Fibre channel hubs – Maximum of 4 non-cooperating servers per hub or 2 cooperating servers per hub (one Windows NT Cluster per hub). Non-cooperating (standalone) and cooperating (clustered) servers cannot be mixed on the same hub
- The maximum number of active controller ports per HBA is 4
- Server maximums using Controller Transparent Failover Mode (assumes one FC HBA per server)
 - Up to 4 servers on a single FC hub with up to 2 storage systems - using 4 controllers with 2 active and 2 standby controller host ports per controller pair
 - Up to 8 servers on two FC hubs (4 servers per hub) with 1 storage system - using 2 controllers with 2 active and 2 standby controller host ports
- Maximums using Controller Multiple-Bus Failover Mode
 - Up to 4 storage systems on four hubs – using 8 controllers with 4 active controller host ports per controller pair (refer to HA Configuration 5)
 - Up to 4 servers on two hubs with up to 2 storage systems – using 4 controllers with 4 active controller host ports per controller pair (refer to HA Configuration 8)
 - Up to 8 servers on four hubs with 2 storage systems – using 4 controllers with 4 active controller host ports per controller pair (refer to HA Configuration 9)
- Maximum storage capacity stated assumes 36GB disks, increases in disk drive capacity will increase overall storage capacity for the same enclosure footprint

General Configuration Notes

- Dual redundant controllers can be configured for Transparent Failover Mode or Multiple-Bus Failover Mode
- All configuration diagrams show a front view of the storage system, Controller A is the top controller; Controller B is the bottom controller. Controller Host Port 1 is the left port; Host Port 2 is the right port
- Each storage system can be configured using SWCC or the Command Line Interface (CLI) configured through either the HSG80 controller maintenance serial port or a TCP/IP interface
- All configurations utilize Array Controller Software (ACS) V8.3 or V8.5 with all controller ports configured for FC-AL topology. Dual controllers must be configured with the same ACS version
- All configurations shown utilize short wavelength lasers/multi-mode fibre channel optical cables in all cable segments
- All configurations require the *Arbitrated Loop Physical Address (ALPA)* for each loop device be set to hard and be unique. Refer to the product documentation for a list of valid addresses
- All configurations require the Connection Name *Operating System* parameter set to “WINNT”
- By default the HSG80 Command Console LUN (CCL) is enabled. This must be disabled for

Windows NT (using the CLI, “SET *controller* NOCOMMAND_CONSOLE_LUN”)

- For two (or more) enclosure configurations with more than one controller host port on the same hub, set the ALPA for each controller host port in the additional enclosure(s) to a different hard address (using the CLI, “SET *controller* PORT_1_AL_PA = nn”)
- All High Availability Multiple-Bus Failover configurations require Compaq Secure Path for Windows NT. The minimum revision required is V3.0.

NOTE

Refer to the Secure Path documentation listed in Table 3 for specific installation procedures.

- For version 3.0 of Secure Path, one instance of the Secure Path Manager can manage multiple standalone servers or multiple clustered servers. Use more than one instance if you need to concurrently manage environments that include both standalone servers and clustered servers.
- All Secure Path configurations utilizing 4 active controller ports connected to the same server or servers offer the flexibility to use the 4 active ports for either increased total LUN count, or increased path accessibility to a lower number of LUNs.

For *Maximum LUN Count* use distinct controller port unit offsets and access control on controller port 1 and controller port 2 to configure up to 16 LUNs total, 8 available through each pair of port paths. This means you can configure up to 8 LUNs on the two port 1 paths, and another 8 LUNs on the two port 2 paths. It is suggested that for units accessed through controller host port 1 you use unit number and offset values in the range of 0 – 99. For units accessed through controller host port 2, use unit number and offset values in the range 100 – 199. For static controller load balancing individual LUNs should be distributed across each path of a port pair using the “Preferred Path” controller feature.

For *Maximum Controller Port PATH Accessibility* to the same set of LUNs, you can configure all 4 controller ports for access to the same 8 LUNs using the same unit offset on all 4 controller ports. In addition to the static controller load balancing feature, in this configuration you can enable dynamic port load distribution which distributes I/O load to each LUN across both ports on the same controller. The dynamic load distribution feature is available for non-clustered servers only.

- Distribute units equally across both controllers for proper static load balancing using the Unit Preferred Path parameter to assign units to a specific controller at initial boot
- For two (or more) server Secure Path configurations, it is suggested that the first adapter in each server be connected to the first (same) fibre channel hub, the second two adapters to the second hub, etc. This is not required, however, it does aid in understanding logical to physical LUN and path mapping for maintenance purposes.
- Selective Storage Presentation (SSP) - For configurations with more than one server on the same hub accessing the same controller host port, or configurations with more than one active controller host port on the same hub;

Use the Connection Name *Unit Offset* value to set the range of unit numbers to be visible from each server (using the CLI, “SET *connection-name* UNIT_OFFSET = n”)

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

Set the ALPA to a unique hard address for each FC HBA

- Record the FC HBA *Worldwide ID* (WWID) IEEE address shown on the back of each FC HBA prior to installing into a server
- Use the recorded WWID to identify the connection name displayed from the CLI at the controller using the “SHOW CONNECTIONS” command
- 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 32 (ACS V8.3) or 1 to 64 (ACS V8.5). 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)

- Each active controller host port on a loop presents one SCSI Target ID with up to eight LUNS to each server (FC HBA) on the same loop. LUNs (logical units) can consist of single disks (JBOD), or a storageset of multiple disks or multiple partitions configured for a specific RAID level of 0, 1, 0 + 1, or 3/5

Configuration Descriptions

Table 2 lists the most common RA8000 / ESA12000 FC Windows NT high availability configurations and the pages of this document where a description of capacities, configuration notes, performance considerations, are provided.

Table 2 Index of Common RA8000 / ESA12000 FC-AL Windows NT HA Configurations

High Availability Configuration #	Description	Pages
1	One Server, Secure Path, Dual Controller Multiple-Bus Failover	7 - 8
2	Two Servers, MSCS, Dual Controller Transparent Failover	9 - 10
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Configuration Parts Lists

A list of parts for each specific configuration is provided at the end of this document following the configuration descriptions.

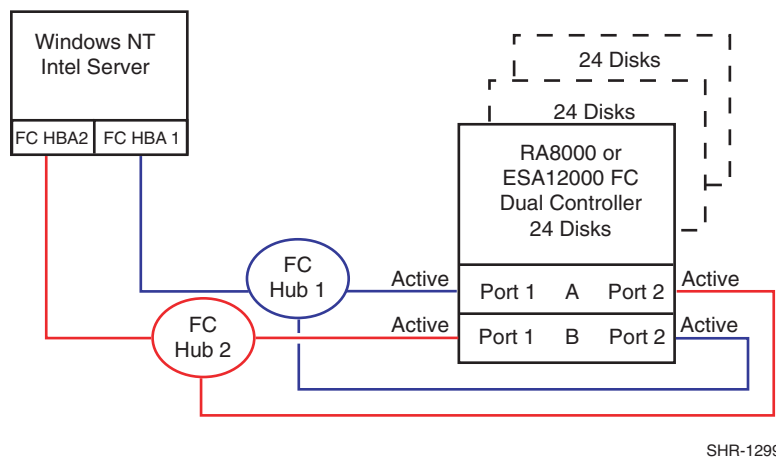
Additional Information/References

Table 3, at the end of this document, lists documentation to reference for further details on product installation and configuration.

HA Configuration 1 – One Server, Secure Path, Dual Controller Multiple-Bus Failover

HA Configuration 1 (Figure 1) represents an entry-level RA8000 or ESA12000 high availability configuration that can be expanded to support additional storage capacity or performance needs as required. The configuration consists of a single RA8000 or ESA12000 storage enclosure with two HSG80 array controllers configured in Multiple-Bus Failover mode. The configuration utilizes two separate paths (two fibre channel loops) to the storage. In the event of a failure of any component within the access path – HBA, cables, hub, or controller host port interface, all LUNs on the failing path will become accessible through the alternate path. The initial configuration provides up to 24 disks, an additional 48 disks can be added using two expansion enclosures. The configuration can also be expanded to support additional servers and up to two storage systems (refer to configuration 8).

Figure 1 HA Configuration 1



HA Configuration 1 Notes

- Two Fibre Channel Loops
- Uses Compaq Secure Path for Windows NT (minimum revision 3.0). Dynamic load distribution is available in this configuration when configured for maximum controller port paths
- One instance of Secure Path Manager can control all paths
- Dual HSG80 controllers configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 72 disks with 2 optional expansion cabinets
- Depending on your specific application needs, configure either for maximum LUNs or for maximum controller port PATH accessibility
 - For Maximum LUN Count – Up to 16 LUNs with 4 active controller host ports. Suggested distinct controller port unit number and offset value assignment: Port 1 units D0 – D7, unit offset = 0, Port 2 units D100 – D107, unit offset = 100. Use the Preferred Path unit parameter to assign units to specific controllers for static load balancing. Prefer units D0 – D3, D100 – D103 to Controller A, prefer units D4 – D7, D104 – D107 to Controller B.
 - For Maximum Controller Port PATH Accessibility – Up to 8 LUNs with 4 active controller host ports and dynamic load distribution between two ports on the same controller. Suggested

controller unit number and offset value assignment: All controller port connections use unit offset = 0 and have access to units D0 – D7. Use the Preferred Path unit parameter to assign units to specific controllers. Units should be distributed equally across controllers for static load balancing. Prefer units D0 – D3 to Controller A, prefer units D4 – D7 to Controller B.

Enable dynamic load distribution.

- In this configuration 4 logical connections are available
- Rename the connection names, i.e., SERVA1P1A, SERVA1P2B, SERVA2P1B, SERVA2P2A
- Set the same ALPA for each FC HBA. Suggested settings: HBA1 = 01, HBA2 = 01

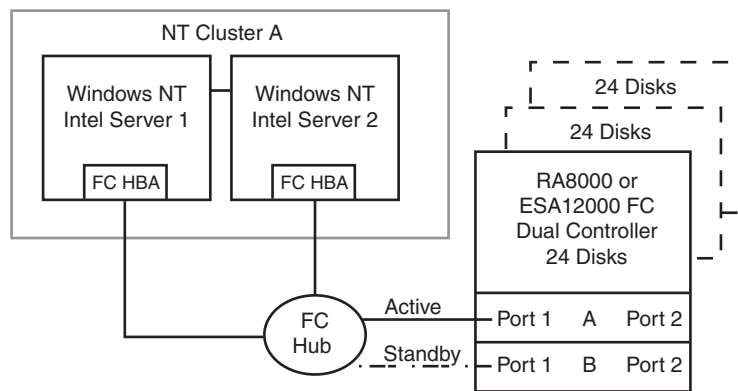
HA Configuration 1 Performance Considerations

This configuration utilizes dual controllers with four active controller host ports. The overall limit is based on the two active HBA limit of 31,000 I/O/sec and 172 MB/sec data rate. The primary advantage of this configuration is the ability to provide redundant independent paths to the storage. This is a general-purpose configuration that can be utilized for intensive I/O applications and very intensive bandwidth applications.

HA Configuration 2 – Two Servers, MSCS, Dual Controller Transparent Failover

HA Configuration 2 (Figure 2) provides dual redundant controllers configured in Transparent Failover mode. The configuration consists of a single RA8000 or ESA12000 storage enclosure with two HSG80 array controllers connected to two servers running MSCS software. In normal operation Controller A provides the active path for all storage sets to the cluster through Controller A, Port 1. A second controller, Controller B, is a hot standby. In the event of a failure in Controller A, Controller B will automatically become active. All units being accessed through Port 1 of Controller A will become accessible through Port 1 of Controller B. In the event of a server failure, cluster failover will be invoked to provide access to units through the surviving server. In the initial configuration a single controller host port (Port 1) is active providing up to 8 LUNs across up to 24 disks. An additional 48 disks can be added using two expansion enclosures.

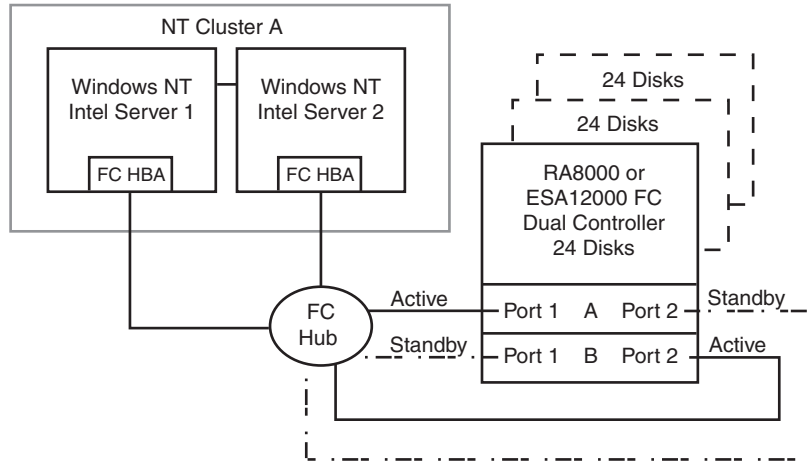
Figure 2 HA Configuration 2



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With the addition of two fibre channel cables, the second controller, Controller B, can become an active controller to increase performance and double LUN capacity. Two additional fibre channel cables, one connected to Controller A Port 2, and one connected to Controller B Port 2, result in the configuration shown in Figure 3. This configuration provides full controller redundancy in the event that Controller A or Controller B fails. In either failover scenario the surviving controller will transition a standby port to active providing access to all units in the cluster.

Figure 3 HA Configuration 2 with Increased Performance and Doubled LUN Capacity



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HA Configuration 2 Notes

- Single Fibre Channel Loop
- Dual HSG80 controllers configured in Transparent Failover Mode
- MSCS
- Up to 500 meters per cable segment
- Up to 72 disks with 2 optional expansion cabinets
- Up to 8 LUNs with 1 active controller host port (Figure 2). Suggested controller unit number assignment: Port 1 units D0 – D7. In this configuration 2 logical connections are available
- Up to 16 LUNs with 2 active controller host ports (Figure 3). Suggested controller unit number assignment: Port 1 units D0 – D7, Port 2 units D100 – D107. In this configuration, 4 logical connections are available
- Utilization of Controller A Host Port 2, and Controller B Host Port 2, requires two additional fibre channel cables
- By default, setting the controller pair in Transparent Failover mode will automatically configure Port 1 and Port 2 of both controllers to the Active and Standby state indicated, and set unit offset values to 0 for Port 1 and 100 for Port 2
- In the Figure 2 configuration, two logical connections are available; in the Figure 3 configuration, four logical connections are available, rename the connection names, i.e., SERVER1P1, SERVER1P2, SERVER2P1, SERVER2P2
- Set each FC HBA ALPA to a unique hexadecimal hard address. Suggested settings: Server 1 HBA = 01, Server 2 HBA = 02

HA Configuration 2 Performance Considerations

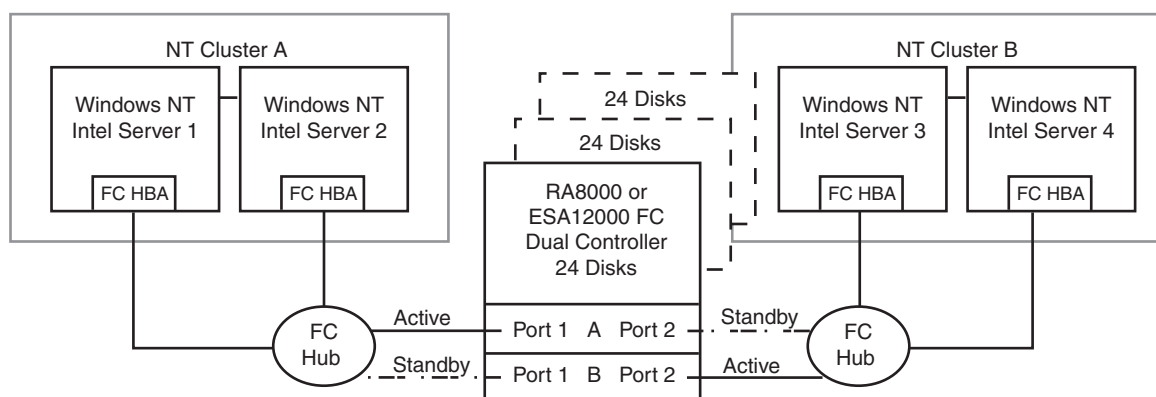
The configuration in Figure 2 utilizes a single active controller host port, resulting in a throughput limit of 12,000(cache)/4,100(media) I/O/sec, and a data rate limit of 77(cache)/54(media) MB/sec. Utilizing the second controller host port as shown in Figure 3, results in a performance increase up the dual controller two active port limit of 24,000 I/O/sec and a theoretical single loop of 100 MB/sec data rate.

This is a general-purpose configuration that can be utilized for typical I/O applications and typical bandwidth applications. Using the second controller will increase performance to allow for intensive I/O applications and moderately intensive bandwidth applications.

HA Configuration 3 – Four Servers, MSCS, Dual Controller Transparent Failover, Two Independent Clusters, Shared Storage Enclosure

This dual-controller configuration (Figure 4) utilizes the two pairs of controller host ports to provide storage for a second, independent Windows NT Cluster. Each Windows NT Cluster can be configured with up to 8 LUNs. The two clusters share the storage enclosure in that each cluster has exclusive access to its own LUNs through the use of mutually exclusive LUN numbering. The controllers are configured in Transparent Failover mode providing controller redundancy for both clusters. In the event of a controller failover, the surviving controller will continue to provide full access to units in both clusters. In the event of a server failure, cluster failover will be invoked to provide access to units through the surviving server. In this configuration two active controller ports provide up to 16 LUNs across up to 24 disks. An additional 48 disks can be added using two expansion enclosures to increase storage capacity.

Figure 4 HA Configuration 3



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HA Configuration 3 Notes

- Two MSCS clusters
- Shared storage enclosure
- Two Fibre Channel Loops
- Dual HSG80 controllers configured in Transparent Failover Mode
- Up to 500 meters per cable segment
- Up to 72 disks with 2 optional expansion enclosures
- Up to 16 LUNs total/8 per cluster with 2 active controller host ports. Suggested controller unit number assignment: Cluster A, Controller A Port 1 units D0 – D7. Cluster B, Controller B Port 2 units D100 – D107
- By default, setting the controller pair in Transparent Failover mode will automatically configure Port 1 and Port 2 of both controllers to the Active and Standby state indicated, and set the unit offset values to 0 for Port 1 and 100 for Port 2
- In this configuration 4 logical connections are available, rename the connection names, i.e., SERVER1P1, SERVER2P1, SERVER3P2, SERVER4P2
- Set exclusive access for each unit to specific server connection names, i.e., for unit D0 ENABLE = SERVER1P1, SERVER2P1, for unit D100 ENABLE = SERVER3P2, SERVER4P2
- For each loop, set each FC HBA ALPA to a unique hexadecimal hard address. Suggested settings: Server 1 HBA = 01, Server 2 HBA = 02

HA Configuration 3 Performance Considerations

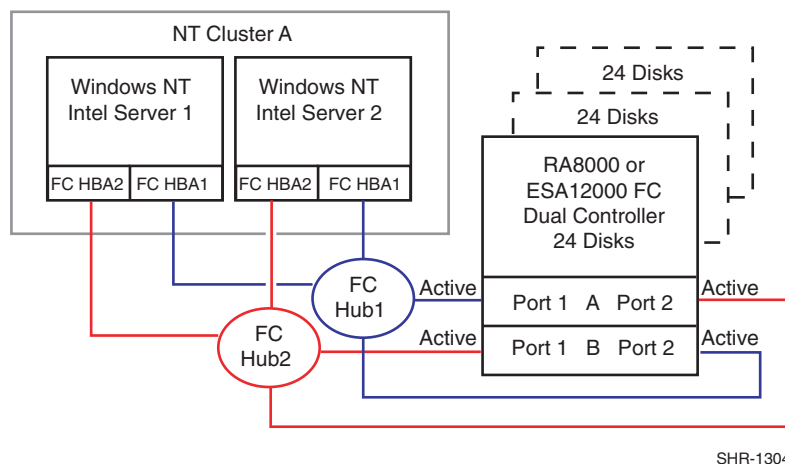
This configuration utilizes dual controllers with two active and two standby controller host ports. The overall limit is based on the dual controller, two active port limit of 24,000(cache)/8,200(media) I/O/sec and 154(cache)/102(media) MB/sec data rate. The primary advantage of this configuration is the ability to share the storage enclosure between two independent clusters without any performance degradation.

This is a general-purpose configuration that can be utilized for intensive I/O applications and very intensive bandwidth applications.

HA Configuration 4 – Two Servers, MSCS, Secure Path, Dual Controller Multiple-Bus Failover

HA Configuration 4 (Figure 5) combines the benefits of MSCS clustering, Secure Path for Windows NT software, and controller redundancy to provide the highest level of availability. The configuration utilizes two separate physical paths to the storage. In the event of a failure of any component within the access path – FC HBA, cables, hub, or controller host port interface, all units on the failing path will become accessible through the alternate path. In the event of a server failure, cluster failover will be invoked to provide access to units through the surviving server. The configuration can also be expanded to support up to two storage systems (refer to configurations 5).

Figure 5 HA Configuration 4



HA Configuration 4 Notes

- Two Fibre Channel Loops
- Uses Compaq Secure Path for Windows NT (minimum revision 3.0). Dynamic load distribution is not available in this configuration
- One instance of Secure Path Manager can control all paths
- Dual HSG80 controllers configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 72 disks with 2 optional expansion cabinets
- Depending on your specific application needs, configure either for maximum LUNs or for maximum controller port paths.
 - For Maximum LUN Count – Up to 16 LUNs with 4 active controller host ports. Suggested distinct controller port unit number and offset value assignment: Port 1 units D0 – D7, unit offset = 0, Port 2 units D100 – D107, unit offset = 100. Use the Preferred Path unit parameter to assign units to specific controllers for static load balancing. Prefer units D0 – D3, D100 – D103 to Controller A, prefer units D4 – D7, D104 – D107 to Controller B.
 - For Maximum Controller Port PATH Accessibility – Up to 8 LUNs with 4 active controller host ports. Suggested controller unit number and offset value assignment: All controller port connections use unit offset = 0 and have access to units D0 – D7. Use the Preferred Path unit parameter to assign units to specific controllers. Units should be distributed equally across controllers for static load balancing. Prefer units D0 – D3 to Controller A, prefer units D4 – D7 to Controller B.

- In this configuration 8 logical connections are available, rename the connection names, i.e., SRV1A1P1A, SRV1A2P1B, SRV1A1P2B, SRV1A2P2A, etc.
- In each server set the ALPA for each FC HBA to the same hexadecimal hard address, but unique on the loop. Suggested settings: Server 1 HBA1 = 01, HBA2 = 01, Server 2 HBA1 = 02, HBA2 = 02

HA Configuration 4 Performance Considerations

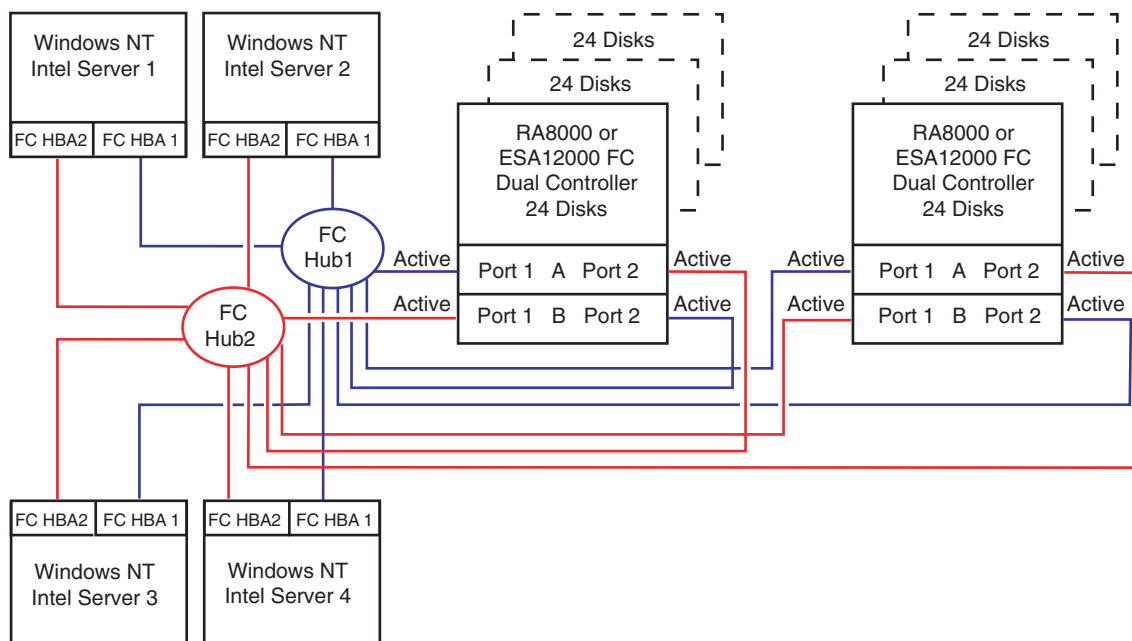
This configuration utilizes dual controllers with four active controller host ports. The overall limit is based on the dual controller, two active port limit of 24,000(cache)/8,200(media) I/O/sec and 195(cache)/102(media) MB/sec data rate. The primary advantage of this configuration is the ability to provide redundant independent paths to the storage and redundant servers.

This is a general-purpose configuration that can be utilized for intensive I/O applications and extremely intensive bandwidth applications.

HA Configuration 5 – Two Servers, MSCS, Secure Path, Four Dual Controller Pairs Multiple-Bus Failover

Configuration 5 (Figure 6) builds on Configuration 4 utilizing four FC HBAs in each cluster server connected to four dual controller pairs on four loops to provide storage path and controller redundancy with high storage capacity. The configuration utilizes two separate paths to each storage enclosure from each server in the cluster. In the event of a failure of any component within the access path – HBA, cables, hub, or controller host port interface, all LUNs on the failing path will become accessible through the alternate path. In the event of a server failure, cluster failover will provide access to all storage from the surviving server.

Figure 6 HA Configuration 5



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HA Configuration 5 Notes

- Four Fibre Channel Loops
- Uses Compaq Secure Path for Windows NT (minimum revision 3.0). Dynamic load distribution is not available in this configuration
- One instance of Secure Path Manager can control all paths
- Four Dual HSG80 controller pairs configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 288 disks with 8 optional expansion cabinets
- In this configuration 32 logical connections are available, 8 in each enclosure. For each enclosure (controller pair), rename the connection names as shown below
- In each server set the ALPA for each FC HBA to the same hexadecimal hard address, but unique on the loop. Suggested settings: Server 1 HBA1 = 01, HBA2 = 01, HBA3 = 01, HBA4 = 01 Server 2 HBA1 = 02, HBA2 = 02, HBA3 = 02, HBA4 = 02

- For the second controller enclosures, Enclosures 2 and 4, set each controller host port ALPA to a different address then set on the first enclosures, Enclosures 1 and 3:
Controller Enclosure 1: Controller Host Port 1 = 71, Port 2 = 72
Controller Enclosure 2: Controller Host Port 1 = 73, Port 2 = 74
Controller Enclosure 3: Controller Host Port 1 = 71, Port 2 = 72
Controller Enclosure 4: Controller Host Port 1 = 73, Port 2 = 74
- Depending on your specific application needs, configure either for maximum LUNs or for maximum controller port paths
 - For Maximum LUN Count – Up to 64 LUNs with 4 active controller host ports. The suggested unit numbering and connection parameters that result in the units being distributed equally across enclosures and controller host ports are:

For all Controller Enclosures, Server 1 and Server 2 units:

Port 1 units D0 – D7, Port 2 units D100 – D107

Prefer units D0 – D3, D100 – D103 to Controller A

Prefer units D4 – D7, D104 – D107 to Controller B

For Controller Enclosures 1 and 2, connection names, unit offset values: SRV1A1P1A, 0. SRV1A2P1B, 0. SRV1A1P2B, 100. SRV1A2P2A, 100. SRV2A1P1A, 0. SRV2A2P1B, 0. SRV2A1P2B, 100. SRV2A2P2A, 100.

Set exclusive access for each unit to the appropriate connection names, i.e.,

D0 ENABLE = SRV1A1P1A, SRV1A2P1B, SRV2A1P1A, SRV2A2P1B

D100 ENABLE = SRV1A1P2B, SRV1A2P2A, SRV2A1P2B, SRV2A2P2A

For Controller Enclosures 3 and 4, connection names, unit offset values: SRV1A3P1A, 0. SRV1A4P1B, 0. SRV1A3P2B, 100. SRV1A4P2A, 100. SRV2A3P1A, 0. SRV2A4P1B, 0. SRV2A3P2B, 100. SRV2A4P2A, 100.

Set exclusive access for each unit to the appropriate connection names, i.e.,

D0 ENABLE = SRV1A3P1A, SRV1A4P1B, SRV2A3P1A, SRV2A4P1B

D100 ENABLE = SRV1A3P2B, SRV1A4P2A, SRV2A3P2B, SRV2A4P2A

- For Maximum Controller Port PATH Accessibility – Up to 32 LUNs when configured for maximum paths, the suggested unit numbering and connection parameters that result in 8 LUNs being accessible through 4 ports in each controller enclosure are:

For all Controller Enclosures, Server 1 and Server 2 units D0 – D7

Prefer units D0 – D3 to Controller A

Prefer units D4 – D7 to Controller B

For Controller Enclosures 1 and 2, connection names, unit offset values: SRV1A1P1A, 0. SRV1A2P1B, 0. SRV1A1P2B, 0. SRV1A2P2A, 0. SRV2A1P1A, 0. SRV2A2P1B, 0. SRV2A1P2B, 0. SRV2A2P2A, 0.

Set exclusive access for each unit to the appropriate connection names, i.e.,

D0 ENABLE = SRV1A1P1A, SRV1A2P1B, SRV2A1P1A, SRV2A2P1B, SRV1A1P2B,

SRV1A2P2A, SRV2A1P2B, SRV2A2P2A

For Controller Enclosures 3 and 4, connection names, unit offset values: SRV1A3P1A, 0. SRV1A4P1B, 0. SRV1A3P2B, 0. SRV1A4P2A, 0. SRV2A3P1A, 0. SRV2A4P1B, 0. SRV2A3P2B, 0. SRV2A4P2A, 0.

Set exclusive access for each unit to the appropriate connection names, i.e.,

D0 ENABLE = SRV1A3P1A, SRV1A4P1B, SRV2A3P1A, SRV2A4P1B, SRV1A3P2B,

SRV1A4P2A, SRV2A3P2B, SRV2A4P2A

- Unit configurations and numbering can be identical for each storage enclosure, as each server will see each active controller host port as a unique target ID with a unique set of LUNs.

HA Configuration 5 Performance Considerations

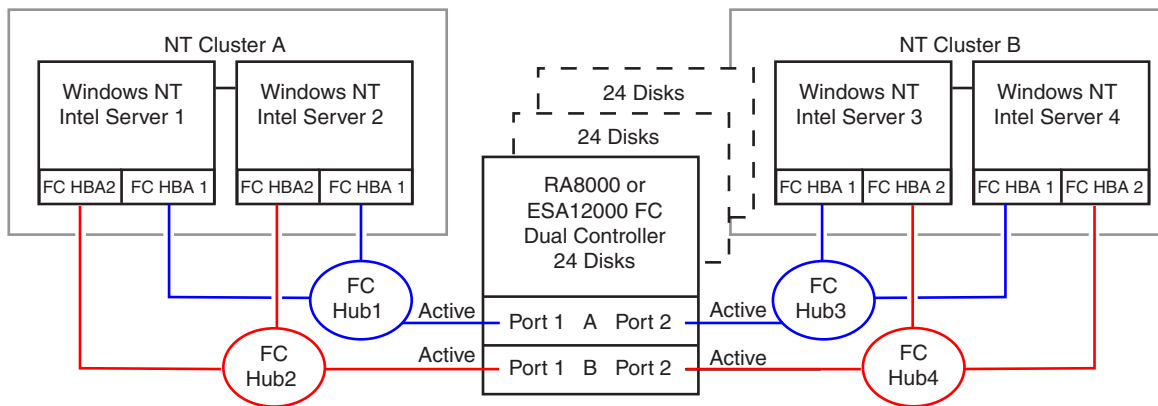
This configuration utilizes 4 dual controller pairs with an overall aggregate limit based on a theoretical four-loop limit of 62,400 I/O/sec and 400 MB/sec data rate. The primary advantage of this configuration is the ability to connect up to four storage systems with redundant independent paths to the servers.

This is a high availability, high capacity configuration that can be utilized for extremely intensive I/O applications and extremely intensive bandwidth applications.

HA Configuration 6 – Four Servers, MSCS, Secure Path, Dual Controller Multiple-Bus Failover, Two Independent Clusters, Shared Storage Enclosure

HA Configuration 6 (Figure 7) builds on configurations 3 and 4, combining the benefits of MSCS clustering, Secure Path for Windows NT software, controller redundancy, and sharing of the storage enclosure. The configuration provides two independent clusters with two separate physical paths to the storage through two pairs of controller host ports. In the event of a failure of any component within the access path – FC HBA, cables, hub, or controller host port interface, all units on the failing path will become accessible through the alternate path. In the event of a server failure, cluster failover will be invoked to provide access to units through the surviving server. Each Windows NT Cluster can be configured with up to 8 LUNs. The two clusters share the storage enclosure in that each cluster has exclusive access to its own LUNs through the use of mutually exclusive LUN numbering. An additional 48 disks can be added using two expansion enclosures to increase storage capacity.

Figure 7 HA Configuration 6



SHR-1306

HA Configuration 6 Notes

- Four Fibre Channel Loops
- Uses Compaq Secure Path for Windows NT (minimum version 3.0). Dynamic load distribution is not available in this configuration
- One instance of Secure Path Manager can control all paths
- Dual HSG80 controllers configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 72 disks with 2 optional expansion cabinets
- Up to 16 LUNs total/8 per Cluster with 4 active controller host ports. Suggested controller unit number and offset value assignment: Port 1 units D0 – D7, unit offset = 0, Port 2 units D100 – D107, unit offset 100
- Set the Unit Preferred Path. Use the Preferred Path unit parameter to distribute units equally across controllers for load balancing
 - Prefer units D0 – D3 to Controller A
 - Prefer units D4 – D7 to Controller B
 - Prefer units D100 – D103 to Controller A
 - Prefer units D104 – D107 to Controller B

- In this configuration 8 logical connections are available, rename the connection names, i.e.,
SERV1P1A, SERV1P1B, SERV2P1A, SERV2P1B, SERV3P2A,
SERV3P2B, SERV4P2A, SERV4P2B
- Set exclusive unit access for each unit to specific server connection names, i.e., for unit D0 ENABLE = SERV1P1A, SERV1P1B, SERV2P1A, SERV2P1B, for unit D100 ENABLE = SERV3P2A, SERV3P2B, SERV4P2A, SERV5P2B
- Set the connection name unit offset values for each connection as shown below
- In each server set the ALPA for each FC HBA to the same hexadecimal hard address, but unique on the loop. Suggested settings: Server 1 HBA1 = 01, HBA2 = 01, Server 2 HBA1 = 02, HBA2 = 02, etc.
- Suggested unit numbering and connection parameters would result in the units being distributed equally across clusters/controller host ports as follows:

Server 1: Port 1 units D0 – D7

Connection names, unit offset values: SERV1P1A, 0. SERV1P1B, 0

Server 2: Port 1 units D0 – D7

Connection names, unit offset values: SERV2P1A, 0. SERV2P1B, 0

Server 3: Port 2 units D100 – D107

Connection names, unit offset values: SERV3P2A, 100. SERV3P2B, 100

Server 4: Port 2 units D100 – D107

Connection names, unit offset values: SERV4P2A, 100. SERV4P2B, 100

HA Configuration 6 Performance Considerations

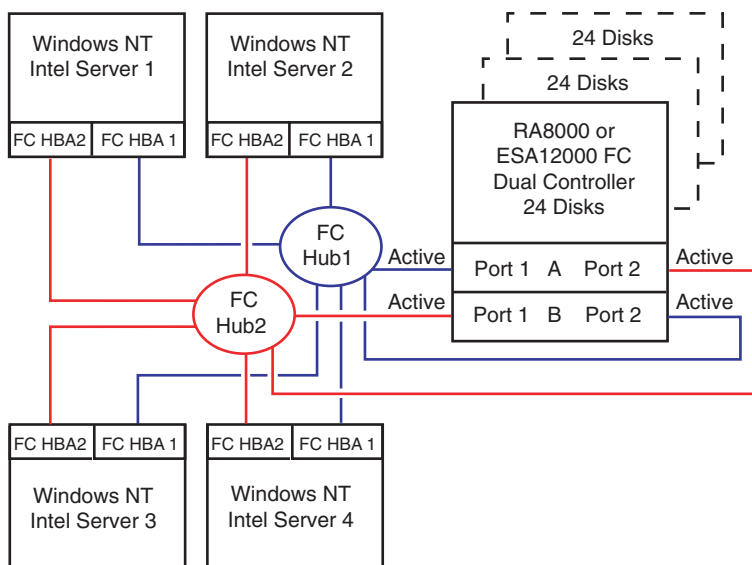
This configuration utilizes dual controllers with four active controller host ports. The overall limit is based on the dual controller, four active port limit of 24,000(cache)/8,200(media) I/O/sec and 195(cache)/102(media) MB/sec data rate. The primary advantage of this configuration is the ability to share the storage enclosure to connect two independent clusters with redundant independent paths to the storage.

This is a general-purpose configuration that can be utilized for intensive I/O applications and extremely intensive bandwidth applications.

HA Configuration 7 – Up to Four Servers, Secure Path, Dual Controller Multiple-Bus Failover, Shared Storage Enclosure

HA Configuration 7 (Figure 8) builds on Configuration 1 providing storage for up to four separate (non-cooperating) servers on two fibre channel loops. The four servers share the storage enclosure in that each server has exclusive access to its own set of LUNs. This is made possible by the setting of explicit “connection name access” at the unit level and using connection name “unit offsets” to give each server an accessible range of unit numbers. Additional levels of access control are necessary for this configuration because all servers are sharing the two fibre channel loops. The configuration utilizes two separate paths to the storage from each server. In the event of a failure of any component within the access path – HBA, cables, hub, or controller host port interface, all LUNs on the failing path will become accessible through the alternate path.

Figure 8 HA Configuration 7



SHR-1307

HA Configuration 7 Notes

- Two Fibre Channel Loops
- Shared storage enclosure
- Uses Compaq Secure Path for Windows NT (minimum version 3.0). Dynamic load distribution is available in this configuration when configured for maximum controller port paths
- One instance of Secure Path Manager can control all paths
- Dual HSG80 controllers configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 72 disks with 2 optional expansion cabinets
- In this configuration 16 logical connections are available
- In each server, set the ALPA for each FC HBA to the same hexadecimal hard address, but unique on the loop suggested settings, Server 1 HBA1 = 01, HBA2 = 01, Server 2 HBA1 = 02, HBA2 = 02, etc.
- Depending on your specific application needs, configure either for maximum LUNs or for maximum controller port paths

- For Maximum LUN Count – Up to 64 LUNs, 16 available to each server with 4 active controller host ports. The suggested unit numbering and connection parameters that result in the units being distributed equally across controller host ports are:

Server 1 Port 1 units D0 – D7, Port 2 units D100 – D107

Prefer units D0 – D3, D100 – D103 to Controller A

Prefer units D4 – D7, D104 – D107 to Controller B

Connection names, unit offset values: SRV1A1P1A, 0. SRV1A2P1B, 0. SRV1A1P2B, 100.

SRV1A2P2A, 100.

Set exclusive access for each unit to the listed connection names, i.e., D0 ENABLE =

SRV1A1P1A, SRV1A2P1B. D100 ENABLE = SRV1A1P2B, SRV1A2P2A

Server 2 Port 1 units D10 – D17, Port 2 units D110 – D117

Prefer units D10 – D13, D110 – D113 to Controller A

Prefer units D14 – D17, D114 – D117 to Controller B

Connection names, unit offset values: SRV2A1P1A, 10. SRV2A2P1B, 10. SRV2A1P2B, 110.

SRV2A2P2A, 110.

Set exclusive access for each unit to the listed connection names, i.e., D10 ENABLE =

SRV2A1P1A, SRV2A2P1B. D110 ENABLE = SRV2A1P2B, SRV2A2P2A

Server 3 Port 1 units D20 – D27, Port 2 units D120 – D127

Prefer units D20 – D23, D120 – D123 to Controller A

Prefer units D24 – D27, D124 – D127 to Controller B

Connection names, unit offset values: SRV3A1P1A, 20. SRV3A2P1B, 20. SRV3A1P2B, 120.

SRV3A2P2A, 120.

Set exclusive access for each unit to the listed connection names, i.e., D20 ENABLE =

SRV3A1P1A, SRV3A2P1B. D120 ENABLE = SRV3A1P2B, SRV3A2P2A

Server 4 Port 1 units D30 – D37, Port 2 units D130 – D137

Prefer units D30 – D33, D130 – D133 to Controller A

Prefer units D34 – D37, D134 – D137 to Controller B

Connection names, unit offset values: SRV4A1P1A, 30. SRV4A2P1B, 30. SRV4A1P2B, 130.

SRV4A2P2A, 130.

Set exclusive access for each unit to the listed connection names, i.e., D30 ENABLE =

SRV4A1P1A, SRV4A2P1B. D130 ENABLE = SRV4A1P2B, SRV4A2P2A

- For Maximum Controller Port PATH Accessibility – Up to 32 LUNs, 8 available to each server with 4 active controller host ports and dynamic load distribution between two ports on the same controller. The suggested unit numbering and connection parameters that result in 8 LUNs for each server being accessible through all 4 controller ports are:

Server 1 units D0 – D7

Prefer units D0 – D3 to Controller A

Prefer units D4 – D7 to Controller B

Connection names, unit offset values: SRV1A1P1A, 0. SRV1A2P1B, 0. SRV1A1P2B, 0.

SRV1A2P2A, 0.

Set exclusive access for each unit to the listed connection names, i.e., D0 ENABLE =

SRV1A1P1A, SRV1A2P1B, SRV1A1P2B, SRV1A2P2A

Server 2 units D10 – D17

Prefer units D10 – D13 to Controller A

Prefer units D14 – D17 to Controller B

Connection names, unit offset values: SRV2A1P1A, 10. SRV2A2P1B, 10. SRV2A1P2B, 10.

SRV2A2P2A, 10.

Set exclusive access for each unit to the listed connection names, i.e., D10 ENABLE = SRV2A1P1A, SRV2A2P1B, SRV2A1P2B, SRV2A2P2A

Server 3 units D20 – D27

Prefer units D20 – D23 to Controller A

Prefer units D24 – D27 to Controller B

Connection names, unit offset values: SRV3A1P1A, 20. SRV3A2P1B, 20. SRV3A1P2B, 20. SRV3A2P2A, 20.

Set exclusive access for each unit to the listed connection names, i.e., D20 ENABLE = SRV3A1P1A, SRV3A2P1B, SRV3A1P2B, SRV3A2P2A

Server 4 units D30 – D37

Prefer units D30 – D33 to Controller A

Prefer units D34 – D37 to Controller B

Connection names, unit offset values: SRV4A1P1A, 30. SRV4A2P1B, 30. SRV4A1P2B, 30. SRV4A2P2A, 30.

Set exclusive access for each unit to the listed connection names, i.e., D30 ENABLE = SRV4A1P1A, SRV4A2P1B, SRV4A1P2B, SRV4A2P2A

HA Configuration 7 Performance Considerations

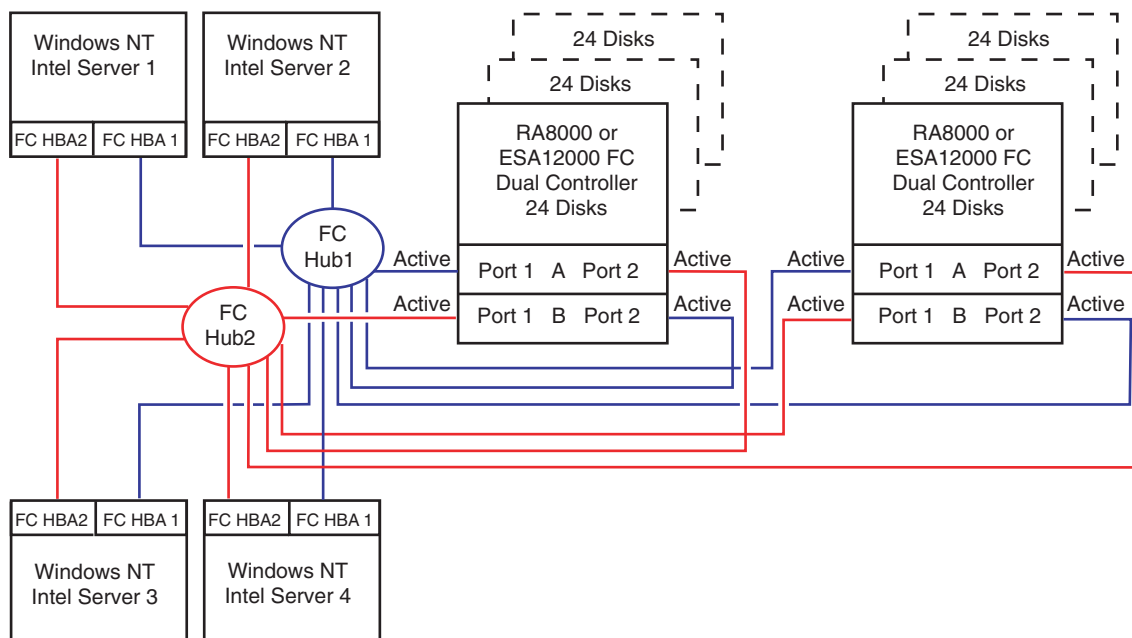
This configuration utilizes dual controllers with two active controller host ports. The overall aggregate limit is based on the dual controller, four active port limit of 24,000(cache)/8,200(media) I/O/sec and 195(cache)/102(media) MB/sec data rate. The primary advantage of this configuration is the ability to provide redundant independent paths to the storage for up to four servers.

This is a general-purpose configuration that can be utilized for intensive I/O applications and extremely intensive bandwidth applications.

HA Configuration 8 – Up to Four Servers, Secure Path, Two Dual Controller Pairs Multiple-Bus Failover, Shared Storage Enclosure

HA Configuration 8 (Figure 9) builds on Configuration 7 by adding storage capacity using a second enclosure and second pair of controllers. The second pair of controllers are connected to two fibre channel loops providing redundant paths for up to four separate (non-cooperating) servers. The four servers share both storage enclosures in that each server has exclusive access to its own LUNs in each enclosure through the use of mutually exclusive LUN numbering, explicit unit host access, and the use of connection unit offsets. Additional levels of access control are necessary for this configuration because all servers are sharing the two fibre channel loops. The configuration utilizes two separate paths to the storage from each server. In the event of a failure of any component within the access path – HBA, cables, hub, or controller host port interface, all LUNs on the failing path will become accessible through the alternate path.

Figure 9 HA Configuration 8



HA Configuration 8 Notes

- Two Fibre Channel Loops
- Shared storage enclosure
- Uses Compaq Secure Path for Windows NT (minimum version 3.0). Dynamic load distribution is available in this configuration when configured for maximum controller port paths
- One instance of Secure Path Manager can control all paths
- Two Dual HSG80 controller pairs configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 144 disks with 4 optional expansion cabinets
- In this configuration 16 logical connections are available, 8 in each enclosure
- In each server set the ALPA for each FC HBA to the same hexadecimal hard address, but unique on the loop. Suggested settings: Server 1 HBA1 = 01, HBA2 = 01, Server 2 HBA1 = 02, HBA2 = 02, etc.

- For the second controller enclosure, Enclosure 2, set each controller host port ALPA to a different address then set on the first enclosure:
Controller Enclosure 1: Controller Host Port 1 = 71, Port 2 = 72
Controller Enclosure 2: Controller Host Port 1 = 73, Port 2 = 74
- Depending on your specific application needs, configure either for maximum LUNs or for maximum controller port paths
 - For Maximum LUN Count – Up to 128 LUNs, 32 available to each server with 8 active controller host ports. Refer to Configuration 7, "Maximum LUN Count" Controller Enclosure settings for a suggested way to define the units that distributes them equally across controller host ports. Unit configurations and numbering can be identical for each storage enclosure, as each server will see each active controller host port as a unique target ID with a unique set of LUNs.
 - For Maximum Controller Port PATH Accessibility – Up to 64 LUNs, 16 available to each server with 8 active controller host ports and dynamic load distribution between two ports on the same controller. Refer to Configuration 7, Controller Enclosure "Maximum Controller Port PATH Accessibility" settings for a suggested way to define the units that distributes them equally across controller host ports. Unit configurations and numbering can be identical for each storage enclosure, as each server will see each active controller host port as a unique target ID with a unique set of LUNs.

HA Configuration 8 Performance Considerations

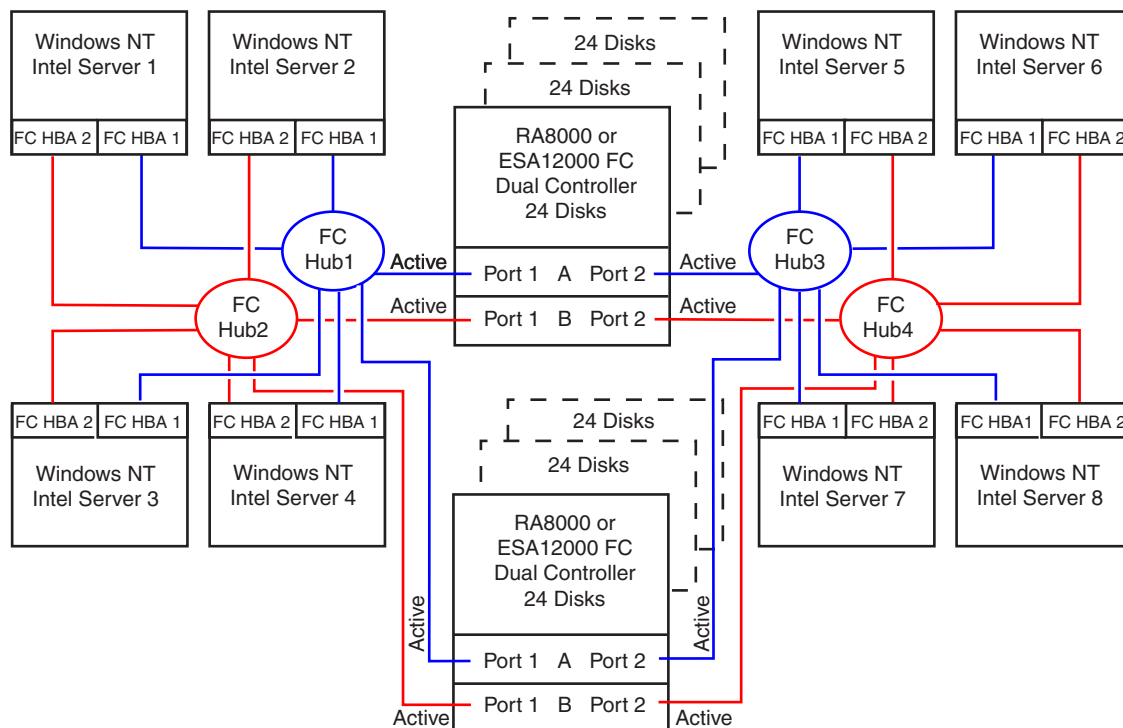
This configuration utilizes 2 dual controller pairs with an overall aggregate limit based on a theoretical two-loop limit of 33,200 I/O/sec and 200 MB/sec data rate. The primary advantage of this configuration is the ability to connect up to four servers and two storage systems with redundant independent paths to the storage.

This is a high availability, high connectivity configuration that can be utilized for extremely intensive I/O applications and extremely intensive bandwidth applications.

HA Configuration 9 – Up to Eight Servers, Secure Path, Two Dual Controller Pairs Multiple-Bus Failover, Two Shared Storage Enclosures

Configuration 9 (Figure 10) builds on Configurations 7 and 8 utilizing two dual controller pairs on four loops to provide storage path and controller redundancy for up to eight separate (non-cooperating) servers. The eight servers share both storage enclosures in that each server has exclusive access to its own LUNs in each enclosure through the use of mutually exclusive LUN numbering, explicit unit host access, and the use of connection unit offsets. Additional levels of access control are necessary for this configuration because each group of four servers is sharing two fibre channel loops. The configuration utilizes two separate paths to the storage from each server. In the event of a failure of any component within the access path – HBA, cables, hub, or controller host port interface, all LUNs on the failing path will become accessible through the alternate path.

Figure 10 HA Configuration 9



SHR-1324

HA Configuration 9 Notes

- Four Fibre Channel Loops
- Shared storage enclosure
- Uses Compaq Secure Path for Windows NT (minimum version 3.0). Dynamic load distribution is not available in this configuration
- One instance of Secure Path Manager can control all paths
- Two Dual HSG80 controller pairs configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 144 disks with 4 optional expansion cabinets
- In this configuration 32 logical connections are available, 16 in each enclosure

- In each server set the ALPA for each FC HBA to the same hexadecimal hard address, but unique on the loop. Suggested settings: Server 1 HBA1 = 01, HBA2 = 01, Server 2 HBA1 = 02, HBA2 = 02, etc.
- For the second controller enclosure, Enclosure 2, set each controller host port ALPA to a different address then set on the first enclosure:
Controller Enclosure 1: Controller Host Port 1 = 71, Port 2 = 72
Controller Enclosure 2: Controller Host Port 1 = 73, Port 2 = 74
- Up to 128 LUNs, 16 available to each server with 8 active controller host ports. The suggested unit numbering and connection parameters that result in the units being distributed equally across controller host ports are:

Server 1 Port 1 units D0 – D7

Prefer units D0 – D3 to Controller A

Prefer units D4 – D7 to Controller B

Connection names, unit offset values: SRV1A1P1A, 0. SRV1A2P1B, 0.

Set exclusive access for each unit to the listed connection names, i.e., D0 ENABLE = SRV1A1P1A, SRV1A2P1B

Server 2 Port 1 units D10 – D17

Prefer units D10 – D13 to Controller A

Prefer units D14 – D17 to Controller B

Connection names, unit offset values: SRV2A1P1A, 10. SRV2A2P1B, 10.

Set exclusive access for each unit to the listed connection names, i.e., D10 ENABLE = SRV2A1P1A, SRV2A2P1B

Server 3 Port 1 units D20 – D27

Prefer units D20 – D23 to Controller A

Prefer units D24 – D27 to Controller B

Connection names, unit offset values: SRV3A1P1A, 20. SRV3A2P1B, 20.

Set exclusive access for each unit to the listed connection names, i.e., D20 ENABLE = SRV3A1P1A, SRV3A2P1B

Server 4 Port 1 units D30 – D37

Prefer units D30 – D33 to Controller A

Prefer units D34 – D37 to Controller B

Connection names, unit offset values: SRV4A1P1A, 30. SRV4A2P1B, 30.

Set exclusive access for each unit to the listed connection names, i.e., D30 ENABLE = SRV4A1P1A, SRV4A2P1B

Server 5 Port 2 units D100 – D107

Prefer units D100 – D103 to Controller A

Prefer units D104 – D107 to Controller B

Connection names, unit offset values: SRV5A1P2B, 100. SRV5A2P2A, 100.

Set exclusive access for each unit to the listed connection names, i.e., D100 ENABLE = SRV5A1P2B, SRV5A2P2A

Server 6 Port 2 units D110 – D117

Prefer units D110 – D113 to Controller A

Prefer units D114 – D117 to Controller B

Connection names, unit offset values: SRV6A1P2B, 110. SRV6A2P2A, 110.

Set exclusive access for each unit to the listed connection names, i.e D110 ENABLE = SRV6A1P2B, SRV6A2P2A

Server 7 Port 2 units D120 – D127

Prefer units D120 – D123 to Controller A

Prefer units D124 – D127 to Controller B

Connection names, unit offset values: SRV7A1P2B, 120. SRV7A2P2A, 120.

Set exclusive access for each unit to the listed connection names, i.e D120 ENABLE = SRV7A1P2B, SRV7A2P2A

Server 8 Port 2 units D130 – D137

Prefer units D130 – D133 to Controller A

Prefer units D134 – D137 to Controller B

Connection names, unit offset values: SRV8A1P2B, 130. SRV8A2P2A, 130.

Set exclusive access for each unit to the listed connection names, i.e D130 ENABLE = SRV8A1P2B, SRV8A2P2A

- Unit configurations and numbering can be identical for each storage enclosure, as each server will see each active controller host port as a unique target ID with a unique set of LUNs

HA Configuration 9 Performance Considerations

This configuration utilizes 2 dual controller pairs with an overall aggregate limit based on the dual controller four active port limit (times 2) of 48,000(cache) I/O/sec and 390(cache) MB/sec data rate. The primary advantage of this configuration is the ability to connect up to eight servers and two storage systems with redundant independent paths to the storage.

This is a high availability, high connectivity configuration that can be utilized for extremely intensive I/O applications and extremely intensive bandwidth applications.

HA Configuration 1 Parts List

- One Intel Server with Microsoft Windows NT 4.0, Service Pack 3 - 6 (minimum Service Pack 3 for ACS V8.3) or Service Pack 4 - 6 (minimum Service Pack 4 for ACS V8.5)

Compaq Part #	Description	Quantity
380551-001	RA8000/ESA12000 FC Solution Software V8.5 for Windows NT/Intel	1
128697-B21	ACS V8.5F Controller SW	2
380594-001	Secure Path for WNT	1
380574-001	KGPSA-BC PCI FC HBA	2
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)	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	Choose 1
234453-001/B31/291 295573-B22	FC 7-Port Hub/Domestic/Intl/Japan FC 12-Port Hub 41U/42U Bracket	Choose 2
380561-B21	FC Optical GBIC	4
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	Choose 4
380691-B21 380595-B21 380694-B21 380588-B21 380589-B21 147599-001	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	Choose up to 24 (48 for ESA 48 slot)

HA Configuration 1 Optional Components

Compaq Part #	Description	Quantity
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	Up to 2 OR Choose 1
See above	Additional Disks Drives	Up to 48

HA Configuration 2 Parts List

- Two Intel Servers with Microsoft Windows NT 4.0, Service Pack 3 - 6 (minimum Service Pack 3 for ACS V8.3) or Service Pack 4 - 6 (minimum Service Pack 4 for ACS V8.5)

Compaq Part #	Description	Quantity
380551-001	RA8000/ESA12000 FC Solution Software V8.5 for Windows NT/Intel	1
128697-B21	ACS V8.5F Controller SW	2
380574-001	KGPSA-BC PCI FC HBA	2
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)	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	Choose 1
234453-001/B31/291 295573-B22	FC 7-Port Hub/Domestic/Intl/Japan FC 12-Port Hub 41U/42U Bracket	Choose 1
380561-B21	FC Optical GBIC	4
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	Choose 4
380691-B21 380595-B21 380694-B21 380588-B21 380589-B21 147599-001	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	Choose up to 24 (48 for ESA 48 slot)

HA Configuration 2 Optional Components

Compaq Part #	Description	Quantity
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	Up to 2 OR Choose 1
See above	Additional Disks Drives Additional FC Optical GBIC Additional FC Optical Cable	Up to 48 2 Choose 2

HA Configuration 3 Parts List

- Four Intel Servers with Microsoft Windows NT 4.0 Service Pack 3 - 6 (minimum Service Pack 3 for ACS V8.3) or Service Pack 4 - 6 (minimum Service Pack 4 for ACS V8.5)

Compaq Part #	Description	Quantity
380551-001	RA8000/ESA12000 FC Solution Software V8.5 for Windows NT/Intel	1
128697-B21	ACS V8.5F Controller SW	2
380574-001	KGPSA-BC PCI FC HBA	4
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)	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	Choose 1
234453-001/B31/291 295573-B22	FC 7-Port Hub/Domestic/Intl/Japan FC 12-Port Hub 41U/42U Bracket	Choose 2
380561-B21	FC Optical GBIC	8
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	Choose 8

380691-B21	4GB UW 7200 RPM Disk	Choose up to 24 (48 for ESA 48 slot)
380595-B21	9GB UW 7200 RPM Disk	
380694-B21	18GB UW 7200 RPM Disk	
380588-B21	9GB UW 10000 RPM Disk	
380589-B21	18GB UW 10000 RPM Disk	
147599-001	36GB UW 7200 RPM Disk	

HA Configuration 3 Optional Components

Compaq Part #	Description	Quantity
380570-B21 (Blue)	Pedestal Expansion 24 slots	Up to 2
380570-B22 (Opal)	Pedestal Expansion 24 slots	
380568-B21	Rackable Expansion 24 slots	OR Choose 1
380640-001 (Blue)	ESA12000 Expansion 48 Slot 60HZ	
380640-002 (Opal)	ESA12000 Expansion 48 Slot 60HZ	
380650-B21 (Blue)	ESA12000 Expansion 48 Slot 50HZ	
380650-B22 (Opal)	ESA12000 Expansion 48 Slot 50HZ	
See above	Additional Disks Drives	Up to 48

HA Configuration 4 Parts List

- Two Intel Servers with Microsoft Windows NT 4.0 Service Pack 3 - 6 (minimum Service Pack 3 for ACS V8.3) or Service Pack 4 - 6 (minimum Service Pack 4 for ACS V8.5)

Compaq Part #	Description	Quantity
380551-001	RA8000/ESA12000 FC Solution Software V8.5 for Windows NT/Intel	1
128697-B21	ACS V8.5F Controller SW	2
380594-001	Secure Path for WNT	1
380574-001	KGPSA-BC PCI FC HBA	4
380560-B21 (Blue)	RA8000 Pedestal w/dual HSG80	Choose 1
380560-B22 (Opal)	RA8000 Pedestal w/dual HSG80	
380670-B21	RA8000 Rackable w/dual HSG80	
380580-001 (Blue)	ESA12000 w/dual HSG80 24 Slot 60HZ	
380580-002 (Opal)	ESA12000 w/dual HSG80 24 Slot 60HZ	
380590-B21 (Blue)	ESA12000 w/dual HSG80 24 Slot 50HZ	
380590-B22 (Opal)	ESA12000 w/dual HSG80 24 Slot 50HZ	
380600-001 (Blue)	ESA12000 w/dual HSG80 48 Slot 60HZ	
380600-002 (Opal)	ESA12000 w/dual HSG80 48 Slot 60HZ	
380610-B21 (Blue)	ESA12000 w/dual HSG80 48 Slot 50HZ	
380610-B22 (Opal)	ESA12000 w/dual HSG80 48 Slot 50HZ	

234453-001/B31/291 295573-B22	FC 7-Port Hub/Domestic/Intl/Japan FC 12-Port Hub 41U/42U Bracket	Choose 2
380561-B21	FC Optical GBIC	6
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	Choose 6
380691-B21 380595-B21 380694-B21 380588-B21 380589-B21 147599-001	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	Choose up to 24 (48 for ESA 48 slot)

HA Configuration 4 Optional Components

Compaq Part #	Description	Quantity
380570-B21 (Blue) 380570-B22 (Opal) 380568-B21	Pedestal Expansion 24 slots Pedestal Expansion 24 slots Rackable Expansion 24 slots	Up to 2
380640-001 (Blue) 380640-002 (Opal) 380650-B21 (Blue) 380650-B22 (Opal)	ESA12000 Expansion 48 Slot 60HZ ESA12000 Expansion 48 Slot 60HZ ESA12000 Expansion 48 Slot 50HZ ESA12000 Expansion 48 Slot 50HZ	OR Choose 1
See above	Additional Disks Drives	Up to 48

HA Configuration 5 Optional Components

Compaq Part #	Description	Quantity
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	Up to 8 OR Choose 2 OR Choose 4
See above	Additional Disks Drives	Up to 192

HA Configuration 6 Parts List

- Four Intel Servers with Microsoft Windows NT 4.0 Service Pack 3 - 6 (minimum Service Pack 3 for ACS V8.3) or Service Pack 4 - 6 (minimum Service Pack 4 for ACS V8.5)

Compaq Part #	Description	Quantity
380551-001	RA8000/ESA12000 FC Solution Software V8.5 for Windows NT/Intel	1
128697-B21	ACS V8.5F Controller SW	2
380594-001	Secure Path for WNT	1
380574-001	KGPSA-BC PCI FC HBA	8
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)	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	Choose 1
234453-001/B31/291 295573-B22	FC 7-Port Hub/Domestic/Intl/Japan FC 12-Port Hub 41U/42U Bracket	Choose 4
380561-B21	FC Optical GBIC	12
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	Choose 12

380691-B21	4GB UW 7200 RPM Disk	Choose up to 24 (48 for ESA 48 slot)
380595-B21	9GB UW 7200 RPM Disk	
380694-B21	18GB UW 7200 RPM Disk	
380588-B21	9GB UW 10000 RPM Disk	
380589-B21	18GB UW 10000 RPM Disk	
147599-001	36GB UW 7200 RPM Disk	

HA Configuration 6 Optional Components

Compaq Part #	Description	Quantity
380570-B21 (Blue)	Pedestal Expansion 24 slots	Up to 2
380570-B22 (Opal)	Pedestal Expansion 24 slots	
380568-B21	Rackable Expansion 24 slots	OR Choose 1
380640-001 (Blue)	ESA12000 Expansion 48 Slot 60HZ	
380640-002 (Opal)	ESA12000 Expansion 48 Slot 60HZ	
380650-B21 (Blue)	ESA12000 Expansion 48 Slot 50HZ	
380650-B22 (Opal)	ESA12000 Expansion 48 Slot 50HZ	
See above	Additional Disks Drives	Up to 48

HA Configuration 7 Parts List

- Four Intel Servers with Microsoft Windows NT 4.0, Service Pack 3 - 6 (minimum Service Pack 3 for ACS V8.3) or Service Pack 4 - 6 (minimum Service Pack 4 for ACS V8.5)

Compaq Part #	Description	Quantity
380551-001	RA8000/ESA12000 FC Solution Software V8.5 for Windows NT/Intel	1
128697-B21	ACS V8.5F Controller SW	2
380594-001	Secure Path for WNT	1
380574-001	KGPSA-BC PCI FC HBA	8
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)	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	Choose 1
234453-001/B31/291 295573-B22	FC 7-Port Hub/Domestic/Intl/Japan FC 12-Port Hub 41U/42U Bracket	Choose 2
380561-B21	FC Optical GBIC	10
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	Choose 10
380691-B21 380595-B21 380694-B21 380588-B21 380589-B21 147599-001	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	Choose up to 24 (48 for ESA 48 slot)

234453-001/B31/291 295573-B22	FC 7-Port Hub/Domestic/Intl/Japan FC 12-Port Hub 41U/42U Bracket	Choose 2
380561-B21	FC Optical GBIC	24
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	Choose 24
380691-B21 380595-B21 380694-B21 380588-B21 380589-B21 147599-001	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	Choose up to 24 (48 for ESA 48 slot)

HA Configuration 9 Optional Components

Compaq Part #	Description	Quantity
380570-B21 (Blue) 380570-B22 (Opal) 380568-B21	Pedestal Expansion 24 slots Pedestal Expansion 24 slots Rackable Expansion 24 slots	Up to 4
380640-001 (Blue) 380640-002 (Opal) 380650-B21 (Blue) 380650-B22 (Opal)	ESA12000 Expansion 48 Slot 60HZ ESA12000 Expansion 48 Slot 60HZ ESA12000 Expansion 48 Slot 50HZ ESA12000 Expansion 48 Slot 50HZ	OR Choose 1 OR Choose 2
See above	Additional Disks Drives	Up to 96

Product Details

The RA8000/ESA12000 storage systems utilize the Compaq HSG80 RAID controller running Array Controller Software (ACS) V8.3 or 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 his 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 2nd 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 RAID subsystems and notify you of events by updating a video 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 and on Intel/Alpha platforms running Windows NT. A Storage Window for the HSG80 controller supports the Array Controller Software 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.

Configuration Reference Material

Table 3 lists the documents to reference for further information on the configuration of RA8000 and ESA12000 Fibre Channel Storage Systems.

Table 3 Related Configuration Documentation

Topic	Document Title	Order Number
<i>RA8000/ESA12000 Standard FC-AL Configurations Application Note</i>	<i>RA8000/ESA12000 FC-AL Configurations for Windows NT – Intel</i>	<i>AA-RH0RB-AA Available via the WEB</i>
<i>Windows NT - Intel HSG80 Array Controller</i>	<i>Release Notes, HSG80 Array Controller (ACS V8.5) for Windows NT Server – Intel</i>	<i>AA-RH0QB-TE or 387393-002</i>
<i>Windows NT - Intel HSG80 Array Controller</i>	<i>Release Notes, HSG80 Array Controller (ACS V8.3) for Windows NT Server – Intel</i>	<i>AA-RFA8A-TE</i>
<i>Windows NT - Intel RA8000/ESA12000 Installation</i>	<i>RA8000/ESA12000 Fibre Channel Solution Software for Windows NT Intel – Installation Reference Guide</i>	<i>AA-RFA9C-TE</i>
<i>Secure Path Installation</i>	<i>StorageWorks Secure Path v3.0 for Windows NT – Installation and Reference Guide</i>	<i>AA-RL4SA-TE</i>
<i>HSG80 Array Controller Configuration</i>	<i>HSG80 Array Controller ACS Version 8.5 Configuration Guide</i>	<i>EK-HSG85-CG or 165144-001</i>
<i>HSG80 Array Controller Command Line Interface</i>	<i>HSG80 Array Controller ACS Version 8.5 CLI Reference Guide</i>	<i>EK-HSG85-RG or 165145-001</i>
<i>HSG80 Array Controller Maintenance</i>	<i>HSG80 Array Controller ACS Version 8.5 Maintenance and Service Guide</i>	<i>EK-HSG84-SV or 118620-002</i>
<i>StorageWorks Command Console</i>	<i>Command Console V2.2 (HSG80) for RAID Array 8000/ESA12000, User's Guide</i>	<i>AA-RFA2D-TE</i>
<i>Warranty Information</i>	<i>DIGITAL StorageWorks Warranty Terms and Conditions</i>	<i>EK-HSXSU-WC</i>

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