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Compaq RAID Array 4000 Storage System: Deployment and Configuration

Abstract: As the performance of processors and peripherals improves and companies increasingly move to distributed architectures while consolidating servers, the company's administrators generate high-speed and data intensive network applications. As a result, interconnects between servers and the I/O devices they support have become a management bottleneck.

Fibre Channel storage solutions shatter distance, connectivity, capacity, and bandwidth limitations of SCSI. Fibre Channel allows highly scalable, high-performance storage solutions for the most demanding applications. Compaq believes Fibre Channel is the best interconnect technology choice for future storage solutions and has developed the RAID Array 4000 (RA4000) Storage System, which is based on this technology.

This paper describes how to:

- Upgrade an existing single controller Fibre Channel Storage System to the dual controller RA4000
- Install an RA4000 with either single or dual controllers
- Deploy full redundancy with either a Fibre Channel Storage System or an RA4000

For more information on Fibre Channel technology, go to

<http://www.compaq.com/products/servers/storage/fibre.html>

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Compaq RAID Array 4000 Storage System: Deployment and Configuration
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Fibre Channel Storage System to RAID Array 4000

The Compaq StorageWorks RAID Array 4000 (RA4000), formerly the Fibre Channel Storage System (FCSS), is an external storage solution incorporating Fibre Channel interconnect technology. Compaq changed the name of the FCSS to the RA4000 to clearly position this product within our line of external storage solutions and leverage the new rebranded Storageworks. None of the functionality of the FCSS has been reduced, in fact, Compaq has added significant new features to the RA4000.

With the RA4000, Compaq has implemented redundant controller support for both the RA4000 and the FCSS for Windows NT 4.0 and NetWare 4.x and 5.x. Redundant controller support allows for dual fibre loop configurations and further reduces both planned and unplanned downtime.

The FCSS controller board contained 32 megabytes of cache for systems manufactured before September 15, 1998, and 64 megabytes of cache for systems manufactured after September 15, 1998. The controller board for the RA4000 system features 64 megabytes of cache. With both systems, the array controller is housed in the external storage cabinet. With the RA4000, the customer can utilize two controller cards with the accompanying software.

The RA4000 Storage System

In its base configuration, an RA4000 storage system consists of the following components:

- A Fibre Channel Host Adapter (installed in a Compaq X86 server)
- A Fibre Channel Storage Hub and required Fibre Channel interconnects
- One or more RA4000s shipped standard with RA4000 Controllers

A description of each component is detailed in the sections below.

Fibre Channel Host Adapter

The Compaq Fibre Channel Host Adapter is a high-speed host interface that provides connectivity from the server to one or multiple RA4000s via a Fibre Channel Storage Hub.

The adapter is available in either a PCI version or an EISA version. The Fibre Channel Host Adapter/P is a 33 MHz 32-bit PCI bus master device. The Fibre Channel Host Adapter/E is for use in a server equipped only with an EISA expansion bus or with a server that has a majority of EISA bus slots. The Fibre Channel Host Adapter/E takes advantage of the EISA architecture by performing 32-bit bus master burst transfers.

IMPORTANT: Both the PCI and EISA versions of the Fibre Channel Host Adapter require installation of a gigabit interface converter module into the I/O port before the multi-mode fibre cable is connected.

Gigabit Interface Converters

Gigabit interface converters (GBICs) are industry-standard connection devices that hot plug into Fibre Channel storage hubs and controllers. A GBIC converts serial electrical signals to serial optical signals for bi-directional transmission of data across the Fibre Channel media.

GBICs are available in two varieties:

- **Short wave (GBIC-SW)**—For connections up to 500 meters. A GBIC-SW provides a transmission rate of 100 megabytes per second at distances up to 500 meters using 50-micron, multi-mode fiber optic cables. 62.5-micron, multi-mode fiber optic cable is also supported, but distances are limited to 300 meters.
- **Long wave (GBIC-LW)**—For connections between 500 meters and 10 kilometers. A GBIC-LW provides a transmission rate of 100 megabytes per second at distances up to 10 kilometers of 9-micron, single-mode fiber optic cable. GBIC-LW are not currently supported on Microsoft Cluster Server configurations.

Note: GBICs on both ends of any Fibre Channel cable link must be the same type. For example, GBIC-SW must link to GBIC-SW and GBIC-LW must link to GBIC-LW. Intermixing short wave types and long wave types on any single link is functionally incompatible.

Fibre Channel Storage Hubs

Fibre Channel Storage Hubs accept different cable types, allowing for intermixed cable pairs within a topology, and use port bypass circuitry to keep a Fibre Channel loop topology intact. The RA4000 can be configured using a Fibre Channel Storage Hub 7 or a Fibre Channel Storage Hub 12.

Fibre Channel Storage Hub 7

The Compaq Fibre Channel Storage Hub 7 is a seven-port hub that creates a 100-megabytes-per-second Fibre Channel Arbitrated Loop through its internal wiring and logic.

Note: GBICs on both ends of any Fibre Channel cable link must be the same type. For example, GBIC-SW must link to GBIC-SW and GBIC-LW must link to GBIC-LW. Intermixing short wave types and long wave types on any single link is functionally incompatible.

A Fibre Channel Storage Hub 7 is capable of supporting:

- Up to six RA4000s per hub
- Up to 72 spindles per server slot
- Up to 1.75 TB per server slot
- Interconnect distances up to 500 meters per link using GBIC-SW
- Interconnect distanced up to 10 kilometers per link using GBIC-LW

Fibre Channel Storage Hub 12

The Compaq Fibre Channel Storage Hub 12 is an intelligent, 12-port hub similar to the Fibre Channel Storage Hub 7.

A Fibre Channel Storage Hub 12 is capable of supporting:

- Up to 11 RA4000s per hub.
- Up to 132 spindles per server slot.
- Up to 3.2 TB per server slot.
- Interconnect distances up to 500 meters per link using GBIC-SW.
- Interconnect distances up to 10 kilometers per link using GBIC-LW.

RAID Array 4000

The RAID Array 4000 (RA4000) is an external drive enclosure containing a high-performance RA4000 Controller, hot-pluggable hard disk drives, fan assembly, and power supplies.

The RA4000 allows you to simultaneously scale capacity, cache, and processing power. Each RA4000 features optional hot-plug redundant power supplies and fans. This array supports dual controllers, which provide controller failover redundancy. The RA4000 is available in tower or 4U rack form factors and supports eight 1.6-inch or twelve 1-inch hard disk drives for a total of 291.2 GB per enclosure using 36.4 GB drives.

The number of RA4000s that can be deployed in an RA4000 Storage System depends on the number and configuration of the Fibre Channel Storage Hubs. The number and configuration of the storage hubs depends on the number of Fibre Channel Host Adapters installed in the server.

Note: The Compaq RA4000 is drive tray compatible with Compaq X86 Servers and ProLiant Storage Systems (Wide Ultra SCSI-3 Hot Plug).

RA4000 Controller

The RA4000 Controller is an intelligent Fibre Channel-to-SCSI array controller integrated into the RA4000. The controller is based on the Compaq Smart Array architecture and has two Wide Ultra SCSI-3 channels. Each channel can transfer data at 40 megabytes per second for a total of 80 megabytes per second possible internal bandwidth. The array controller-to-host interface is Fibre Channel for high-speed connection to the server. The Fibre Channel interface can transfer data to the server at burst rates of 100 megabytes per second.

The RA4000 Controller supports RAID levels 0, 0+1, 1, 4, and 5. It also supports multiple logical drives with hot-swap capabilities and online capacity expansion within the array. The controller features sixth-generation Compaq RAID technology and components and a total of 64 megabytes of usable cache (16 megabytes read and 48 megabytes user-selectable read/write).

The RA4000 Controller supports Wide-Ultra SCSI-3, Fast-Wide SCSI-2, or Fast SCSI-2 drives. Use of SCSI technology inside the RA4000 allows customers to use existing SCSI disk drives. Since hard disk drives are the most costly part of a storage system, this compatibility can reduce the cost of implementing an RA4000 Storage System.

Deploying the RA4000

Upgrading from FCSS to RA4000

The RA4000 is an open solution that has been tested, proven, and optimized for seamless integration and unmatched performance with Compaq X86 servers and critical applications. This solution features a controller board with 64 megabytes of cache. The controller board in some Fibre Channel Storage Systems (FCSS) contain 32 megabytes of cache.

To upgrade your FCSS to an RA4000, you must:

1. Ensure the cache sizes on your controller pairs are equal. Otherwise, your cache will be disabled and performance will be reduced. Your alternatives are to pair controllers with either 32 MB or 64 MB caches or to upgrade an existing 32 MB cache controller with a 64 MB cache. To do so, you must order and install the Compaq Fibre Channel Array Controller 64 MB Cache Upgrade Kit (p/n 262398-B21).

IMPORTANT: When upgrading to the RA4000, make sure the cache sizes of the controller boards match. If the cache sizes do not match, all of the cache will be disabled.

2. Install the new drivers and firmware included on SmartStart 4.3 or later.
3. If you are using Microsoft Windows NT (either clustered or nonclustered installations), purchase the Compaq ProLiant Cluster HA/F 200 kit.

Each integrated RA4000 Controller includes an enhanced Array Accelerator with a total of 64 megabytes of cache. Of that total, 16 megabytes is dedicated read cache that is integrated on the base controller board. The remaining 48 megabytes of cache is user-selectable, battery-backed read/write cache located on a small, removable board that plugs into the base controller.

One major advantage of migrating from an FCSS to the RA4000 is that the customer can run two controller cards, each with 64 megabytes of cache, with available software. In a redundant configuration, if the active controller or other component fails or becomes inoperative, the standby controller will take over, notify the system administrator of the problem, and maintain operation of the storage subsystem. Unplanned downtime is minimized.

An RA4000 can provide redundancy in either a single server environment or in a clustered server environment.

In any type of server environment, the RA4000(s) must have dual controllers installed to ensure controller failover redundancy. With single controllers, there is no controller redundancy to protect the data should a component fail.

Configuration Scenarios

System configurations vary widely, but RA4000s with dual controllers can be easily deployed in any scenario with very little operating interruption. Customers can increase storage capacity and achieve redundancy in an endless number of configuration scenarios. Four common configurations are detailed below.

- **Single Server/Single Controller.** The system contains one server and one controller per RA4000. There is no redundancy in this configuration.
- **Dual Servers/Single Controller.** The system contains two servers and one controller per RA4000 running Microsoft Cluster Server or NetWare High Availability Server. There is no storage system redundancy in this configuration.
- **Single Server/Dual Controllers.** The system contains one server and two controllers per RA4000 to provide redundancy. Dual controllers bring controller failover redundancy for the system to this scenario.
- **Dual Servers/Dual Controllers.** The system contains two servers running Microsoft Cluster Server or NetWare High Availability Server and two controllers per RA4000 to provide redundancy. Dual controllers and servers bring controller failover redundancy for the system to this scenario.

Note: Single Server/Single Controller, Dual Servers/Single Controller, Single Server/Dual Controllers, and Dual Servers/Dual Controllers, are not the only RA4000 configuration scenarios. System configurations may vary depending on the customer's operating environment.

Incompatibilities in bus and drive mapping exist between Compaq ProLiant Storage Systems and the RA4000 except for the F2 or U2 models. For this reason, data stored on hard drives in a ProLiant Storage System F2 or U2 connected to a Smart Array Controller can be migrated directly to an RA4000 provided the HDDs are kept in the same physical order and RA4000 Controller FW 1.14 or later is used. For ProLiant Storage Systems models F1, U1, and UE, migrating stored data to an RA4000 requires a full backup and restore operation. Refer to www.compaq.com for details about migrating to an RA4000 from a Compaq ProLiant Storage System using Compaq Smart Array Controllers.

Single Server/Single Controller

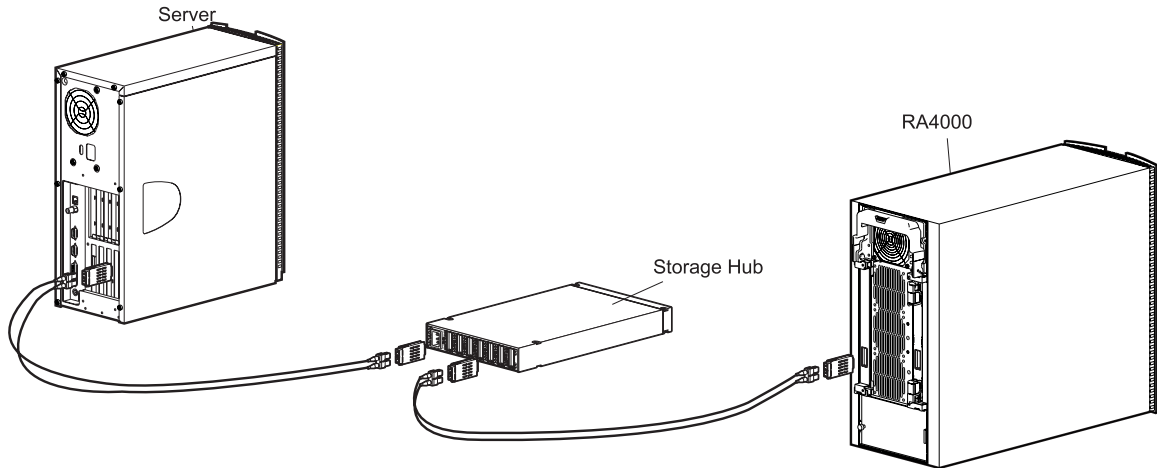


Figure 1. RA4000 Storage System with Single Server/Single Controller

Customers deploying a single server or an entirely new storage system with a single server/single controller configuration must:

1. Insert a GBIC into the Fibre Channel Host Adapter.
2. Install the Fibre Channel Host Adapter in the server.
3. Insert a GBIC into the Fibre Channel Storage Hub. Use a GBIC-SW if the connection to the server is 500 meters or less, or a GBIC-LW if the connection to the server is between 500 meters and 10 kilometers.

IMPORTANT: Systems deploying GBIC-SW use 50-micron, multi-mode fiber optic cable. Systems deploying GBIC-LW use 9-micron, single-mode fiber optic cable.

4. Connect a Fibre Channel Storage Hub to the Fibre Channel Host Adapter.
5. Insert a GBIC into the array controller at the RA4000. Use a GBIC-SW if the connection to the hub is 500 meters or less, or a GBIC-LW if the connection to the hub is between 500 meters and 10 kilometers.

Note: The necessary GBIC and the appropriate fiber optic cable are determined by individual customer needs and system design.

6. Connect the RA4000(s) to the Fibre Channel Storage Hub.

Note: In single-server environments, the server can be connected directly to the RA4000.

7. Run the Compaq Options ROMPaq. It is provided on the Compaq SmartStart and Support Software CD 4.30 or later that is shipped with the Compaq StorageWorks RA4000 and RA4000 Redundant Controller.

Dual Servers/Single Controller

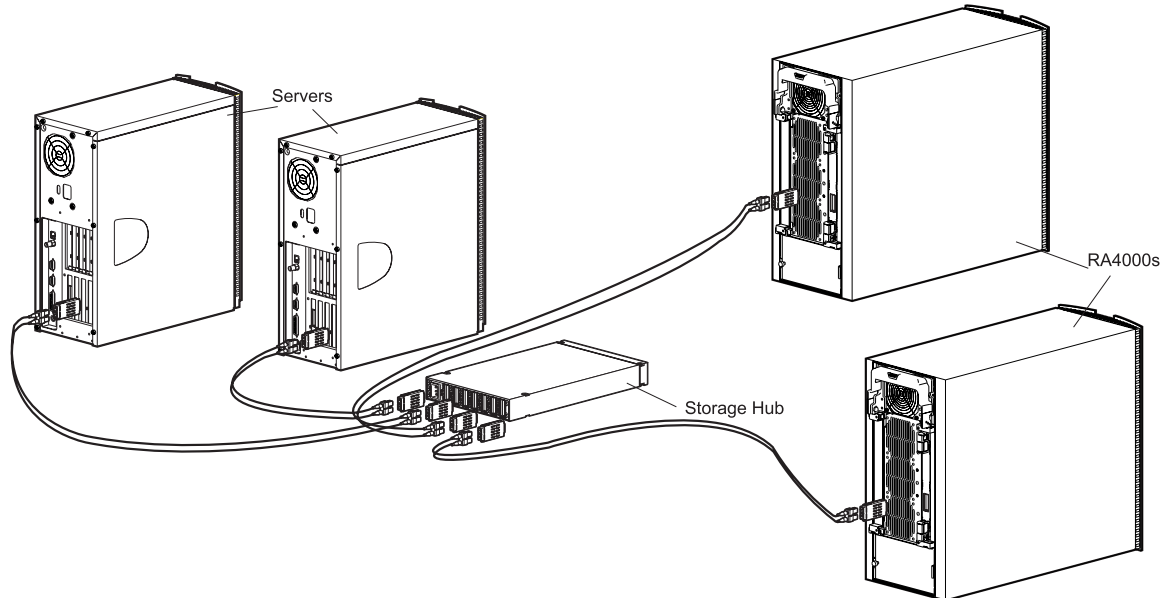


Figure 2. RA4000 Storage System with Dual Server/Single Controller

Customers who only require a system with a single array controller, may want the flexibility of a system with two servers.

Customers migrating from a single server to a server cluster or deploying an entirely new storage system with a dual servers/single controller configuration must:

1. Insert a GBIC into the Fibre Channel Host Adapter.
2. Install the Fibre Channel Host Adapter into the added server or into both servers if the storage system is entirely new.
3. Insert a GBIC into the Fibre Channel Storage Hub. Use a GBIC-SW if the connection to the server is 500 meters or less, or a GBIC-LW if the connection to the server is between 500 meters and 10 kilometers.

IMPORTANT: Systems deploying GBIC-SW use 50-micron, multi-mode fiber optic cable. Systems deploying GBIC-LW use 9-micron, single-mode fiber optic cable.

4. Connect a Fibre Channel Storage Hub to the Fibre Channel Host Adapters.
 5. Insert a GBIC into the array controller at the RA4000. Use a GBIC-SW if the connection to the hub is 500 meters or less, or a GBIC-LW if the connection to the hub is between 500 meters and 10 kilometers.
-

Note: The necessary GBIC and the appropriate fiber optic cable are determined by individual customer needs and system design.

6. Connect the RA4000 to the Fibre Channel Storage Hub.
7. Run the Compaq Options ROMPaq. It is provided on the Compaq SmartStart and Support Software CD 4.30 or later that is shipped with the Compaq StorageWorks RA4000 and RA4000 Redundant Controller.

Single Server/Dual Controllers

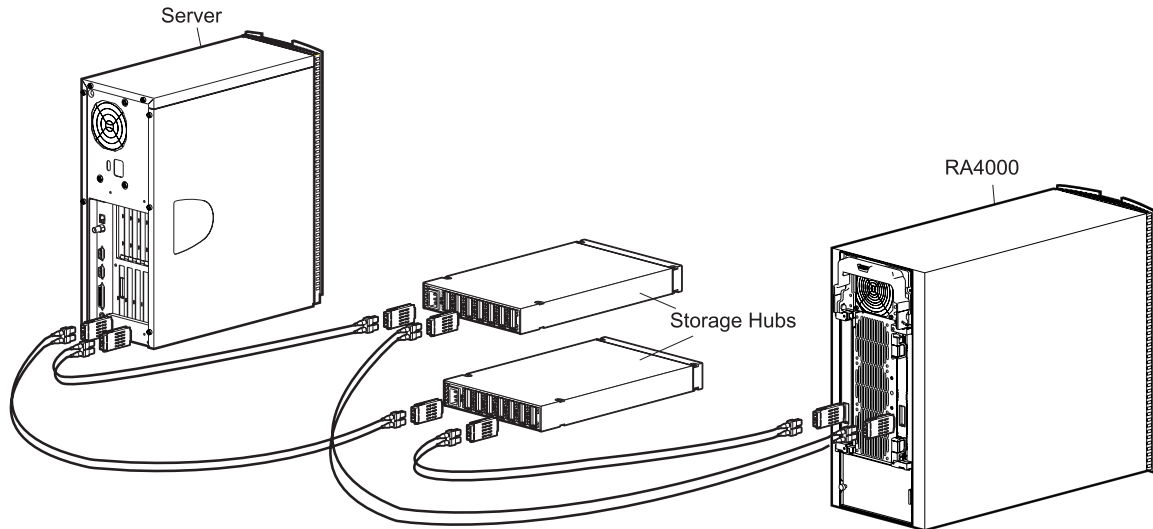


Figure 3. RA4000 Storage System with Single Server/Dual Controllers

Customers who want a redundant storage system, but do not require a server cluster, can deploy a system containing a single server/dual controller deployment scenario.

Customers deploying a single server or installing an entirely new storage system with a single server/dual controllers configuration must:

1. Insert a GBIC into two Fibre Channel Host Adapters.
2. Install the two Fibre Channel Host Adapters into the server.
3. Insert a GBIC into each of two Fibre Channel Storage Hubs. Use a GBIC-SW if the connection to the server is 500 meters or less, or a GBIC-LW if the connection to the server is between 500 meters and 10 kilometers.

IMPORTANT: Systems deploying GBIC-SW use 50-micron, multi-mode fiber optic cable. Systems deploying GBIC-LW use 9-micron, single-mode fiber optic cable.

4. Connect a Fibre Channel Storage Hub to each Fibre Channel Host Adapter.
5. Insert a GBIC into each array controller at the RA4000(s). Use a GBIC-SW if the connection to the hub is 500 meters or less, or a GBIC-LW if the connection to the hub is between 500 meters and 10 kilometers.

IMPORTANT: One Fibre Channel link per array controller is required.

Note: The necessary GBIC and the appropriate fiber optic cable are determined by individual customer needs and system design.

6. Connect each RA4000 to the Fibre Channel Storage Hub for each controller link.

Note: In single server environments, the server can be connected directly to the RA4000.

7. Run the Compaq Options ROMPaq. It is provided on the Compaq SmartStart and Support Software CD 4.30 or later that is shipped with the Compaq StorageWorks RA4000 and RA4000 Redundant Controller.

Dual Servers/Dual Controllers

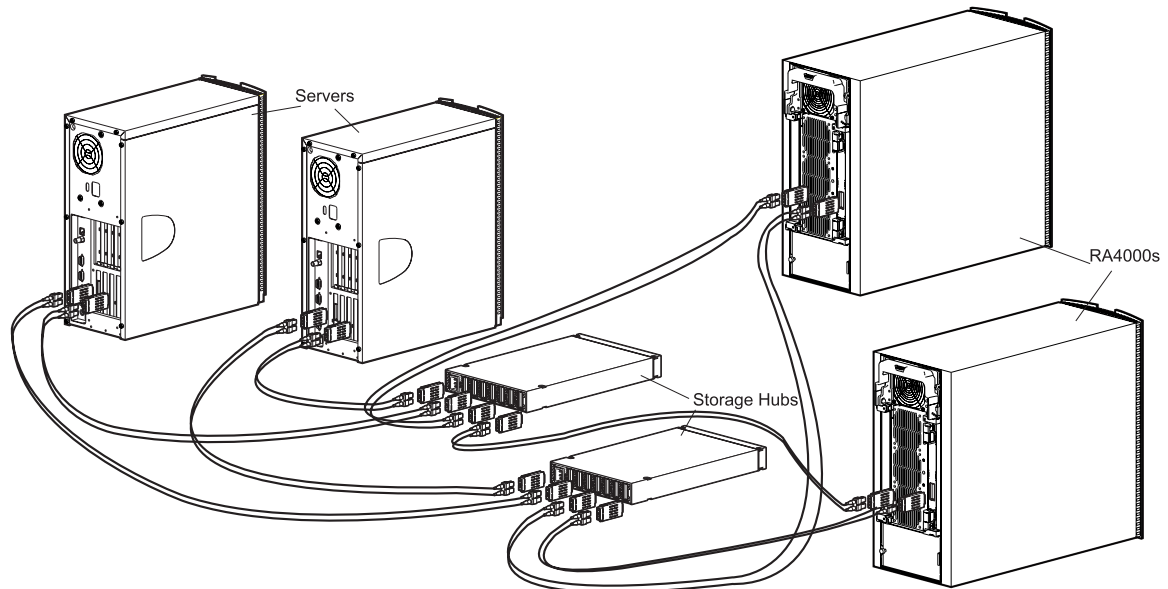


Figure 4. RA4000 Storage System with Dual Servers/Dual Controllers

The most common configuration uses a system containing two servers and two array controllers. The dual servers/dual controllers configuration ensures hardware redundancy.

Customers migrating from a single server to a server cluster or installing an entirely new storage system with a dual servers/dual controllers configuration must:

1. Insert a GBIC into two Fibre Channel Host Adapters.
2. Install the two Fibre Channel Host Adapters into the added server or to both servers if the storage system is entirely new.
3. Insert a GBIC into each of two Fibre Channel Storage Hubs. Use a GBIC-SW if the connection to the server is 500 meters or less, or a GBIC-LW if the connection to the server is between 500 meters and 10 kilometers.

IMPORTANT: Systems deploying GBIC-SW use 50-micron, multi-mode fiber optic cable. Systems deploying GBIC-LW use 9-micron, single-mode fiber optic cable.

4. Connect a Fibre Channel Storage Hub to each Fibre Channel Host Adapter in each server.
5. Insert a GBIC into each array controller at the RA4000(s). Use a GBIC-SW if the connection to the hub is 500 meters or less, or a GBIC-LW if the connection to the hub is between 500 meters and 10 kilometers.

IMPORTANT: One Fibre Channel link per array controller is required.

Note: The necessary GBIC and the appropriate fiber optic cable are determined by individual customer needs and system design.

6. Connect each RA4000 to the Fibre Channel Storage Hub for each controller link.
7. Run the Compaq Options ROMPaq. It is provided on the Compaq SmartStart and Support Software CD 4.30 or later that is shipped with the Compaq StorageWorks RA4000 and RA4000 Redundant Controller.

Firmware

The firmware stored in read only memory (ROM) on the RA4000 Controllers defines the features of the RA4000. The firmware controls RAID operation, error handling, and management information as reported to Compaq Insight Manager. The RA4000 ships with the appropriate firmware loaded. If a customer chooses to install previously used disk drives in an RA4000, the administrator may need to flash the disk ROM to upgrade the firmware on the used disk drives. Firmware upgrades for the RA4000 can be flashed onto the RA4000 Controller using Compaq Options ROMPaq.

The Compaq SmartStart and Support Software CD contains software, drivers, and utilities that automate the installation of a reliable and well-integrated server configuration. This easy-to-follow program streamlines server setup, tunes the Compaq server to take full advantage of the hardware and software, and provides consistent server performance.

The RA4000 has enhanced drive array capabilities. Therefore, Compaq recommends that customers use the latest Systems ROMPaq to flash the ROM on existing servers before installing a Fibre Host Adapter.

Systems ROMPaq is a special Compaq utility for updating the firmware in Compaq servers. It is provided on the Compaq SmartStart and Support Software CD 4.30 or later.

Operating Systems Supported

The following operating systems can support the RA4000 in a single controller configuration:

- Windows NT 4.0
- NetWare 3.12/3.20, 4.11, and 5.0
- UnixWare 2.1 and 7
- SCO OpenServer 5.0
- Banyan Vines 6.x and 7.x
- OS/2 SMP 2.11 and Warp Server
- Solaris 2.5, 2.5.1, and 2.6

The following operating systems can support the RA4000 in a dual controller configuration:

- Windows NT 4.0 - Microsoft Windows NT Enterprise Edition, Version 4.0, provides Clustering Services to increase application availability. The Clustering Services allow a server's applications to failover to another server in the event of a server hardware, OS, or application failure. Compaq produced the first fibre channel storage system to receive certification from Microsoft for clustering support, and the Compaq solution has the largest number of approved configurations.
- NetWare 4.11 and 5.0 - NetWare needs little downtime for capacity upgrades because it allows PCI switching, capacity expansion, and volume extension to be carried out in hot plug mode. Compaq was the beta platform for NetWare High Availability Server, and has the only fibre channel system currently qualified on NHAS.

Upgrading from Single Controller Solutions

Windows NT 4.0 Installation Instructions

To install the RA4000 using Windows NT:

1. Shut down the server.
2. Install the redundant components:
 - Fibre Channel Host Adapter
 - Storage Hub (7 or 12)
 - Redundant RA4000 Controller
 - GBICs and FC cables
3. Boot using Options ROMPaq to upgrade FW on all RA4000 Controllers.
4. Install latest NT OS drivers from SSD 2.13.
5. Run the Redundancy Manager Install CD.
6. Install the OS Redundancy Manager software from CD and reboot.
7. Configure the storage using Compaq Redundancy Manager.

NetWare Installation Instructions

To install the RA4000 using NetWare:

1. Shut down the server.
2. Install the redundant hardware components:
 - Fibre Channel Host Adapter
 - Storage Hub (7 or 12)
 - Redundant RA4000 Controller
 - GBICs and FC cables
3. Boot Options ROMPaq to upgrade FW on all RA4000 Controllers.

4. Boot to DOS on the server
5. Copy the latest CPQFC.HAM driver (version 2.00 or greater) to C:\NWSERVER from NSSD 5.10 or later.
6. Ensure that the CPQFC.HAM driver will be loaded for new Fibre Channel Host Adapter(s) by editing the server's STARTUP.NCF file and either:
7. Add new "load" command(s) for CPQFC.HAM using the "slot = n" command line parameter where "n" is the slot number of the new Fibre Channel Host Adapter(s).

OR

8. Use a single instance of "load cpqfc.ham" without a "slot =" command line parameter so that the driver will load for all supported Fibre Channel Host Adapters installed in the server.
9. Restart the server. CPQFC.HAM will automatically detect and utilize new redundant paths.

RA4000 Configuration

Compaq has developed the following utilities to simplify configuration of an RA4000 storage system.

- Array Configuration Utility
- Fibre Fault Isolation Utility
- Compaq Redundancy Manager

Array Configuration Utility

The Compaq Array Configuration Utility (ACU) is provided on the Compaq SmartStart and Support Software CD and uses a graphical interface to streamline configuration of RA4000s. The ACU contains intuitive online configuration wizards that provide guided paths for complete array configuration. The ACU also contains customized paths for administrators needing complete control over configuration options.

Version 1.20 and later of the ACU provides an interface to intelligent features of the RA4000 Controller that make it easy for administrators to configure, modify, expand, manage, and monitor their storage.

Using the ACU, an administrator can quickly assign physical drives to an array. Up to 4 drives can be assigned as online spares, and from 1 to 32 logical drives can be created per controller. The ACU steps through each logical drive configuration until all space is allocated. Fault tolerance levels can be selected on a logical drive basis.

Custom configuration paths allow the administrator to examine the details of both logical and physical views and to make specific configuration changes if necessary. Graphical views of the array and the logical drives make it easy to visualize how the storage is configured.

Capacity expansion is done at the array level, not at the logical drive level. In most cases, all disk drives attached to a controller should be grouped together into a single array. This allows for the most efficient use of RAID redundancy.

Other features of the ACU include three light-emitting diodes (LEDs). If several RA4000s are installed in one location (such as a data center), it may be difficult for an administrator to remember the physical location of the drive being configured at any given time. To eliminate that problem, the ACU flashes all three LED indicators on the physical drive tray for the controller being configured.

The user interface displays information such as the ID assigned to each RA4000 on the Fibre Channel Arbitrated Loop (FC-AL). The administrator may change these ID assignments in the Controller Settings window.

The Compaq ACU was designed to configure a maximum of eight controllers. Windows NT 4.0 supports a maximum of eight logical drives in an RA4000. In maximum configuration environments, the ACU may operate a bit slower than expected. The ACU displays an hourglass cursor to indicate that it is processing.

Fibre Fault Isolation Utility

Since the RA4000 is the first Compaq product to use an FC-AL topology and the loop includes many components, Compaq developed two new support tools found on the SmartStart and Support Software CD:

- The Fibre Channel Troubleshooting Guide
- The Fibre Fault Isolation Utility

The troubleshooting guide describes components of the RA4000 and the Fibre Fault Isolation Utility. It contains flowcharts and other information for troubleshooting.

The purpose of the Fibre Fault Isolation Utility is to verify the installation and operation of a new or existing RA4000. When used with the troubleshooting flowcharts, this utility provides fault detection and help in isolating problems on the FC-AL.

Before configuring the system, Compaq recommends running the Fibre Fault Isolation Utility as soon as all hardware components of the RA4000 have been connected. This utility is run offline¹ on the server. It displays a graphical window showing each Fibre Channel Host Adapter and each RA4000 that is properly connected on the loop. If one of these components is not displayed on the screen, consult the troubleshooting guide to determine why.

The Fibre Fault Isolation Utility displays all devices that are properly logged on to the FC-AL and tests for link errors within the loop. A link is the portion of the loop between the Fibre Host Adapter and a storage hub or between a storage hub and an RA4000.

¹ In this case, offline means equipment that is turned off, not operating, or is not physically connected to the system.

Compaq Redundancy Manager (NT)

The Compaq Redundancy Manager software is a redundancy management solution, which provides a range of functionality for servers using Fibre Channel storage. The software allows configurations with redundancy to be built. The Redundancy Manager provides the ability to configure the environment with redundant Fibre Channel Host Adapters.

Active/Active Host Adapters (NT)

In RA4000 Storage Systems, data is transferred from the server to the arrays and recalled via data paths through each Fibre Channel Host Adapter. Since the system contains multiple data paths, different configurations are possible. The Redundancy Manager automatically configures multiple data paths with the first available path being set as Active and the next path as Standby. However, the Redundancy Manager can be manually configured to have Active/Active paths to allow load balancing of the system and to utilize multiple paths at the same time. After the environment is configured, the Redundancy Manager provides redundancy and path management in your configuration.

Load Balancing (NT)

Online load balancing allows for the configuration of the data path to the RA4000. When more than one RA4000 and Fibre Channel Host Adapter are on the same Fibre Channel loop, the system can be configured to use a different Fibre Channel Host Adapter to distribute all of the traffic to each RA4000 and all of the logical drives on it. Using different paths to each array increases performance by decreasing the workload of the Fibre Channel Host Adapter.

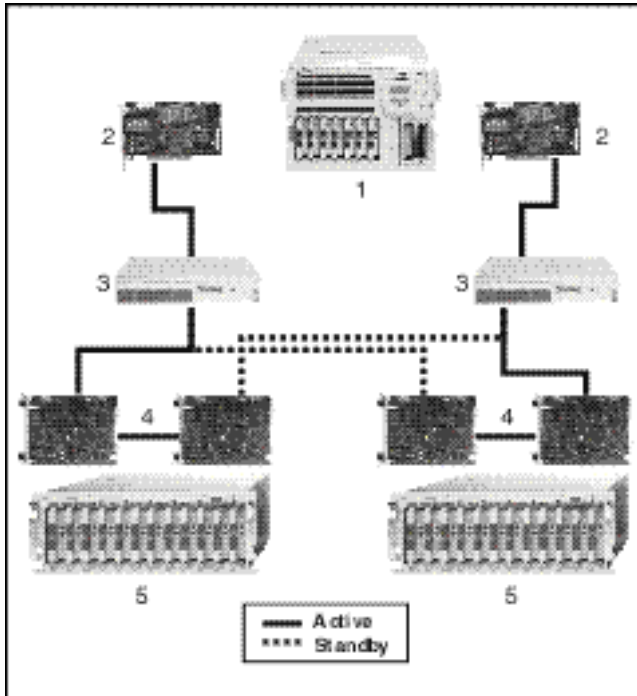


Figure 5. Load Balancing

Table 1. Load Balancing Example

Item	Description
1	Server
2	Fibre Channel Host Adapters
3	Fibre Channel Hubs
4	RA4000 Controllers
5	RA4000s