COMPAQ

RAID LC2 Controller

User Guide

Notice

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About This Guide

This guide is designed to provide step-by-step instructions for the installation of the Compaq RAID LC2 Controller and to be a reference for operation, troubleshooting, and future upgrades.

Text Conventions

This document uses the following conventions to distinguish elements of text:

Keys	Keys appear in boldface. A plus sign (+) between two keys indicates that they should be pressed simultaneously.
USER INPUT	User input appears in a different typeface and in uppercase.
FILENAMES	File names appear in uppercase italics.
Menu Options, Command Names, Dialog Box Names	These elements appear in initial capital letters.
COMMANDS, DIRECTORY NAMES, and DRIVE NAMES	These elements appear in uppercase.
Type	When you are instructed to *type* information, type the information **without** pressing the **Enter** key.
Enter	When you are instructed to *enter* information, type the information and then press the **Enter** key.

Symbols in Text

These symbols may be found in the text of this guide. They have the following meanings.

WARNING: Text set off in this manner indicates that failure to follow directions in the warning could result in bodily harm or loss of life.

CAUTION: Text set off in this manner indicates that failure to follow directions could result in damage to equipment or loss of information.

IMPORTANT: Text set off in this manner presents clarifying information or specific instructions.

NOTE: Text set off in this manner presents commentary, sidelights, or interesting points of information.

Symbols on Equipment

The following symbols may be placed on equipment to indicate the presence of potentially hazardous conditions:

This symbol in conjunction with any of the following symbols indicates the presence of a potential hazard. The potential for injury exists if warnings are not observed. Consult your documentation for specific details.

This symbol indicates the presence of hazardous energy circuits or electric shock hazards. Refer all servicing to qualified personnel.

WARNING: To reduce the risk of injury from electric shock hazards, do not open this enclosure. Refer all maintenance, upgrades, and servicing to qualified personnel.

This symbol indicates the presence of electric shock hazards. The area contains no user or field serviceable parts. Do not open for any reason.

WARNING: To reduce the risk of injury from electric shock hazards, do not open this enclosure.

	This symbol on an RJ-45 receptacle indicates a Network Interface Connection.
	WARNING: To reduce the risk of electric shock, fire, or damage to the equipment, do not plug telephone or telecommunications connectors into this receptacle.
	This symbol indicates the presence of a hot surface or hot component. If this surface is contacted, the potential for injury exists.
	WARNING: To reduce the risk of injury from a hot component, allow the surface to cool before touching.
	These symbols on power supplies or systems indicate the equipment is supplied by multiple sources of power.
	WARNING: To reduce the risk of injury from electric shock, remove all power cords to completely disconnect power from the system.
	This symbol indicates that the component exceeds the recommended weight for one individual to handle safely.
Weight in kg Weight in lb	**WARNING:** To reduce the risk of personal injury or damage to the equipment, observe local occupational health and safety requirements and guidelines for manual material handling.

⚠ Important Safety Information

Before installing this product, read the *Important Safety Information* document provided.

Getting Help

If you have a problem and have exhausted the information in this guide, you can get further information and other help in the following locations

Compaq Technical Support

In North America, call the Compaq Technical Phone Support Center at 1-800-OK-COMPAQ. This service is available 24 hours a day, 7 days a week. For continuous quality improvement, calls may be recorded or monitored.

Outside North America, call the nearest Compaq Technical Support Phone Center. Telephone numbers for world wide Technical Support Centers are listed on the Compaq website. Access the Compaq website by logging on to the Internet at

http://www.compaq.com

Be sure to have the following information available before you call Compaq:

- Technical support registration number (if applicable)

- Product serial number

- Product model name and number

- Applicable error messages

- Add-on boards or hardware

- Third-party hardware or software

- Operating system type and revision level

Compaq Website

The Compaq website has information on this product as well as the latest drivers and Flash ROM images. You can access the Compaq website by logging on to the Internet at

http://www.compaq.com

Compaq Authorized Reseller

For the name of your nearest Compaq authorized reseller:

- In the United States, call 1-800-345-1518.

- In Canada, call 1-800-263-5868.

- Elsewhere, see the Compaq website for locations and telephone numbers.

Features

The Compaq RAID LC2 Controller is a single-channel SCSI array controller that supports a robust feature set.

Overview of Features

Software features include:

- Pre-Failure notification and Pre-Failure Warranty (via Compaq Insight Manager)

- 15 SCSI devices per SCSI bus

- Upgrade migration paths to all Compaq Smart Array Controllers

- RAID 0, 1, 0+1, and 5 configurations

- Online spares

- Hot-pluggable drives

- Automatic Reliability Monitoring (ARM)

- Background dynamic sector repair

- Read-ahead caching

- Multiple logical drives per array controller

- Logical drive movement

Hardware features include:

- One Wide Ultra2 SCSI channel (80-MB/s total bandwidth)

- Support for Single Ended (SE) and Low Voltage Differential (LVD) SCSI devices

- 16-MB EDO DRAM with parity

- Compaq hardware XOR engine

- ARM 32-bit RISC processor

- Upgradable Flash ROM

- PCI 2.2

- One internal 68-pin Wide SCSI connector

Main Components
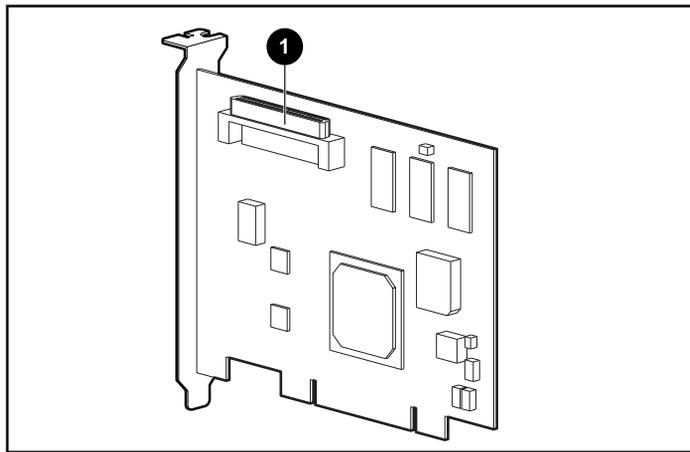
Figure 1-1. RAID LC2 Controller

❶ Internal 68-pin Wide SCSI connector

PCI System Interface

The RAID LC2 Controller interfaces to the server through a Peripheral Component Interface (PCI) bus. The PCI bus is a high-performance, 32-bit, 33-MHz bus with multiplexed address and data lines, and includes a parity protection signal. It provides a high-speed (up to 132 MB/s) path between the system board and the array controller. The RAID LC2 Controller is a PCI Bus

Master device supporting 32-bit addressing and conforming to Rev. 2.2 of the PCI Local Bus Specification.

SCSI Support

The RAID LC2 Controller supports the following SCSI devices:

■ Wide Ultra3 drives, operating at Wide Ultra2 speed (up to 80 MB/s)

■ Wide Ultra2 drives, capable of a 80 MB/s maximum transfer rate (Low Voltage Differential signaling, or LVD)

■ Wide-Ultra drives, capable of a 40 MB/s maximum transfer rate (Single-Ended signaling, or SE)

LVD and SE Signaling

Wide Ultra2 SCSI devices use LVD signaling on the SCSI bus. LVD allows devices to run at higher speeds and longer distances. Wide-Ultra SCSI devices use SE signaling only on the SCSI bus.

LVD and SE signaling are not supported concurrently on the same SCSI bus. Therefore, if SCSI devices that support LVD signaling are placed on the same SCSI bus as SCSI devices that support SE signaling, then the LVD SCSI devices will revert to SE signaling to maintain compatibility. This means that Wide Ultra2 devices will only operate at SE speeds in this environment.

If all of the SCSI devices on the SCSI bus use LVD signaling, they will operate at LVD speeds.

Maximizing Performance

NOTE: Compaq recommends using only Wide Ultra2 SCSI devices on the SCSI bus for maximum performance. Combining LVD and SE SCSI devices on the same SCSI bus will decrease the overall bandwidth to SE speeds.

Options ROM Configuration for Arrays

Options ROM Configuration for Arrays (ORCA) is a software tool used to configure your array. The features of this tool are summarized below. See Chapter 6, "Configuring Your Array," for details on using this utility.

This utility:

- Can be started while the server is booting.

- Does not require diskettes or CD-ROM drive to run.

- Can configure any number of logical drives.

- Supports RAID 0, RAID 1, RAID 0+1, and RAID 5 configurations

- Allows online spare (hot spare) configurations

- Allows separate fault tolerance configuration on a logical drive basis

- Can be used to designate a boot controller

Working with Drive Arrays

Drive array technology distributes data across a series of hard drives to unite these physical drives into one or more higher-performance *logical drives*. Distributing the data makes it possible to access data concurrently from multiple drives in the array, yielding I/O rates faster than those of non-arrayed drives. Each logical drive in the array can be set to a different fault-tolerant configuration. The array controller manages the drive array independently of the host processor.

There are several ways to configure each set of hardware. Array configuration utility software helps configure the hardware to meet your needs.

> △ **CAUTION:** Back up all data whenever you move drive arrays or change configurations.

See Appendix D, "Understanding Drive Arrays," for more information on drive arrays. See Chapter 6, "Configuring Your Array," for information on configuring your drive arrays.

Using Fault Tolerance

Fault tolerance refers to the protection of data if a hardware failure occurs in the storage system. There are several fault tolerance methods; understanding each of these is important in determining the best method for the particular needs of your storage system. The fault tolerance methods supported by the RAID LC2 Controller and ORCA include:

- RAID 5: Distributed Data Guarding

- RAID 1 or RAID 0+1 (also called RAID 10): Drive Mirroring

- RAID 0: Data Striping with no fault tolerance

Further data protection can be achieved by assigning an online spare to any RAID 1, RAID 0+1, or RAID 5 configuration. See Appendix D, "Understanding Drive Arrays," for more information on fault-tolerance methods. See Chapter 6, "Configuring Your Array," for information on configuring your system for fault tolerance.

Drive Movement

An array of drives can be moved :

■ from one system to another

■ from one controller to another

■ from one SCSI ID to another on the same controller

See Chapter 3 for details and restrictions on moving drives and arrays.

Operating System Drivers

The latest drivers for Compaq products can be obtained from the Compaq website, http://www.compaq.com. Further information on driver installation is provided in Chapter 7, "Installing the Operating System Drivers."

Chapter 2

Installation and Interconnect Guidelines

This chapter provides instructions to install and connect a RAID LC2 Controller to Compaq servers. Refer to the Installation Overview Card for supported server information.

For first-time installation of the RAID LC2 Controller on a server, these are the general steps required:

1. Update the server firmware (Chapter 4).

2. Install the hardware (Chapters 2 and 3).

3. Configure the system (Chapter 5).

4. Decide on a fault tolerance method (Appendix D).

5. Configure the drive array (Chapter 6).

6. Install the operating system drivers (Chapter 7).

However, subtle differences are required in the installation procedures, depending on how the RAID LC2 Controller is used and depending on whether there is data (in the form of user data or in the form of an installed operating system) to be preserved. The table below shows the steps required in each of these situations. The steps must be performed in the order provided. In particular, the server firmware must be updated before the hardware is installed to ensure that the system will boot properly.

Table 2-1
RAID LC2 Controller Installation Scenarios

Scenario	RAID LC2 to be Primary Controller	To Be Secondary Controller
First use of controller and disk drives – no existing data to be preserved	1 Upgrade system ROM 2 Install controller 3 Configure controller 4 Install operating system	1 Upgrade system ROM 2 Install controller 3 Configure controller 4 Install OS drivers
Migration from non-array controller to RAID LC2 Controller	1 Backup data contained on drives connected to non-array controller. 2 Upgrade system ROM. 3 Install controller. 4 Configure controller. 5 Re-install operating system, since the data format between non-arrayed controllers and RAID LC2 Controller is incompatible. 6 Install OS drivers. 7 Restore data to RAID LC2 Controller, being sure not to overwrite the newly installed operating system files.	1 Backup data contained on drives connected to non-array controller. 2 Upgrade system ROM. 3 Install controller. 4 Configure controller. 5 Install OS drivers. 6 Restore data to RAID LC2 Controller since the data format between non-arrayed controllers and RAID LC2 Controller is incompatible.

Preparing the Server

> **WARNING:** To reduce the risk of personal injury or damage to the equipment, consult the safety information and user documentation provided with your computer before attempting the installation.
>
> Many computers are capable of producing energy levels that are considered hazardous. These computers are intended to be serviced by qualified personnel trained to deal with those hazards. Do not remove enclosures or attempt to bypass any interlocks that may be provided for the purpose of removing these hazardous conditions.

To prepare the server for RAID LC2 Controller installation:

1. Perform a normal system shutdown.

> **CAUTION:** If you will be moving non-arrayed SCSI drives to the RAID LC2 Controller, you must first back up all of your data. Data is not preserved when drives are moved between array controllers and non-array controllers.

> **CAUTION:** In systems using external data storage, be sure the server is the first unit powered down and the last to be powered back up. This will ensure that the system will not erroneously mark the drives as "failed."

2. Turn OFF the server.

3. Turn OFF any peripheral devices attached to the server.

4. Unplug the AC power cord from the outlet, then from the server.

5. Disconnect any peripheral devices from the server.

> **WARNING:** To reduce the risk of personal injury from hot surfaces, allow the internal system components and hot-plug hard drives to cool before touching.

6. Remove or open the access panel.

Installing the Controller

To install a RAID LC2 Controller in a Compaq server:

1. Select an available PCI slot.

2. Remove the slot cover or open the latch. Save the retaining screw, if present.

> **CAUTION:** Electrostatic discharge (ESD) can damage electronic components. Be sure you are properly grounded before beginning this procedure. See Appendix B for ESD information.

3. Press the RAID LC2 Controller firmly into the slot so the contacts on the board edge seat fully in the system board connector.

4. Secure the board in place with the retaining screw or latch.
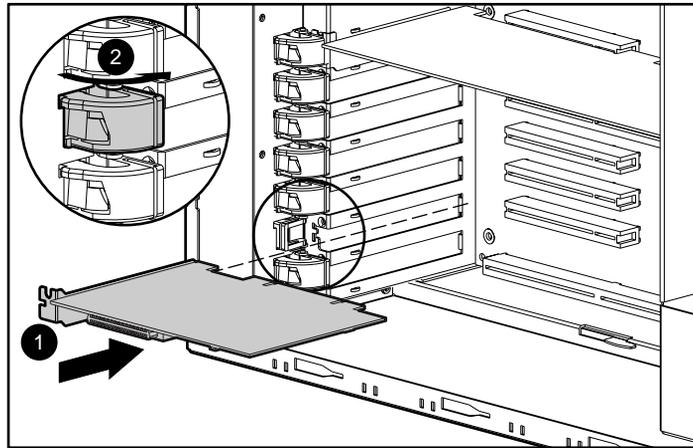
Figure 2-1. Installing a RAID LC2 Controller in a Compaq server

NOTE: Your server may look slightly different from the one illustrated in Figure 2-1.

SCSI Port Utilization

This section provides cabling information for installing and changing the SCSI cabling within the server. The RAID LC2 Controller can be connected to SCSI hard drives located internally in the server.

SCSI Termination

All SCSI buses require termination on both ends of the bus to prevent signal degradation. The RAID LC2 Controller supplies the termination on the origination end of the SCSI bus. Termination for the opposite end of the bus is provided by the internal SCSI cable or by the backplane. Individual SCSI drives in Compaq servers should *not* contain bus termination.

External SCSI devices must also provide termination for the SCSI bus. This is supplied in Compaq Storage systems. Therefore, individual SCSI drives in Compaq Storage systems should not contain bus termination.

SCSI IDs

The RAID LC2 Controller contains one SCSI bus (port), which supports up to 15 drives. Peripherals attached to any of the connectors must have a unique SCSI ID in the range from 0 to 6, or from 8 to 15. SCSI IDs on all peripherals are set manually with switches or jumpers on the device itself or set

automatically on Compaq products that support hot-pluggable drives. The SCSI ID determines the device's priority when attempting to use the SCSI bus. The highest priority, SCSI ID 7, is reserved for use by the controller.

Internal Cabling for Compaq Servers

IMPORTANT: Determine whether your storage device is hot-pluggable.

Hot-Pluggable Drives

1. Install the hot-pluggable Wide Ultra3, Wide Ultra2 or Wide-Ultra drives into the server hot-pluggable drive cage. To maximize performance, the drives must all be the same type, LVD or SE. Drives need not be the same capacity except for maximum space efficiency when grouped in the same array.

   NOTE: For additional hot-pluggable drive installation instructions, consult the original installation information that accompanied your drives.

2. Use the internal point-to-point SCSI cable provided with your server. Attach the point-to-point SCSI cable from the SCSI port of the RAID LC2 Controller to the hot-plug drive cage.

Non-Hot-Pluggable Drives

1. Install the non-hot-pluggable Wide Ultra3, Wide Ultra2 or Wide-Ultra drives into the server's removable media bays. To maximize performance, the drives must all be the same type, LVD or SE. Drives need not be the same capacity except for maximum space efficiency when grouped in the same array.

   NOTE: For additional non-hot-pluggable drive installation instructions, consult the original installation documentation that accompanied your drives.

2. You must manually set the SCSI ID on each drive to a unique value in the range of 0 to 6, or from 8 to 15, for each SCSI bus; SCSI ID 7 is reserved for controller use. Consult the documentation that came with the drive for instructions on setting the SCSI ID.

3. Attach the multi-device SCSI cable:

    a. If drives are Wide-Ultra, use the multi- device SCSI cable that was provided with your server. Attach the multi- device SCSI cable from the SCSI port of the RAID LC2 Controller to the non-hot-pluggable hard drives.

    b. If drives are Wide Ultra3 or Wide Ultra2, the multi-device cable **may** have been provided with your server. If additional cables are needed, order cable option kit, part number 166389-B21. This cable is equipped to terminate Wide Ultra3, Wide Ultra2 or Wide-Ultra drives.

4. Attach the multi-server cable from the SCSI port of the RAID LC2 Controller to the non-hot-pluggable hard drives.

See Appendix G, "Hot-Plug Drive Replacement and Recovering from Drive Failure," for additional information.

Cabling for Compaq Servers

Figure 2-2 on the following page shows several common SCSI cable connectors to allow you to identify the SCSI cable type required for installation of the controller.

For a list of SCSI cables that allow you to connect the RAID LC2 Controller to SCSI drives in any Compaq server or external SCSI product, refer to the Compaq website at:

http://www.compaq.com/products/servers

Use this list to determine cabling requirements and order the cable option kit from your local Compaq Reseller or Authorized Compaq Service Provider.
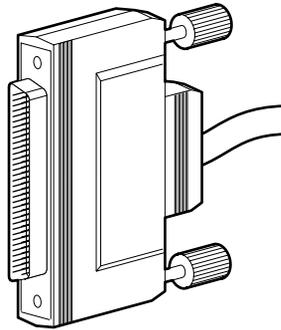
External Wide-Ultra SCSI/Fast-Wide SCSI-2
(Wide SCSI) 68-Pin
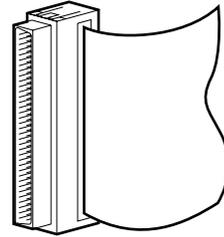
Internal Wide-Ultra SCSI/Fast-Wide SCSI-2
(Wide SCSI) 68-Pin

Key
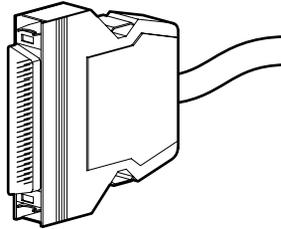
External Fast-SCSI-2
(Standard SCSI) 50-Pin
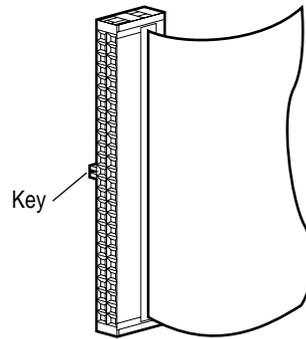
Internal Fast-SCSI-2
(Standard SCSI) 50-Pin
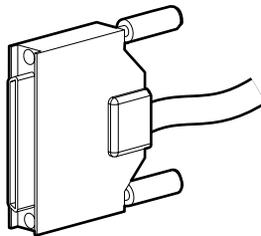
VHDCI Cable
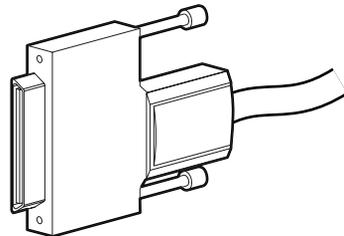
Offset VHDCI Cable

Figure 2-2. Identifying SCSI cable connectors

Chapter 3

Changing Current Installations

If you will be installing or replacing drives in your Compaq server, keep in mind these points:

■ Drives may be a mixture of available drives and storage systems supporting hot-pluggable drives.

■ Hot-pluggable drives cannot be combined with non-hot-pluggable drives on the same SCSI bus.

■ Drives should not contain termination. Compaq servers and internal cabling provide the required termination of the SCSI bus.

■ Drives should be the same capacity to provide the greatest storage space efficiency when drives are grouped together into the same drive array.

■ The RAID LC2 Controller has one internal SCSI channel to support the internal drives inside your Compaq server.

■ Drives for the RAID LC2 Controller may be Wide Ultra3 (operating at 80 MB/s), Wide Ultra2, or Wide-Ultra, installed in servers that support hot-pluggable drives.

■ Except on hot-pluggable drives in ProLiant servers and storage systems, you must manually set the SCSI ID on each drive to a unique value in the range from 0 to 6, or from 8 to 15, for each SCSI bus. The highest priority setting, SCSI ID 7, is reserved for the controller. Consult the documentation that came with the drive for instructions on setting the SCSI ID.

■ A current list of supported drives is available on the Compaq website at www.compaq.com.

To determine the number of drives supported by your server, refer to the user guides that accompanied your server. Server specifications are also available at www.compaq.com.

Moving Drives and Arrays

CAUTION: Back up all data before removing drives or changing configurations. Failure to do so could result in permanent loss of data.

Drives can be moved to other ID positions on the same array controller. To move drives, the following conditions must be met:

■ System power is OFF (includes all system components).

■ The move will not result in more than 15 physical drives per channel and/or 32 logical drives (volumes) connected to a single controller.

■ No failed drives are identified. The array should be in its original configuration with no active spare drives.

■ Controller firmware is the latest version (recommended).

When the above conditions are met, follow these steps to move drives:

1. Power the system OFF.

2. Move the drives.

3. Power the system ON. A 1724 POST message should display, indicating that drive positions were changed and the configuration was updated. If a 1785 POST message is displayed, turn the system OFF immediately to avoid data loss and return the drives to their original locations.

4. Run ORCA to view the new drive configuration (optional).

You may also move a complete array from one controller to another, even if the controllers are on different servers. To move an array, the conditions listed previously for moving drives must be met, and the following additional restrictions:

■ All of the drives in the array must be moved at the same time.

■ Positions of drives on the destination controller should not be changed during relocation of the array.

If any drives are missing or have failed, all data on the moved arrays could be lost.

Chapter ***4***

Updating the Firmware

The ROMs on all Compaq servers and most Compaq options can be updated easily. By programming the ROM using a special Compaq utility called ROMPaq, the existing contents of the ROM are replaced with another version stored in a disk file. This conveniently distributes new firmware to keep Compaq products updated with the latest capabilities.

There are two ROMPaq utilities:

System ROMPaq   Updates the system ROM in all Compaq servers supporting Flash ROM. Use System ROMPaq when installing a new array controller in a Compaq server to be sure that the server can use all the capabilities of the array controller.

Options ROMPaq   Updates the onboard ROM on all Compaq options that support flashing. Use Options ROMPaq when new versions of the array controller firmware or SCSI drive firmware become available to take advantage of expanded capabilities.

> **IMPORTANT:** Before you install the new array controller in your server, you **must** run the latest version of System ROMPaq to update the system firmware. Instructions are provided in the following section.

Accessing ROMPaq

ROMPaq is available either on the SmartStart and Support Software CD (obtainable from Compaq) or as a SoftPaq download from the Compaq

website. You should check the website to ensure that the version of ROMPaq on the CD is the most current. In either case, you will need to create ROMPaq diskettes to run ROMPaq.

Creating ROMPaq Diskettes from the SoftPaq

To download the SoftPaq and create the ROMPaq utility diskettes:

1. Create a temporary directory on your hard drive.

2. Locate the page containing the ROMPaq SoftPaq on the Compaq website.

3. Click on the ROMPaq SoftPaq.

4. Click on the Download button, and direct the download to the temporary directory you created.

5. Click Save.

6. Execute the downloaded SoftPaq and follow the on-screen instructions to create diskettes.

Creating ROMPaq Diskettes from the SmartStart and Support Software CD

You will need access to a server with a bootable CD-ROM drive. This can be the system in which you are installing the array controller.

To create the ROMPaq diskettes:

1. From the Compaq System Utilities screen, select Create Support Software.

2. From the Diskette Builder screen, scroll through the list and select System ROMPaq Firmware Upgrade Diskette for Compaq ProLiant Servers

3. Follow the instructions on the screen to create the ROMPaq diskettes.

4. Repeat steps 3 and 4 to create Options ROMPaq diskettes.

Running System ROMPaq

System ROMPaq updates the firmware in Compaq servers. The array controller has enhanced drive array capabilities; many servers may need updated firmware to take advantage of these capabilities. Since it is difficult to determine when the firmware needs to be updated, run the latest System ROMPaq on all servers when installing a new array controller.

△ **CAUTION:** If you are replacing an existing array controller, the system may not boot after hardware installation. This occurs if the old array controller was the primary controller containing the boot disk.

To avoid this problem, run System ROMPaq **before** you install the hardware. This ensures that the server recognizes the new array controller and does not hang up on boot.

Running System ROMPaq from the SmartStart and Support Software CD

To run System ROMPaq directly from the SmartStart and Support Software CD:

1. Boot the server from the SmartStart and Support Software CD.

2. Select Run ROMPaq from the Compaq System Utilities menu screen.

Running System ROMPaq from Diskette

To run System ROMPaq from diskette:

1. Place the System ROMPaq diskette in the server diskette drive.

2. Boot the server by turning on the power.

3. Press **Enter** at the Welcome screen.

4. At the Select A Device screen, select the server from the list of the programmable devices. This may be the only item in the list. Press **Enter**.

5. At the Select An Image screen you will see:

   Device to reprogram: your server
   Current ROM revision: date of existing ROM version
   Select Firmware Images: date of latest ROM version

   Press **Enter**.

6. Review the information on the Caution screen:

   Device to reprogram: your server
   Current ROM revision: date of existing ROM version
   Selected ROM revision: date of ROM version to be installed

   Press **Enter** to reprogram the system ROM or **Esc** to discontinue reprogramming and return to the Select An Image screen.

7. "Reprogramming Firmware indicates that the system ROM is being reprogrammed. DO NOT INTERRUPT."

> △ **CAUTION:** Do not interrupt this cycle. Interrupting the ROM reprogramming will leave the firmware in an unknown state. You may not be able to boot the server if this happens. You will be notified when reprogramming is complete.

8. When ROMPaq finishes reprogramming the system ROM, press **Esc** to exit the System ROMPaq Utility.

9. Remove the System ROMPaq diskette and reboot the server by cycling the power (cold boot).

If you have not installed your new controller, install it now. See Chapter 2, "Installation and Interconnect Guidelines," for additional information about installing the array controller.

Running Options ROMPaq

Options ROMPaq updates the firmware on Compaq options. Since it is difficult to determine when to update the firmware, Compaq recommends that you run the latest Options ROMPaq on all Compaq array controllers whenever new versions of the firmware are released.

To run Options ROMPaq:

1. Place the Options ROMPaq diskette 1 in the server diskette drive.

2. Boot the server by turning on the power.

3. Press **Enter** at the Welcome screen.

4. At the Select A Device screen, select:

   ALL COMPAQ RAID LC2 Controller(s)

   from the list of programmable devices; then press **Enter**.

5. If the ROM firmware for the RAID LC2 Controller is the same or newer than that on the Options ROMPaq diskette, you will get the message:

   The ROM image files found for the device selected are not newer than the current ROM image

Press **Enter,** and go to step 9 of these instructions.

or

If the ROM firmware for the RAID LC2 Controller is older than that on the Options ROMPaq diskette, you will get the Select an Image screen:

Device to reprogram:	ALL COMPAQ RAID LC2 Controllers
Controller(s) Current ROM revision:	COMPAQ RAID LC2 Controller x.xx
Select Firmware Images:	COMPAQ RAID LC2 Controller y.yy

Press **Enter**.

6. Review the information on the Caution screen:

Device to reprogram:	RAID LC2 Controller(s)
Current ROM revision:	RAID LC2 Controller x.xx
Selected ROM revision:	RAID LC2 Controller y.yy

Press **Enter** to reprogram the RAID LC2 Controller ROM or **Esc** to discontinue the reprogramming and return to the Select an Image screen.

7. "Reprogramming Firmware" indicates that the system ROM is being reprogrammed. DO NOT INTERRUPT.

> **CAUTION:** Do not interrupt this cycle. Interrupting the ROM reprogramming will leave the firmware in an unknown state. If this happens you may not be able to reprogram the ROM and the controller may have to be replaced. You will be notified when reprogramming is complete.

8. When Options ROMPaq finishes reprogramming the array controller ROM, press **Enter** if you want to reprogram another Compaq option. Repeat steps 4 through 7.

9. If you are finished with reprogramming options, press **Esc** to exit the ROMPaq Utility.

10. Remove the Options ROMPaq diskette and reboot the server by cycling the power (cold boot). To upgrade additional options in the server, repeat steps 2 through 9 by booting from each Options ROMPaq diskette in succession.

The array controller ROM has been updated. If there are any new or increased capabilities, they have been enabled with the new firmware.

Chapter **5**

Configuring Your System

> **NOTE:** If you do not need to configure your system, you may omit this chapter and go directly to Chapter 6, "Configuring Your Array."

The Compaq System Configuration Utility provides easy configuration of hardware installed in or connected to the server. This utility detects each hardware device and configures the server to work with it.

The configuration activities performed by the System Configuration Utility include:

■   Configuring PCI boards automatically.

■   Providing switch and jumper settings.

■   Resolving resource conflicts in areas such as memory, port addresses, and interrupts (IRQs).

■   Managing the installation of memory, processor upgrades, and mass storage devices such as hard drives, tape drives, and diskette drives.

■   Setting and storing power-on features, such as date and time.

■   Storing configuration information in nonvolatile memory.

■   Assisting in the installation of the operating system.

■   Assisting in running diagnostic tools such as TEST and INSPECT.

The System Configuration Utility can be run directly from the SmartStart and Support Software CD. You may already have a version of this utility in the system partition of the boot disk; however, you will need the latest version, either from the Compaq website or from a new SmartStart and Support

Software CD provided by Compaq. The version on the web is the latest one that supports the RAID LC2 Controller.

If your server does not have a bootable CD-ROM drive, you can use the version of the System Configuration Utility available at the Compaq website, or create diskettes of the latest version of the System Configuration Utility from the SmartStart and Support Software CD. See the following section for instructions on creating the diskettes. To run the utility from a CD-ROM drive, proceed to "Running the System Configuration Utility."

Creating System Configuration Utility Diskettes

To create System Configuration Utility diskettes from the SmartStart and Support Software CD, you will need at least four blank diskettes, and access to a server or workstation with a bootable CD-ROM drive. This may be the system in which you are installing the array controller.

To create the System Configuration Utility diskettes:

1. Power up the system from the SmartStart and Support Software CD.

2. From the Main Menu screen, select Create Support Software.

3. Scroll down the list and select System Configuration Utility.

4. Follow the instructions on the screen to create the utility diskettes.

Running the System Configuration Utility

To run the System Configuration Utility:

1. Place the SmartStart and Support Software CD in the server CD-ROM drive.

    or

    Place the System Configuration Utility diskette 1 in the server floppy drive.

2. Restart the server.

    During the startup process, several messages appear. Among these is a notice that one or more array controllers were detected in option slots and a recommendation to run the System Configuration Utility.

3. Press **F1** to resume booting, if prompted.

4. If you are using the SmartStart and Support Software CD, select Run the System Configuration Utility from the Main Menu screen.

5. If you are given a choice of Auto Configuration, choose Yes. The system loads configuration files for all detected devices.

6. In the Configuration Complete screen, choose Review or Modify Hardware Settings.

7. At the next screen, Steps In Configuring Your Computer, select Step 3: View or Edit Details.

8. Set the RAID LC2 Controller configuration parameters at the View Or Edit Details screen. Scroll down to the option slot for the first array controller and edit each parameter according to the configuration information described in the following section.

Configuring the Controller

This section describes how to set the Controller Order parameters. To enable you to make the correct selections, read the Controller Order discussion below before following the configuration steps.

Controller Order

Select the order in which you want this array controller to be recognized. All hard disk controllers, including the integrated controller on the system board, must be assigned a unique order number.

First   The primary disk controller contains the boot disk.
             The first disk drive on this controller is the disk that the
             server will boot from.

Second   The second disk controller.
                  .
                  .
                  .

Fifteenth   The fifteenth disk controller.

When installing a new array controller, you must determine if the boot disk is to be handled by the new array controller or by the integrated SCSI controller, if present. If the new array controller will be the primary controller, choose *First.* A Configuration Changes screen appears, indicating that if you accept this change, the integrated SCSI controller will be changed automatically to *Second*. Press **Enter** to accept these changes.

If you want the order of the integrated SCSI controller to be something other than *Second*, scroll to the Embedded Compaq Integrated Controller and set the Controller Order manually.

When installing a new array controller in a system with an existing array controller, you can either place the new controller at the end of the controller order or reorder the controllers. Reordering changes the current drive letter assignments for all drives on the system. To avoid changing drive letter assignments, place the new controller at the end of the controller order.

> **IMPORTANT:** Do not create a primary partition on any of the added disks.

Configuration Steps

1. Highlight the Controller Order parameter for the new and press **Enter.**

2. Review and edit the Controller Characteristics of all array controllers shown in the View or Edit Details screen.

3. Press **F10** when finished editing.

4. Select Step 5: Save and Exit at the Steps in Configuring Your Computer.

5. Choose Save the Configuration and restart the computer at the Save and Exit screen.

6. Press **Enter** at the Reboot screen.

7. Remove the CD or System Configuration diskette and verify that the server boots normally without POST errors.

System hardware configuration is complete.

Chapter **6**

Configuring Your Array

To configure your array, a utility called Option ROM Configuration for Arrays (ORCA) is used. The main features of ORCA are that it:

- Does not require diskettes or CDs to run

- Can be started when the server is powering up

- Can create, configure and/or delete logical drives

- Can configure controller order

- Can assign online spare for the created logical drives

- Can specify RAID level

- Cannot set stripe size or controller settings

- Supports only English

ORCA executes out of the Option ROM that is located on the array controller. It is designed for users who have minimal configuration requirements.

Before You Begin

During a first-time installation and configuration of the RAID LC2 Controller, you should complete the following tasks before running ORCA:

1. Update the system ROM with System ROMPaq.

2. Install the RAID LC2 Controller.

3. Run Options ROMPaq to update the controller firmware, option ROM, and drive firmware.

4. Run the System Configuration Utility to verify the controller order settings.

5. Decide which fault-tolerance method and array configuration you want to use.

Starting ORCA

Part of the power-on sequence of a computer system is the Power-On Self-Test (POST). During this process, any array controllers in the system will be initialized. Any array controller that supports ORCA will provide a prompt to the computer system console as part of the initialization process.

■ If there are no configured logical drives on the array controller then this prompt will wait 10 seconds before bypassing ORCA and continuing with POST.

■ If there are any logical drives configured on the array controller then this prompt will wait 5 seconds before bypassing ORCA and continuing with POST.

While the prompt displays, you can:

■ Press **F8** to start the ORCA utility

   or

■ Press the **ESC** key to bypass ORCA immediately

Compaq RAID LC2 Controller (ver x.xx)

 Press <F8> to run the Option ROM Configuration for Arrays utility

 Press <Esc> to skip configuration and continue

Figure 6-1. POST prompt message

Follow the onscreen instructions to configure your array.

Before starting to build your array, bear in mind these facts:

■ If you mix drive sizes, the excess capacity of the larger drives cannot be used, and is wasted. Therefore, always group physical drives of the same size.

■ Only one spare drive may be assigned per array, and only one array per spare drive.

■ Given the reliability of a particular generation of hard drive technology, the probability of an array experiencing a drive failure increases with the number of drives in an array.

Handling Disk Drive Failures

If you configured your array controller with hardware fault tolerance, complete the following steps after a disk drive failure:

1. Determine which physical drive failed. On hot-pluggable drives in a ProLiant server or storage system, this is indicated by an amber Drive Failure LED on each drive tray.

   NOTE: Servers using NetWare as the operating system cannot detect a single physical drive failure when using hardware-based fault tolerance. NetWare determines that the data is still valid and accessible during the rebuilding process. However, the driver does know that a physical drive has failed. A message will be printed on the console notifying the user that a logical drive is in a degraded state.

2. If the unit containing the failed drive does **not** support hot-pluggable drives, perform a normal system shutdown.

3. Remove the failed drive and replace it with a drive that is of the same capacity. For hot-pluggable drives, after you secure the drive in the bay, the LEDs on the drive each light once in an alternating pattern to indicate that the connection was successful. The Online LED blinks, indicating that the controller recognized the drive replacement and began the recovery process.

4. Power ON the server, if applicable.

5. The array controller firmware reconstructs the information on the new drive based on information from the remaining physical drives in the logical drive. While reconstructing the data on hot-pluggable drives, the Online LED blinks. When drive rebuild is complete, the Online LED is illuminated.

Optimizing Array Controller Performance in NetWare

To improve system performance, keep these tips in mind before creating NetWare volumes or partitions:

■ If you selected a fault tolerance option, such as mirroring or distributed data guarding, when using the Compaq System Configuration Utility, do not select mirroring while using *INSTALL.NLM* or *NWCONFIG.NLM*. The fault tolerance capabilities of the array controller provide performance improvements and automatic data recovery features.

■ Novell recommends that you create volumes with a 64-KB block size and that you use the Block Sub-Allocation feature of NetWare. Using a large block size decreases the amount of RAM required to mount the volume, while Block Sub-Allocation allows NetWare to allocate disk space more efficiently.

Use of linear memory provides the best performance in the NetWare environment. When you use the Compaq System Configuration Utility to configure your server with NetWare, the memory options default so that linear memory is used. To verify the setting, run the Compaq System Configuration Utility and view the Compaq Memory settings. Make sure that a linear option has been selected under the Base Memory option.

Installing the Operating System Drivers

This chapter outlines driver installation steps to set up the RAID LC2 Controller in a server running any of the following operating systems:

■ Microsoft Windows 2000

■ Microsoft Windows NT 4.0

■ Novell NetWare 4.2 and 5.x

■ SCO UnixWare 7.x

■ SCO OpenServer 5

■ Linux

This chapter also contains related information for using the array controller with these operating systems. If you are setting up a new system, you can use the latest version of the SmartStart and Support Software CD to install both the operating system software and the device drivers for the array controller.

> **NOTE:** If you install the operating system software from the latest SmartStart and Support Software CD, all the software, including device drivers, will be installed automatically and configured for the array controller. The array controller is supported by the current version of the SmartStart and Support Software CD. See the documentation that came with the CD for installation instructions.

Before installing operating system drivers, you should have:

■ Updated your system firmware by running System ROMPaq.

■ Installed the array controller.

■ Configured the hardware (if necessary) by running the System Configuration Utility.

■ Configured your drive array(s) using ORCA.

Microsoft Windows 2000

You may install the drivers either during or after installation of the operating system.

Installing the Drivers During Windows 2000 Installation

To install the array controller drivers during installation of Windows 2000:

1. Build a driver diskette for Windows 2000 using the latest drivers available on the Internet at http:\\www.compaq.com.

2. Start the Windows 2000 installation as directed by the OS instructions. The following screen is displayed.


```
Windows 2000 Setup
```

```
Press F6 if you need to install a third party SCSI or RAID driver...
```
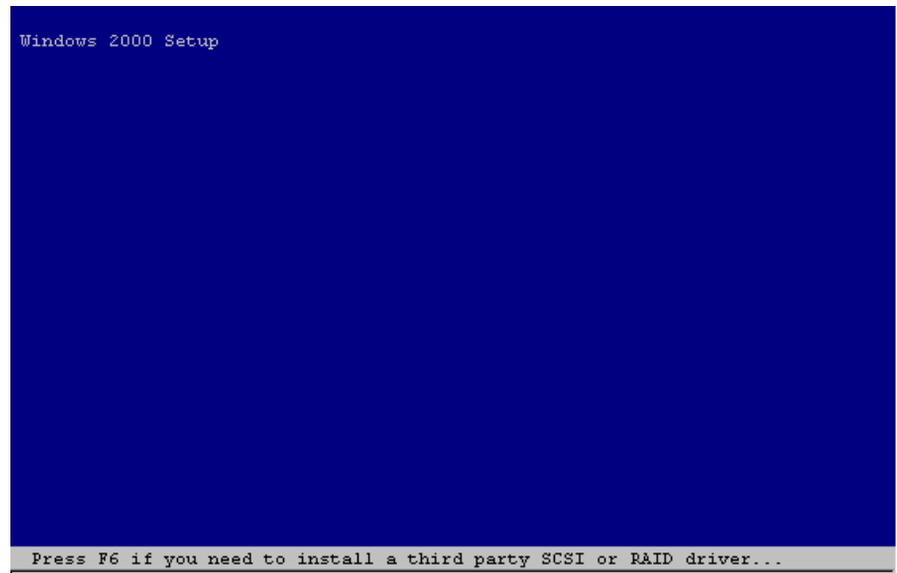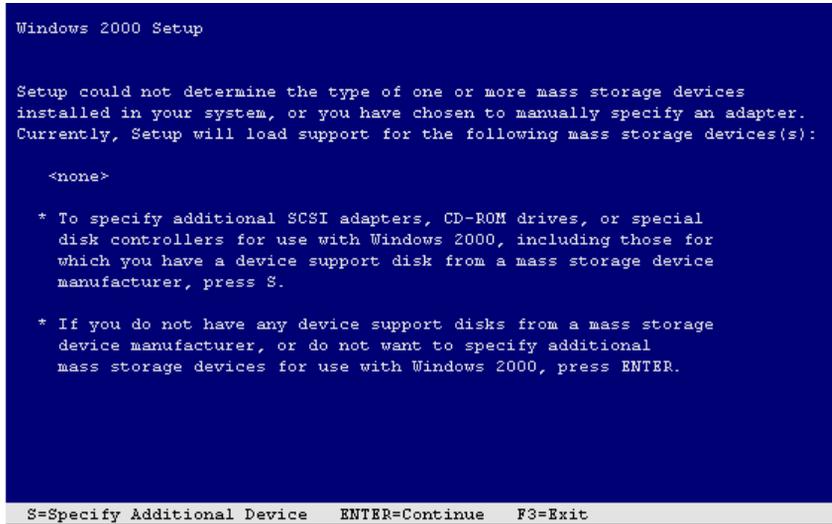
Figure 7-1. Windows 2000 Opening Screen

Press the **F6** key while the text "Press F6 if you need to install a third party SCSI or RAID driver…" is displayed in the bottom of the screen. If you do not press **F6** during the brief interval that this statement is on the bottom of the screen, you must restart the installation.

3. The following screen is displayed after you press the **F6** key during display of the Windows 2000 opening screen.

Figure 7-2. Manual device specification screen

Press the letter **S** on your keyboard to specify an additional device.

4. The next screen asks you to insert a diskette into the diskette drive. Insert the diskette that you built from http:\\www.compaq.com for Windows 2000 and press **Enter**.

5. Use the arrow scroll keys to move the highlight to the Compaq RAID LC2 Controller option and press **Enter**.

The Compaq RAID LC2 Controller driver should be in the list of drivers to be installed. If this is the case, press **Enter** to continue the driver installation. If the driver is not in the list, press **S** on the keyboard to return to the SCSI adapter selection screen.

6. Continue the installation using the OS instructions. Leave the diskette in the diskette drive until instructed to remove it.

Installing the Drivers After Windows 2000 Installation

To install the array controller drivers after Windows 2000 has already been installed on the system:

1. Create diskettes containing the latest Compaq Server Support Software for Windows 2000 by downloading from the Compaq website at www.compaq.com. If prompted, *do not restart*.

2. The Windows 2000 Device Manager will recognize a new device and prompt for the drivers. Install the drivers from the diskettes and work your way through the dialog boxes.

Microsoft Windows NT 4.0

This section includes instructions for installing the initial driver for a new array controller or for upgrading the driver in an existing Windows NT server/ array controller system. If you used the latest version of the SmartStart and Support Software CD to install Windows NT and drivers on a new server, you do not need to make the Support Software Diskette (SSD) utility. Omit this section.

Creating the Windows NT Support Software Diskettes

The Windows NT driver for the array controller is located on the SmartStart and Support Software CD. To access the driver, you will first need to create Windows NT Support Software Diskettes (SSDs). These diskettes contain the latest operating system software, drivers, and support documentation for all Compaq equipment supported by Windows NT. To install the array controller Windows NT drivers on your server, you will need:

■ The most current version of the Compaq SmartStart and Support Software CD

■ Blank diskettes

■ Access to a server or workstation with a bootable CD-ROM drive. This may be the system in which you are installing the array controller.

To create the diskettes:

1. Start the server from the SmartStart and Support Software CD.

2. From the Compaq System Utilities screen, select Create Support Software.

3. From the Diskette Builder screen, select Create Support Software Diskettes from CD only.

4. Scroll through the list and select Compaq Support Software for Windows NT.

5. Follow the instructions on the screen to create the Windows NT SSD diskettes.

Additional Information

An *NTREADME.HLP* file, on the Compaq SSD for Windows NT diskettes contains the latest information about Windows NT, including the driver installation procedure. Review this information and, where different from the instructions shown here, use the instructions provided in the *NTREADME.HLP* file.

To access the *NTREADME.HLP* file, you need a server running Windows NT or a PC running Windows. Perform the following steps:

1. Insert disk 1 of the Windows NT SSD in the diskette drive.

2. At a command prompt, make A: the current drive and type:

    readme.bat

    or

    From the File pull-down menu in Windows Program Manager, select Run, and enter:

    A:\readme.bat

3. Select the help topic(s) to read or print. Important sections include:

    ❑ Compaq SSD for Windows NT Installation Methods

    ❑ Using the Compaq SSD for Windows NT Setup Program

    ❑ Windows NT Device Driver Specifics

    ❑ Compaq SCSI Controller Support

    ❑ Compaq Drive Array Support

    ❑ Installing the Compaq Drive Array Driver during Windows NT Installation

    ❑ Installing the Compaq Drive Array Driver after Windows NT Installation

    ❑ Updating the Compaq Drive Array Driver

    ❑ Removing the Compaq Drive Array Driver

Installation Procedures

You can install device drivers on a Windows NT server using:

■ Compaq SSD for Windows NT Setup program installation.

   or

■ Standard Windows NT device driver installation.

If you will be installing the drivers after installing Windows NT, use the Compaq SSD for Windows NT installation method. However, if you need to install the driver during an initial Windows NT installation, you must use the standard Windows NT device driver installation method. Both methods are outlined in this chapter.

Installing the Array Controller Drivers during Windows NT Installation

This section describes how to install the array controller drivers during the initial installation of Windows NT 4.0. The drivers can be installed using the Windows NT SSD. To install the drivers after Windows NT has been installed, see the section titled "Installing the Array Controller Drivers after Windows Installation."

1. Begin the Windows NT 4.0 installation process.

2. When the blue start screen displays, press the **F6** key within five seconds to start the driver installation process. If dialog appears in the lower left corner of the screen before you press **F6**, you must restart installation of the drivers.

   NOTE: There will not be any text on the screen prompting you to press the F6 key.

   NOTE: There may be a delay of up to 60 seconds before the next screen appears after you have pressed the F6 key.

3. Setup automatically detects mass storage devices. When prompted to specify additional mass storage devices, press **S**.

4. From the displayed list, highlight "Other (Requires disk provided by manufacturer)" and press **Enter**.

5. As prompted, insert the Windows NT SSD diskette #2 and press **Enter**.

6. Use the arrow keys to select Compaq RAID LC2 Controller for Windows NT 4.0 from the list of displayed controllers and press **Enter**.

7. Press **Enter** and continue installation of Windows NT 4.0.

8. Reinsert the Compaq SSD for Windows NT 4.0 diskette when prompted. Setup copies the drivers to the system.

Updating the Array Controller Drivers

Updating the array controller drivers is a two-step process: removing the drivers, then re-adding the drivers. With the new Compaq SSD for Windows NT Setup program, you can omit the remove/add steps and update the drivers by following these steps:

1. Start Windows NT and log in to an account with administrative privileges.

2. Insert the Compaq SSD diskette (Diskette #1) into the diskette drive.

3. Start Setup by entering:

   A:\setup

   where A: is the letter of the diskette drive.

4. Select Compaq RAID LC2 Controller, and then click Update. The Setup program updates the drivers on your system from the Compaq SSD diskettes.

5. Select Close and exit the Setup program or select other components to install, update, or remove.

6. Remove the Compaq SSD diskette, shut down Windows NT, and restart the system to load the driver.

Installing the Array Controller Drivers after Windows NT Installation

Device drivers are installed via Setup, located on the Compaq SSD for Windows NT diskettes. Setup identifies hardware components that are physically installed on the system and recommends device drivers that you should install or update.

Use the following steps to run Setup:

1. Start Windows NT on the system you wish to install the device drivers on and log in to an account with administrative privileges.

2. Insert the Compaq SSD for Windows NT diskette #1 into the diskette drive.

3. From the Program Manager, select File → Run.

4. Enter the following:

    A:\setup

    NOTE: The Compaq RAID LC2 Controller menu item displays in the Custom Setup menu only if a RAID LC2 Controller is detected. It displays in the Express Setup menu only if the appropriate hardware is detected **and** the driver is not installed or not current.

5. Select the Compaq RAID LC2 Controller component. If you have previously installed these drivers on your system, Setup indicates whether the drivers can be updated - click Update to do so. If you have not installed the drivers, click Install to do so. Insert the correct diskettes as prompted during the installation.

6. You can install other components through Setup, or click Close if you are done. Setup prompts you to restart the system to load the newly installed or updated driver.

Removing the Array Controller Drivers

Removal of Compaq drivers can only be done through the Control Panel.

> **IMPORTANT:** **Do not** remove these drivers if the system is powering up from a device attached to an array controller. You will get a dialog box stating the selected controller is marked as a boot device. Removing it may cause the system not to boot.

1. Start Windows NT and log in to an account with administrative privileges.

2. From the Control Panel, launch the SCSI Adapter Utility.

3. Select the Drivers tab.

4. Select the Compaq RAID LC2 Controller, then click Remove.

5. After the driver has been removed, click OK. You must restart for the removal to take effect.

Updating the Compaq Insight Manager Agents

If you are using Compaq Insight Manager, you will need to update the Insight Agents to support the new array controller.

■   The agents will automatically be updated if you use the latest version of the SmartStart and Support Software CD to install or upgrade the controller drivers.

■ The agents may also be updated manually. Contact your local Compaq Reseller or Authorized Compaq Service Provider to obtain the agents, and refer to the documentation included with Compaq Insight Manager for the correct procedure to update the agents.

Installation of the RAID LC2 Controller is complete. Restart the server to begin using the array controller.

Novell NetWare 4.x and 5.x

Use the instructions in this section to install the driver for a new array controller or to upgrade the driver in a server running NetWare and using the array controller. If you use the current version of the SmartStart and Support Software CD to install NetWare and the drivers, you do not need to create the Novell Support Software Diskettes (SSD). Go directly to the section "Software Drive Mirroring with NetWare."

Installation Requirements

Before installing device drivers, install and load the latest Support Pack or operating system patch kit. Novell's Support Packs and patch kits are available from the Novell website. These patches correct known OS-specific problems and provide support for newly developed and enhanced drivers.

Materials needed

To install the array controller drivers on your server, you will need:

■ Compaq SmartStart and Support Software CD

■ Blank diskettes

■ A server or workstation with a bootable CD-ROM drive

Additional Information

The SmartStart and Support Software CD contains the latest information about using Compaq options in a NetWare environment, including the driver installation procedure. Locate and read this procedure. If the procedure differs from the one described here, use the one in the *STORAGE.RDM* file on the SmartStart and Support Software CD.

To view and print the readme files:

1. Open README.COM.

   C:\readme

2. Select the file(s) to read or print. Important files include:

   ❏ *READ1ST.RDM*

   ❏ *STORAGE.RDM*

Installing the Driver

The SmartStart and Support Software CD automatically detects the newly installed array controller, then copies the necessary drivers and updates the server *STARTUP.NCF* file. The process for installing or upgrading device drivers is different for NetWare.

NetWare 4.x or 5.x Driver Installation from the SmartStart and Support Software CD

Compaq provides an installation script on the SmartStart and Support Software CD that integrates Novell's *INSTALL.NLM* Product Options menu option. Use this option to install or upgrade Compaq Storage adapter and device drivers automatically. The drivers are copied from the SmartStart and Support Software CD to both the DOS server startup directory (typically C:\NWSERVER) and to the SYS:SYSTEM directory.

To install the driver for the array controller:

1. Load *INSTALL.NLM* from the server console prompt.

2. Select Product Options from the main menu.

3. Choose Install a Product Not Listed from the Other Installation Actions menu.

4. Select the options/products to be installed. Select the option for Compaq NWPA Storage Support. Compaq recommends that you also select the Compaq Online Configuration Utility.

5. Press **F10** to accept the selected options and continue the installation or upgrade.

6. Follow the instructions on the screen to complete the installation. You will be warned that the latest intraNetWare Support Pack should be installed. If you have already performed that installation, choose to continue. Otherwise, Compaq recommends that you abort this installation and install the intraNetWare Support Pack first.

Updating the Compaq Insight Manager Agents

If you are using Compaq Insight Manager, you will need to update the Insight Agents to support the new array controller.

- The agents will automatically be updated if you use the latest version of the SmartStart and Support Software CD to install or upgrade the controller drivers.

- The agents may also be updated manually. Contact your local Compaq Reseller or Authorized Compaq Service Provider to obtain the agents, and refer to the documentation included with Compaq Insight Manager for the correct procedure to update the agents.

After the Insight Agents have been updated, installation of the array controller is complete. Restart the server to begin using the array controller.

Software Drive Mirroring with NetWare

NetWare recognizes each logical drive in an array as a separate physical drive. If you mirror logical drives on the same array and a physical drive fails, both logical drives in the mirrored pair will fail and your data will be lost.

To avoid this, you must mirror logical drives on separate arrays. Use the Compaq Array Configuration Utility for NetWare (*CPQONLIN.NLM*) on Novell SSD Disk 1 to view the logical configuration for the array controller. Record the logical drives and the arrays on which they reside. When configuring NetWare for drive mirroring, select equally sized logical drives on different arrays.

IMPORTANT: Do not use NetWare drive mirroring unless you have at least two arrays.

Handling Disk Drive Failures

Although drive failures are not common, it is important to protect your critical data. The best way to recover from a failed drive is to configure your drive system with some form of fault tolerance.

To ensure a quick and transparent recovery, Compaq recommends that you configure your array controller with hardware fault tolerance. Another advantage of hardware fault tolerance is that the controller is able to perform a background surface analysis on the hard drives to monitor for bad sectors and to remap data to a new location on the media. This feature enhances the reliability and availability of your data. Compaq also recommends that you use good backup procedures, in case of catastrophic failure.

If you discover a failed drive:

■ Identify and document which physical drive has failed. Note the drive type and capacity.

■ Note which partition and volume, if any has failed. This information is provided in the error message on the server console. It is also recorded in the server error log file, which can be viewed using the SYSCON utility or NWADMIN utility.

■ Make sure that you have a recent backup. If the drive is part of a fault-tolerant mirrored volume, or a hardware fault-tolerant volume, you will be able to back up the data again in case of a second drive failure.

■ Locate a replacement drive of the same type and capacity.

■ Follow the instructions in the following sections for replacing a drive for your server configuration.

DOS Partitions and NetWare Fault Tolerance

NetWare does not mirror information on DOS partitions. Only hardware fault tolerance supports mirrored DOS partitions. If you have a mirrored drive containing a DOS partition, you need to restore the DOS partition information from another backup source.

If the failed drive contains a DOS partition, NetWare cannot access information on that partition. For example, files on the DOS partition include *STARTUP.NCF* and Novell disk drivers. To prevent NetWare from attempting to read from or write to the failed device, execute the following command from the console.

REMOVE DOS

Recovering a DOS Partition Without Hardware Fault Tolerance

If your server is not configured for hardware fault tolerance, and if the failed drive contained the DOS partition used to boot your server, you will not be able to restart the server once it has been powered off. Schedule maintenance time as soon as possible. Then do the following:

1. Power down your server.

2. Replace the failed drive.

3. Restart the system with the Compaq System Configuration Utility diskette.

4. Select the option to Install a System Partition on your DOS boot device. This partition should contain the Compaq System Configuration Utility and the Compaq Diagnostic Utility. Exit the System Configuration Utility.

5. Locate a DOS bootable diskette that contains the DOS FDISK and FORMAT programs.

6. Use the FDISK program to create a primary DOS partition on the replaced drive. Compaq recommends that your DOS partition be at least 60-MB.

7. Set the active partition to the DOS partition you just created.

8. Use the FORMAT command to format the DOS partition to include the necessary files to make the partition bootable. For example:

   FORMAT C: /s

9. If you have a backup of your DOS partition, use it to create the previous image. Otherwise, use your NetWare server diskettes and copy the following files to a NetWare directory on your DOS partition:

    SERVER.EXE
    INSTALL.NLM
    VREPAIR.NLM
    MONITOR.NLM
    CLIB.NLM
    STREAMS.NLM

10. Copy the required disk drivers, LAN drivers, and utility NLMs that should reside on the DOS partition from the Novell SSD.

11. Copy any other necessary information to the DOS partition, then restart your system. You can now start your NetWare server. You may need to create your *STARTUP.NCF* file.

Recovering Drives Configured for NetWare Fault Tolerance

If you have chosen no fault tolerance for the drives connected to your array controller and have configured NetWare mirroring or NetWare controller duplexing, perform the following steps to recover the data after a drive failure:

1. Identify the failed physical drive that caused the NetWare device to be deactivated. Record the device number and device name of the failed logical drive. For example:

   NWPA: [V503-A2-D1:0] Compaq SMART-2 Slot 8 Disk 2 NFT

The failure messages are recorded on the server console and also in the server error log file, which may be viewed using the NWADMIN utility (4.x). You will use this information later to create a valid partition.

2. Load *INSTALL.NLM* and *NWCONFIG* for NetWare v5 and select the Disk Options Mirroring menu. Select the mirrored logical partition that was affected by the drive failure (See Step 1). Record the device number and partition number of the operational logical drive in this mirrored group. This information will be used later to remirror the repaired logical drive. For example:

   NWPA: [V503-A2-D1:0] Compaq SMART-2 Slot 8 Disk 2 NFT

3. Delete the unavailable (possibly out of sync) device from the Mirror Partition group. This device is unavailable due to the drive failure.

4. Record the drive bay location of the failed physical drive. The new physical drive must be inserted in this drive bay.

5. If the failed drive is hot-pluggable, go to step 6. Otherwise, schedule server down time, take the server offline, and power off the unit.

6. Insert the replacement physical drive in the drive bay where the failed drive was located. The physical drive must be of the same capacity as the failed drive. Be sure that all cable connections are secure.

   For replacements in a ProLiant server or storage system, after you secure the drive in the bay, the LEDs on the drive each light once in an alternating pattern to indicate that the connection was successful. The Online LED turns green, indicating that the controller has recognized and successfully initialized the replacement drive. If the Online LED does not light after a few minutes, verify that you added the new drive in the same slot as the failed drive and that the drive capacity is the same as the failed drive.

7. Activate the replaced device. Use the *MONITOR.NLM* Disk Information option to select the device. Some versions of NetWare will cause a "device activate" to occur automatically when this option is chosen. Other versions of NetWare require manual activation of the device by changing the operating status to active. If reactivation of the failed logical drive is successful, the driver sends a console alert.

8. Use the *INSTALL.NLM* and *NWCONFIG* for NetWare v5 option Change Hot Fix (look at the information provided about the mirrored drive, not the failed drive) to determine the number of Hot Fix Redirection blocks set up for this partition.

9. Use the *INSTALL.NLM* and *NWCONFIG* for NetWare v5 to delete and create the partition on the repaired logical drive.

> **NOTE:** Although the logical drive may have a valid partition table, the data on this logical drive is **no longer valid**. Some data may appear valid because the failed physical drive was only a portion of the arrayed logical drive. However, there is a hole in the logical drive data at this point. Delete any old, invalid data and create a new partition on the logical drive.

10. From the *INSTALL.NLM* Disk Options menu, select the Modify Disk Partitions and Hot Fix Option. In the *INSTALL.NLM* Available Disk Drives menu, select the previously failed logical drive, which has now been repaired. The device information was recorded in step 1. For example:

    NWPA: [V503-A2-D1:0] Compaq SMART-2 Slot 8 Disk 2 NFT

    Select the Delete Partition. INSTALL may display several error messages. Since you will delete this partition, do not update any Volume Definition Table information. Continue until the partition has been deleted.

    If INSTALL reports that it cannot delete the partition because another process has it locked, load MONITOR and look at the System Resources option to determine which NLM has locked the device. It may be *MONITOR.NLM*, so you will need to unload MONITOR and any other NLMs that have the partition locked. After you create the partition and volume information, reload those NLMs.

11. Create the partition on the same logical drive.

12. Return to the Disk Options Mirroring menu. Select the previously mirrored NetWare 386 Partition number (recorded in step 2).

    NWPA: [V503-A2-D1:0] Compaq SMART-2 Slot 8 Disk 2 NFT

13. Press **Insert** for a list of partitions available to remirror. Select the partition associated with the repaired device (step 1). This causes NetWare to resynchronize the mirrored partitions.

    A console message indicates successful completion of the resynchronization step.

Recovering Drives Configured for No Fault Tolerance

If you configured no fault tolerance, you must recover the data from a backup media. Perform the following steps:

1. Identify the failed physical drive that caused the logical drive to be deactivated. Record the device number and device name of the failed logical drive. For example:

NWPA: [V503-A2-D1:0] Compaq SMART-2 Slot 8 Disk 2 NFT

Failure messages are recorded on the server console. They are also recorded in the server error log file, which can be viewed using the SYSCON utility or the NWADMIN utility. This information will be used later to create a valid partition.

For hot-pluggable drives in a ProLiant server or storage system, record the location drive bay of the failed physical drive. The failed physical device can be identified by the illumination of the amber LED on the drive tray. This is where the new physical drive must be inserted.

2. Remove the failed drive.

3. Insert the replacement physical drive in the same drive bay where the failed drive was located. The physical drive must be of the same capacity as the failed drive.

   For hot-pluggable drives, after you secure the drive in the bay, the LEDs on the drive each light once in an alternating pattern to indicate that the connection was successful. The Online LED turns green, indicating that the controller recognized and successfully initialized the replacement drive. If the Online LED does not light after a few minutes, verify that you added the new drive in the same slot as the failed drive, and that the drive capacity is the same as the failed drive.

4. Activate the replaced device. Use the *MONITOR.NLM* Disk Information option to select the device. Some versions of NetWare will cause a "device activate" to occur automatically when this option is chosen. Other versions of NetWare require manual activation of the device by changing the operating status to active. If reactivation of the failed logical drive is successful, the driver sends a console alert.

5. Use the *INSTALL.NLM* and *NWCONFIG* for NetWare v5 option Change Hot Fix (look at the information provided about the mirrored drive, not the failed drive) to determine the number of Hot Fix Redirection blocks set up for this partition.

   NOTE: Although the logical drive may have a valid partition table, the data on this logical drive is no longer valid. Some data may appear valid because the failed physical drive was only a portion of the arrayed logical drive. However, there is a hole in the logical drive data at this point. Delete any old, invalid data and create a new partition on the logical drive.

6. Use the *INSTALL.NLM* and *NWCONFIG* for NetWare v5 to delete and create the partition on the repaired logical drive.

7. Return to the *INSTALL.NLM* Disk Options menu. Select the Modify Disk Partitions and Hot Fix Option. The driver should reactivate the failed logical drive. The driver sends a console alert if reactivation of the failed logical drive is successful. In the *INSTALL.NLM* Available Disk Drives menu, select the previously failed logical drive, which has now been repaired. The device information was recorded in step 1. For example:

   NWPA: [V503-A2-D1:0] Compaq SMART-2 Slot 8 Disk 2 NFT

   Select the Delete Partition option. INSTALL may display several error messages. Delete the volume associated with this partition. Since you will delete this partition, do not update any Volume Definition Table information. Continue until the partition has been deleted.

   If INSTALL reports that it cannot delete the partition because another process has it locked, load MONITOR and look at the System Resources option to determine which NLM has locked the device. It may be *MONITOR.NLM*, so you will need to unload MONITOR and any other NLMs that have the partition locked. After you create the partition and volume information, reload these NLMs.

8. Create the partition on the same logical drive.

9. Create and mount the volume.

10. Locate the recent backup media and restore the data to this server volume.

SCO UnixWare 7.x

The instructions in this section describe where you can find the latest driver and support information necessary to install the initial driver for a new RAID LC2 Controller, or to upgrade the driver in an existing UnixWare server/RAID LC2 system. If you use the SmartStart and Support Software CD to install UnixWare drivers on a new server, or to upgrade an existing server, you can omit this section and you do not need to create the Extended Feature Supplement (EFS) diskettes.

Getting the Driver and Installation Information

The latest drivers and support files for SCO UnixWare and information about installing the driver are located on the SmartStart and Support Software CD. To access these files, create a set of Compaq EFS diskettes for SCO UnixWare from the SmartStart and Support Software CD.

Creating the EFS Diskettes

You will need:

■ SmartStart and Support Software CD

■ Blank diskettes

■ Access to a server or workstation with a bootable CD-ROM drive. This may be the system in which you are installing the RAID LC2 Controller.

To create the diskettes:

1. Boot the server from the SmartStart and Support Software CD.

2. From the Compaq System Utilities screen, select Create Support Software.

3. From the Diskette Builder screen, select Create Support Software Diskettes from CD only.

4. Scroll down the list and select Compaq SCO UnixWare 7.x EFS.

5. Follow the instructions on the screen to create and label diskettes.

Accessing the Information

To access the driver installation information:

1. Place the diskette labeled *Documentation Diskette* in the diskette drive of a server or PC.

2. Reboot the system.

3. Select the file named *README.HBA* to view or print the file.

4. Follow the instructions in this file to install the device driver for the RAID LC2 Controller in an existing UnixWare server.

Installation of the RAID LC2 Controller is complete. Reboot the server to begin using the array controller.

SCO OpenServer 5

This section includes instructions for getting the latest driver and support information for installing the driver. If you use the SmartStart and Support Software CD to install SCO OpenServer 5 and drivers, you can skip this section; you do not need to create the Extended Feature Supplement (EFS) diskettes.

If your system has an older SCO operating system, or if you are setting up a new system with SCO OpenServer 5, Compaq recommends you use the latest version of the SmartStart and Support Software CD to upgrade your operating system. This CD may be obtained from your local Compaq Reseller or Authorized Compaq Service Provider, or the contents of the CD may be downloaded from the Compaq website.

Getting the Driver and Installation Information

The latest drivers and support files for SCO OpenServer 5 and information about installing the driver are on the Compaq SmartStart and Support Software CD. To access these files, first create a set of Compaq EFS for OpenServer 5 diskettes from the SmartStart and Support Software CD.

You will need:

■   SmartStart and Support Software CD

■   Blank diskettes

■   Access to a server or workstation with a bootable CD-ROM drive. This may be the system in which you are installing the RAID LC2 Controller.

To create the diskettes:

1. Boot the server from the SmartStart and Support Software CD.

2. From the Compaq System Utilities screen, select Create Support Software.

3. From the Diskette Builder screen, select Create Support Software Diskettes from CD only.

4. Scroll down the list and select:

    Compaq SCO OpenServer 5.0 EFS (for SCO OpenServer 5)

5. Follow the instructions on the screen to create and label the diskettes.

6. At the SCO Products screen again, select SCO Installation Notes for Compaq Servers.

7. Follow the instructions on the screen to create and label the diskettes.

Accessing the Information

Driver installation procedures for SCO OpenServer 5 from Compaq and SCO OpenServer 5 (non-Compaq) are different. Choose the correct procedure below.

Servers Running Compaq SCO OpenServer 5

To access the driver installation information for systems running
SCO OpenServer 5 from Compaq:

1. Place the diskette labeled *SCO Installation Notes for Compaq Servers* in
   the diskette drive of a server or PC capable of reading a DOS text file.

2. Use a text editor or other DOS utility to read the *INSTALL.TXT* file on
   the diskette.

3. Follow the instructions in this file to install the RAID LC2 driver in a
   server running SCO OpenServer 5 from Compaq.

Servers Running Non-Compaq SCO OpenServer 5

To access the driver installation information for systems running non-
Compaq SCO OpenServer 5:

1. Place the diskette labeled *Documentation Diskette* in the diskette drive
   of a server or PC.

2. Reboot the system.

3. Select the file named *INSTALL.TXT* to view (**Enter**) or print (**F7**).

4. Follow the instructions in this file to install the RAID LC2 driver in a
   server running a non-Compaq version of SCO OpenServer 5.

Installation of the RAID LC2 Controller is complete. Reboot the server to
begin using the array controller.

Linux

The latest Linux drivers are available for download at

http:\\ecgwdev.wins.compaq.com\products\servers\linux\index.html

Support information for installing the drivers is also available at this site.

Regulatory Compliance Notices

Federal Communications Commission Notice

Part 15 of the Federal Communications Commission (FCC) Rules and Regulations has established Radio Frequency (RF) emission limits to provide an interference-free radio frequency spectrum. Many electronic devices, including computers, generate RF energy incidental to their intended function and are, therefore, covered by these rules. These rules place computers and related peripheral devices into two classes, A and B, depending upon their intended installation. Class A devices are those that may reasonably be expected to be installed in a business or commercial environment. Class B devices are those that may reasonably be expected to be installed in a residential environment (that is, personal computers). The FCC requires devices in both classes to bear a label indicating the interference potential of the device as well as additional operating instructions for the user.

The rating label on the device shows which class (A or B) the equipment falls into. Class B devices have an FCC logo or FCC ID on the label. Class A devices do not have an FCC logo or FCC ID on the label. Once the class of the device is determined, refer to the following corresponding statement.

Class A Equipment

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at personal expense.

Class B Equipment

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio or television technician for help.

Declaration of Conformity for Products Marked with the FCC logo – United States Only

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

For questions regarding your product, contact:

Compaq Computer Corporation
P. O. Box 692000, Mail Stop 530113
Houston, Texas 77269-2000

or call 1-800- 652-6672 (1-800-OK COMPAQ). (For continuous quality improvement, calls may be recorded or monitored.)

For questions regarding this FCC declaration, contact:

Compaq Computer Corporation
P. O. Box 692000, Mail Stop 510101
Houston, Texas 77269-2000

or call (281) 514-3333.

To identify this product, refer to the Part, Series, or Model number found on the product.

Modifications

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Compaq Computer Corporation may void the user's authority to operate the equipment.

Cables

Connections to this device must be made with shielded cables with metallic RFI/EMI connector hoods in order to maintain compliance with FCC Rules and Regulations.

Canadian Notice (Avis Canadien)

Class A Equipment

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Class B Equipment

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

European Union Notice

Products with the CE Marking comply with both the EMC Directive (89/336/EEC) and the Low Voltage Directive (73/23/EEC) issued by the Commission of the European Community.

Compliance with these directives implies conformity to the following European Norms (in brackets are the equivalent international standards):

■ EN55022 (CISPR 22) - Electromagnetic Interference

■ EN50082-1 (IEC801-2, IEC801-3, IEC801-4) - Electromagnetic Immunity

■ EN60950 (IEC950) - Product Safety

Japanese Notice

ご使用になっている装置にVCCIマークが付いていましたら、次の説明文を
お読み下さい。

この装置は、情報処理装置等電波障害自主規制協議会（VCCI）の基準
に基づくクラスB情報技術装置です。この装置は、家庭環境で使用すること
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使用されると、受信障害を引き起こすことがあります。
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妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ず
るよう要求されることがあります。

Taiwanese Notice

警告使用者：

這是甲類的資訊產品，在居住的環境中使用時，可能
會造成射頻干擾，在這種情況下，使用者會被要求採
取某些適當的對策。

Appendix **B**

Electrostatic Discharge

A discharge of static electricity from a finger or other conductor can damage printed circuit boards or other static-sensitive devices. This type of damage may reduce the life expectancy of the device.

Preventing Electrostatic Damage

To prevent electrostatic damage, observe the following precautions:

■   Avoid hand contact by transporting and storing parts in static-safe containers.

■   Keep electrostatic-sensitive parts in their containers until they arrive at static-free work stations.

■   Place parts on a grounded surface before removing them from their container.

■   Avoid touching pins, leads, or circuitry.

■   Always make sure you are properly grounded when touching a static-sensitive component or assembly.

Grounding Methods

There are several methods for grounding. Use one or more of the following measures when handling or installing electrostatic-sensitive parts:

■   Use a wrist strap connected by a ground cord to a grounded workstation or the computer chassis. Wrist straps are flexible straps with a minimum of 1 megohm +/- 10 percent resistance in the ground cords.

■   Use heel straps, toe straps, or bootstraps at standing workstations. Wear the straps on both feet when standing on conductive floors or dissipating floor mats.

■   Use conductive field service tools.

■   Use a portable field service kit with a folding static-dissipating work mat.

If you do not have any of the suggested equipment for proper grounding, have an Authorized Compaq Service Provider install the part.

> **NOTE:** For additional information on static electricity or assistance with the installation of this product, contact your Authorized Compaq Service Provider or refer to the Server Maintenance and Service Guide.

Appendix ***C***

Specifications

This appendix provides physical, operating, and performance specifications for the RAID LC2 Controller.

Table C-1
RAID LC2 Controller Specifications

Power Required	
3.3 V	0 W
5 V	5 W
Total	5 W
Heat Dissipated (maximum)	5 W
SCSI Channels	1
Drives Supported (maximum, internal)	15
Data Transfer Method	32-Bit Bus Master
SCSI Bus Transfer Rate (maximum)	80 MB/s per channel
PCI Bus Transfer Rate (maximum)	132 MB/s
SCSI Bus Termination	Required
Internal SCSI Port Connector	68-pin

Table C-1
RAID LC2 Controller Specifications *continued*

Dimensions	English	International
Height	4.2 in	10.6 cm
Length	5.8 in	14.3 cm
Thickness	0.6 in	1.5 cm
Temperature Range		
Operating	50° to 95°F	10° to 35°C
Shipping	-22° to 140°F	-30° to 60°C
Relative Humidity (non condensing)		
Operating	20% to 80%	20% to 80%
Non-operating	5% to 90%	5% to 90%

Understanding Drive Arrays

This chapter explains general drive array concepts, data protection methods (including fault tolerance options), and data reliability features of drive arrays. This information will help you understand terms and concepts required for configuration.

> **NOTE:** The RAID LC2 Controller does not support all the features described in this section. See Chapter 1 for a list of features supported.

What is a Drive Array?

A drive array is a collection of hard disk drives or *physical drives* that are grouped together to create an *array* of physical drives. An array is made up of one or more subsets called *logical drives* (sometimes called logical volumes), which are spread across all physical drives in the array. Operating systems view logical drives as a single, contiguous storage space, although it is made up of parts of several physical drives.

The generic drive array illustrated in Figure D-1 consists of two logical drives spread across three physical drives. Figure D-2 through Figure D-4 illustrate other drive array configurations.
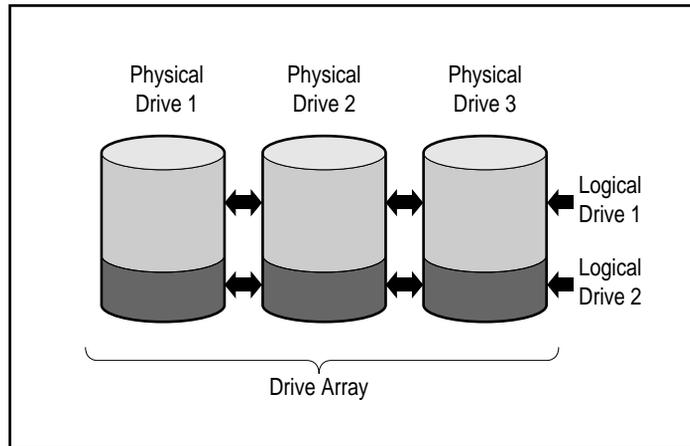
Figure D-1. Drive array with two logical drives

A drive array can also consist of a single logical drive, as illustrated in Figure D-2.
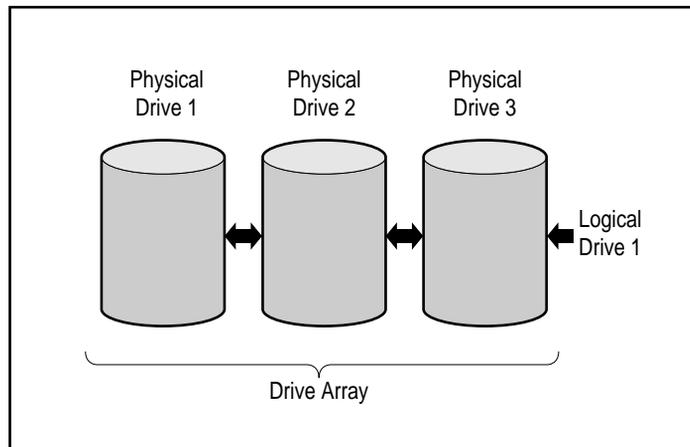
Figure D-2. Drive array with one logical drive
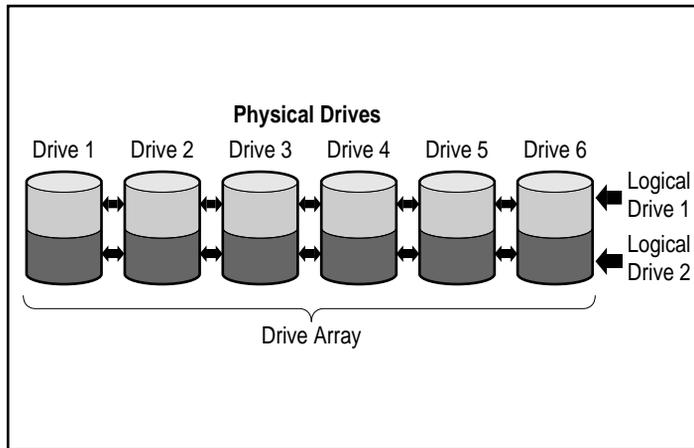
Figure D-3. Drive array with six physical drives and two logical drives

The same physical drives may also be arranged into separate arrays, as illustrated in Figure D-4. Both arrays may be handled by the same controller.
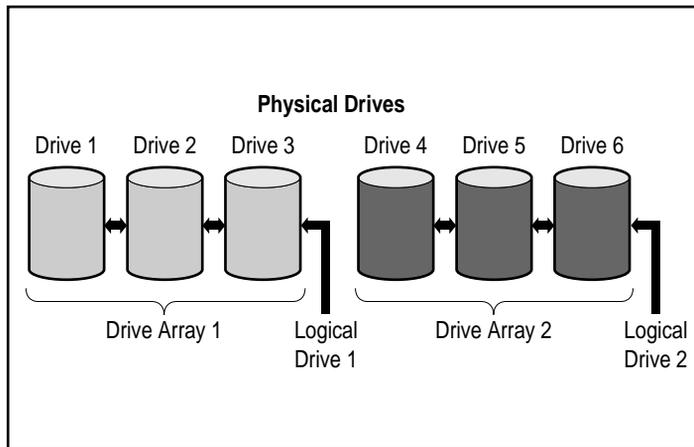
Figure D-4. Two drive arrays with six physical drives

Logical Drives

A logical drive is storage space that is distributed across *all* physical drives in an array (except for online spares)—see Figure D-3. Distributing the storage space provides these advantages:

■   Data can be accessed on all the physical drives simultaneously, resulting in much higher performance data storage and retrieval.

■ Fault tolerance methods may be used to protect your data against hardware failures.

An array can consist of several logical drives, each spanning all of the physical drives in the array. It is important to note that the part of any one logical drive residing on each physical drive is the same size. This means that for maximum space efficiency, all physical drives in each array should also be the same size.

The following are important characteristics of logical drives:

■ The maximum number of logical drives per controller is 32.

■ There must be at least one logical drive in an array.

■ Logical drives in an array may be different sizes.

■ The portion of a logical drive on each physical drive is the same size.

■ Logical drives in an array may use different fault tolerance methods (RAID levels).

Drive Array Limitations

Important drive array characteristics include:

■ A single array cannot span more than one array controller.

■ A single array controller may control multiple arrays. (However, some array controllers are only capable of controlling one array.)

■ An array may have no more than 60 physical drives. (The maximum number of drives is limited to the number of drives that can be installed with the controller.)

■ Arrays consist of at least one and may have up to 32 logical drives.

■ For maximum space efficiency, all drives in a single array should be the same capacity.

Drive Array Benefits

Using drive arrays has several important benefits:

■ Data Protection

■ Performance Enhancement

■ Storage Capacity Changes (on some array controllers)

Data Protection

An array controller provides several options to produce data redundancy for a more reliable system including distributing data, fault tolerance methods, assigning online spares, and rebuilding data.

Fault Tolerance (RAID) Options

During configuration, you will choose a fault tolerance level for your array. RAID (Redundant Array of Independent Disks) is the term used for an array technology that provides data redundancy to increase system reliability and performance.

RAID levels range from RAID 5 to RAID 0. Features of these levels are summarized in Table D-1, and described in more detail following the table.

Table D-1
Fault Tolerance (RAID) Options

	Distributed Data Guarding (RAID 5)	Mirroring (RAID 1)	No Fault Tolerance (RAID 0)
Usable disk space*	67% to 93%	50%	100%
Disk Space Formula (n = no. of drives)	(n-1)/n	n/2	n
Parity and Data Redundancy	Parity distributed over all drives	Duplicate data	None
Minimum Number of Drives	3	2	1
Comments	Tolerant of single drive failures. Uses the least amount of storage capacity for fault tolerance.	Tolerant of single drive failures. Can tolerate multiple drive failures if the failed drives are not mirrored to each other. Higher performance than RAID 5. Requires an even number of drives.	Best performance, but data is lost if any physical drive in the logical drive fails.

* All drives are of the same capacity

The fault tolerance method you choose affects the amount of available disk storage capacity and performance of your drive array. If you require a fault-tolerant system for critical data that only requires the capability of handling a single simultaneous drive failure, Compaq recommends using RAID 5 for

maximum storage space efficiency or RAID 1 if I/O performance is more important. If you store non-critical data, and space and performance are both important, RAID 0 offers the best of both parameters. However, RAID 0 has no data protection and you will have to rely on backups in case of hardware failure.

Distributed Data Guarding (RAID 5)

Distributed data guarding, also called RAID 5, stores parity data across all the drives in the array. If a drive fails, the controller uses the parity data and the data on the remaining drives to reconstruct data from the failed drive. This allows the system to continue operating with a slightly reduced performance until you replace the failed drive.

Distributed data guarding requires an array with a minimum of three physical drives and allows a maximum of 60 drives. Therefore, in an array containing three physical drives, distributed data guarding uses only 33 percent of the total logical drive storage capacity for fault tolerance; a 14-drive configuration uses only 7 percent.

NOTE: Given the reliability of a particular generation of hard drive technology, the probability of an array experiencing a drive failure increases with the number of drives in an array. Compaq recommends the number of drives in an array be limited to 14.
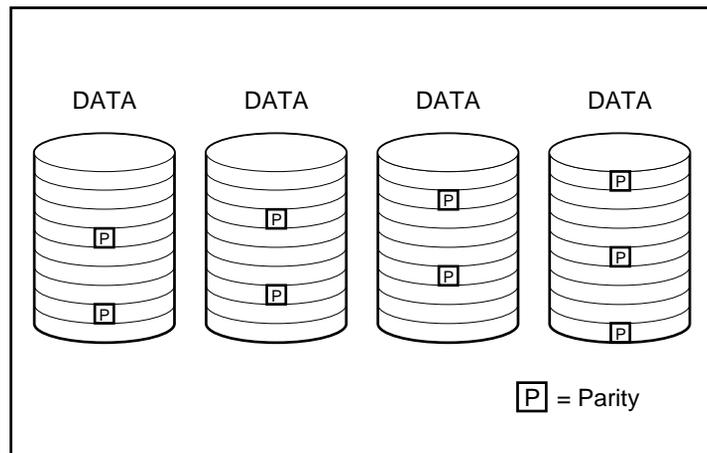
Figure D-5. Distributed Data Guarding distributes the redundant data [P] throughout the physical drives

Drive Mirroring (RAID 1)

Drive mirroring, also called RAID 1, is the highest-performance fault tolerance method. RAID 1 is the only method for fault tolerance protection if only two drives are installed or selected for an array. Drive mirroring creates fault tolerance by storing two sets of duplicate data on a pair of disk drives. Therefore, RAID 1 is an expensive fault tolerance method because 50 percent of the drive capacity is used to store the redundant data. RAID 1 always requires an even number of drives. To improve performance in configurations with more than two drives, the data is striped across the drives. This is also referred to as RAID 0+1 or RAID 10.

If a drive fails, the mirror drive provides a backup copy of the files and normal system operations are not interrupted. The mirroring feature requires a minimum of two drives and, in a multiple drive configuration (four or more drives), mirroring can withstand multiple simultaneous drive failures as long as the failed drives are not mirrored to each other.

> **IMPORTANT:** If two drives being mirrored to each other fail, the volume is failed and data loss may occur.
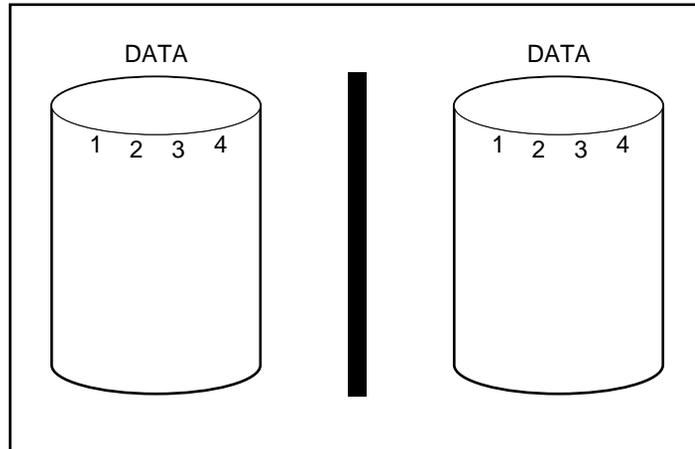
Figure D-6. Drive mirroring stores identical copy of the data

No Fault Tolerance (RAID 0)

RAID 0 does not provide fault tolerance. This level of RAID stripes data across all the drives of the array, but it does not incorporate a method to create redundant data. Therefore, if you choose this RAID option for any of your logical drives, you will experience data loss for that logical drive if one physical drive fails.

However, because none of the capacity of the logical drives is used for redundant data, RAID 0 offers the best processing speed and capacity. For this reason, you may consider assigning RAID 0 to drives that require large capacity and high speed but does not contain critical data.

Before choosing the RAID 0 option, be sure to consider the following:

■ Disk failure will result in data loss for all RAID 0 logical drives.

■ You cannot assign an online spare to an array containing a RAID 0 logical drive.

Online Spare

During configuration, consider assigning an online spare to further improve your system's fault tolerance. An online spare (sometimes called a hot-spare) is a drive the controller uses when a drive failure occurs. If a drive fails, the controller rebuilds the data that was on the failed drive onto the online spare. The controller also sends data that it would normally store on the failed drive directly to the online spare.

The online spare improves the overall system fault tolerance by automatically replacing a failed drive and quickly restoring the system to full RAID fault tolerance protection. During the time the system is operating in interim recovery mode with the failed drive, the system is vulnerable to an additional drive failure.

To provide an online spare, you must have at least one installed but unassigned physical drive and the system must be running some type of fault tolerance method (RAID 1 or higher).

Performance Enhancement

Drive arrays allow data access performance to be dramatically enhanced over non-arrayed drives. Some array controllers have several other performance enhancement features that are discussed in this section.

Distributing Data and Data Striping

Distributing data makes it possible to access data concurrently from multiple drives in an array. This yields I/O rates many times faster than non-arrayed drives. Data striping distributes data across the drives.

Data striping is automatically generated on an array controller in order to store user data. A stripe is a collection of contiguous data that is distributed evenly across all physical drives in a logical drive. The width of the stripe (the

amount stored on each physical drive) is selected to optimize the performance of the operating system.

For example, consider an operating system that typically requests data in 32-sector blocks (a sector contains 512 bytes of data). The array controller may distribute the data so that the first 32 sectors of data are on the first drive in the array. The array controller continues distributing the next 32 sectors on the second drive, the next 32 sectors on the third drive, and so on. Evenly distributed user data across all drives in an array results in improved performance by allowing data access to all drives simultaneously. See Figure D-7.
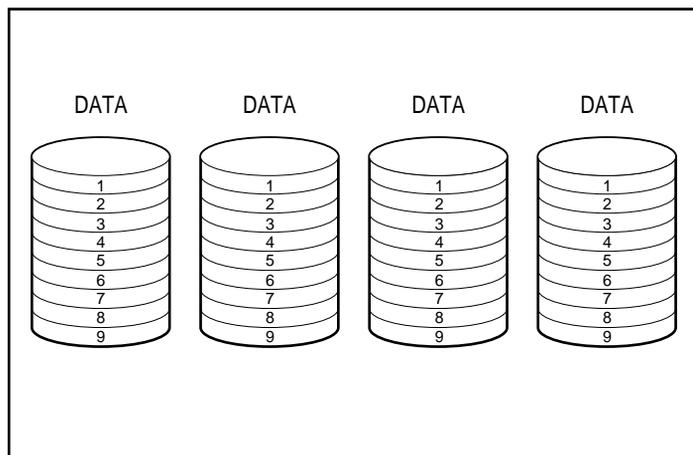
Figure D-7. Data Striping distributes data across all physical drives

User Selectable Stripe Size

If your array controller has an Array Accelerator, you may change stripe size either during the initial configuration of the system or later after the system has been in use for some time. It may also be done online if the new stripe size fits within the existing format. Table D-2 lists the set of valid stripe sizes for each RAID level.

Because data is re-written to the drives in a different format, the write cache must be enabled (batteries charged) to protect the data in the event of power loss during the change. Also, the Array Accelerator memory must be large enough to support the least common multiple of the two different full stripe sizes. During an expand/stripe-size change from an 11-drive RAID 5 volume (default, 32 sectors; full stripe = 320 sectors) to a 14-drive RAID 1 volume (default, 256 sectors; full stripe = 1792 sectors), the least common multiple of a full stripe would require 8960 sectors (4480 KB) available in the Array Accelerator.

The number of sectors on the physical drives cannot be increased. This can occur as a result of a request to increase stripe-size; the newly selected stripe-size would not be allowed. For example, if the user desires to change the stripe-size from 32 to 256 sectors, there may not be enough sectors at the end of the disks for a complete stripe of the larger size. Since a partial stripe cannot be supported, the request would not be allowed. In a new configuration, the area at the end of the disks is not used if there are not enough sectors left for that particular stripe-size. To select the new stripe-size, the current configuration would have to be deleted and the array configured with the new stripe-size. Since the data would be destroyed, you would need to backup the data and restore it after the array was reconfigured.

Table D-2
Valid Stripe Sizes

Fault Tolerance Level	Default (KB)	Valid Stripe Sizes (KB)
RAID 0	128	128, 256
RAID 0+1 / RAID 1	128	8, 16, 32, 64, 128, 256
RAID 5	16	8, 16, 32, 64

Array Accelerator

Some array controllers have an Array Accelerator, which serves as a posted write cache and read-ahead cache. This dramatically improves the performance of read and write commands. The Array Accelerator is particularly useful for increasing performance in database and fault-tolerant configurations.

The Array Accelerator increases performance by having the array controller write data to the cache memory on the Array Accelerator rather than directly to the drives. The system can access this cache memory more than 100 times faster than accessing disk storage. The array controller writes the data in the Array Accelerator to the drive array at a later time, when the controller is otherwise idle.

The controller also uses the Array Accelerator to increase performance by anticipating requests. The Array Accelerator uses a multi-threaded algorithm to predict the next likely read operation for the array. That data is read into the Array Accelerator and, therefore, is ready before you access it. When the array controller receives a read request for the cached data, it can be burst immediately into system memory at PCI bus speeds.

Data Protection

The Array Accelerator was designed to protect data integrity. Batteries and ECC memory protect the cache memory. This allows users to take full advantage of the performance without sacrificing reliability.

The Array Accelerator is also removable. This, along with its integrated batteries, means the Array Accelerator may be removed from one array controller and installed on another. If there is any data in the Array Accelerator that has not been written to the hard drive, it can be transferred to another array controller. This might happen if the array controller or server failed before the cached data could be stored on a drive.

ECC Memory

To assure further data integrity, the Array Accelerator cache is made up of Error Checking and Correcting (ECC) memory. ECC memory detects and corrects all single-bit memory errors in multiple SDRAMs. It also detects all two-bit memory errors in any position and most three- and four-bit memory errors in a single SDRAM. An entire SDRAM can also fail without data loss. This ensures the correction of common memory errors without interrupting system operation.

Batteries

The Array Accelerator contains batteries that maintain any data cached there if a system power failure occurs. The batteries can preserve data in the Array Accelerator for up to four days. When power is restored to the system, an initialization process writes the preserved data to the disk drives.

The cells used in the Array Accelerator batteries are recharged via a "trickle" charge applied while system power is present. If posted writes were stored in the memory of the Array Accelerator and power loss occurs, you must reinstate power within approximately four days or the data stored in the memory will be lost; this depends on the present condition of the Array Accelerator batteries.

> **IMPORTANT:** It is possible for the batteries to be depleted when you install a new array controller. It can take up to 4 hours of system operation to charge the batteries fully. In this case, only the Array Accelerator is affected; your system will continue to run without interruption.

During Power-On Self-Test (POST), the array controller checks the batteries. If the battery charge is low or depleted, a 1794 POST error message displays, indicating that the Array Accelerator is disabled. The controller temporarily disables the Array Accelerator until the batteries reach 90 percent charge. The

board continues to function properly, at a slightly lower performance, until the batteries reach 90 percent charge. At this point, the Array Accelerator is enabled automatically.

Concurrent I/O Request Servicing

The array controller can service hundreds of I/O requests at a time. For example, if you request data that resides on the first drive and another user requests data that resides on the second drive, the controller delivers both pieces of information concurrently.

Optimized Request Management

Optimized Request Management, also known as elevator trend sorting, is another performance enhancement feature provided by array controllers. The controller receives and queues multiple data requests from the operating system. The controller then rearranges the requests in an order that optimizes performance.

For example, the array controller receives a request for a physical drive that is not currently active. The controller schedules the request immediately ahead of previously received requests already queued to other active drives within the array. This request management process operates concurrently with drive operations. The benefits of optimized request management increase as greater demands are made on the drive subsystem.

Bus Master Data Transfers

The array controller is a bus master device that takes control of the PCI bus during high-speed transfers. This allows the system processor to handle application processing or other types of tasks. Data transfer occurs at rates of up to 132 megabytes per second for the PCI bus. Bus master high-speed transfers are particularly important when the supported models are used in conjunction with multiple expansion boards such as network interface controllers (NICs).

Storage Capacity Changes

Some array controllers allow you to increase the storage capacity by capacity expansion and capacity extension. **Capacity expansion** refers to an increase in the size of an array by adding physical drives and creating additional logical drives. **Capacity extension** refers to an increase in the size of an array by adding physical drives and enlarging an existing logical drive (without adding more logical drives).

If the Compaq Array Configuration Utility (ACU) can be used to configure the array, it will allow users to extend (increase) the size of existing logical drives under any operating system. However, only some operating systems allow the user to resize a partition inside the extended (bigger) logical drive, using third party tools.

> **NOTE:** Extending the capacity of an existing logical drive can be done offline by backing up all data, reconfiguring the array, and restoring the data. To extend capacity online, your operating system must support a logical drive increasing in size.

The array controller allows the configuration of one or more separate logical drives into a single drive array. The controller also supports extending the capacity of an existing logical drive. An existing drive array can be expanded by adding one or more logical drives to the array or by growing the capacity of an existing logical drive. To create the room for the additional capacity, more physical drives must be added. See Figure D-8.
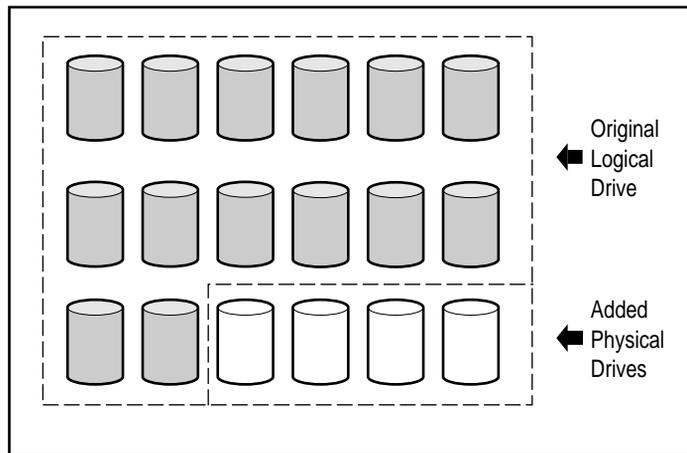
Figure D-8. Adding more physical drives

When initiated by ACU, the array controller automatically redistributes the data in the original logical drive to a logical drive that spans all of the physical drives in the array, including the added drives. The room left over is used to increase the size of a logical drive or create additional logical drives, also spanning all physical drives. The extended logical drive is within the larger drive array. When logical drives are added, both logical drives are then included in the drive array with expanded storage capacity. See Figure D-10.
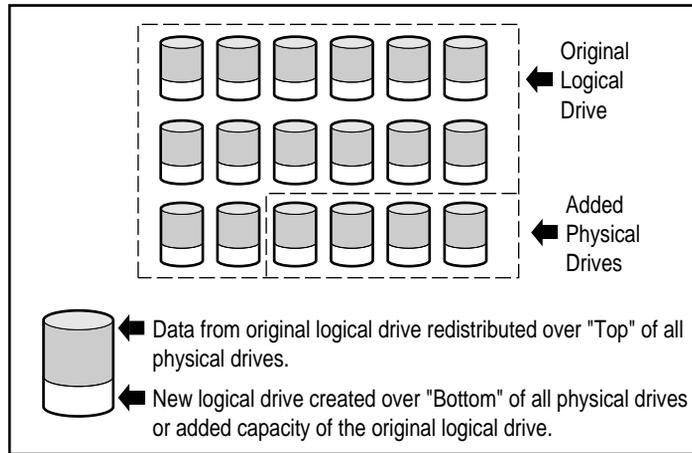
Figure D-9. Expanded array storage capacity with a second logical drive

Example: Assume you have total of 14 physical drives and you want to expand this to 18 drives. With ACU running, simply install four matching drives in the empty drive bays. At this point, your array will resemble Figure D-8, with the original data (original logical drive) represented by the gray shaded drives and the new drives unshaded. Run the Array Configuration Utility (located on the Compaq SmartStart and Support Software CD) to start the expansion process described in Chapter 6.

The array controller redistributes the data to an equal portion of all the drives, using the same fault tolerance method as the original configuration. The first logical drive remains first, but it now spans 18 drives instead of 14. The Array Configuration Utility also detects the unused space on each drive (because each drive contains 14/18ths of the data that it used to) and helps you configure it into a second logical drive with its own fault tolerance, distributed over the extra space of all the drives.

When this process is finished both logical drives, one containing the original data and the new empty one, will be configured into a single array with more total capacity than the original one. Now your array will resemble Figure D-9, using the same shading scheme to represent the logical drives.

It is not necessary for all *logical drives* in an array to be the same size or even have the same fault-tolerant configuration. Each logical drive is treated as a separate entity no matter how many physical drives it crosses. Each may be configured as best suits your needs.

It is important to remember that all *physical drives* in an array should be the same size (capacity). This is because each drive contains an equal portion of one or more logical drives and the portion sizes can only total the size of the

smallest drive. While you are not prevented from expanding storage capacity with larger drives, the extra space cannot be used.

During expansion of an array that initially has two or more logical drives, the redistribution of data takes place one logical drive at a time. When the capacity expansion has completed, any newly created logical drive will become available. Under Windows NT and NetWare, the new logical drive can then be appended to your existing logical volume.

Online Capacity Expansion or Extension

In certain cases, the array controller and ACU also support making storage capacity changes online, without downing the server or storage system. These cases require:

■   Hot-Plug drives, *and*

■   Either Windows NT (only supports capacity extension online) or NetWare

Because ACU reconfigures the array controller, online reconfiguration can only take place if ACU is running in the same environment as the normal server applications.

Hot-plug drives are required for online storage changes because non-hot-plug drives require that the server be powered down to add or remove the drive. All ProLiant Servers and Storage Systems support hot-plug drives.

Disk Drive Capacity Upgrades

Additional storage space can be gained with the same number of physical drives *in a fault-tolerant configuration* by replacing these drives with higher-capacity drives. By replacing the drives one at a time, the data on the new drive is recreated from redundant information on the remaining drives. After each new drive has been rebuilt, the next can be replaced. After all drives have been replaced and rebuilt, the additional capacity on each drive can be utilized by adding a new logical drive. If you are using ACU, it automatically recognizes the unused space and guides you through the procedures to use it.

Other Fault Management Features

The array controller and the network operating system support several other fault management and data reliability features. These features include:

■   Auto reliability monitoring

■   Dynamic sector repairing

- Drive parameter tracking

- Drive failure alert features

- Interim data recovery

- Automatic data recovery

- Hot-plug drives (Compaq ProLiant Storage System, Compaq ProLiant Server, Rack-Mountable Compaq ProLiant Storage System or Rack-Mountable Compaq ProLiant Server)

The following functions are not array controller features, but may be supported by the operating system:

- Controller duplexing

- Software-based drive mirroring

Auto Reliability Monitoring

Auto Reliability Monitoring (ARM) is a background process that scans hard drives for bad sectors in fault-tolerant logical drives. ARM also verifies the consistency of parity data in drives with data guarding or distributed data guarding. This process assures that you can recover all data successfully if a drive failure occurs in the future. ARM operates only when you select RAID 1 or RAID 5.

Dynamic Sector Repairing

Using the dynamic sector repairing process, the controller automatically remaps any sectors with media faults it detects either during normal operation or during auto reliability monitoring.

Drive Parameter Tracking

Drive parameter tracking monitors more than 15 drive-operational parameters and functional tests. This includes parameters such as read, write, and seek errors; spin-up time; cable problems; and functional tests such as track-to-track seek time, one-third stroke, and full stroke seek time. Drive parameter tracking allows the array controller to detect drive problems and predict drive failure before they actually occur. It also makes pre-failure warranty possible on Compaq disk drives.

Drive Failure Alert Features

Drive failure features produce various drive alerts or error messages depending on the Compaq server model. Refer to the documentation included with your server to determine what drive failure features are included on your server model.

Other Compaq options such as Compaq Insight Manager and Compaq Server Manager/R provide additional drive failure features. See your Authorized Compaq Reseller for more information on these products.

Interim Data Recovery

In fault-tolerant (RAID 1 or higher) configurations, if a drive fails, the system continues to operate in an interim data recovery mode. For example, if you selected RAID 5 for a logical drive with four physical drives and one of the drives fails, the system continues to process I/O requests, but at a reduced performance level. Replace the failed drive as soon as possible to restore performance and full fault tolerance for that logical drive. See Appendix G for more information on recovering from drive failure.

Automatic Data Recovery

After you replace a failed drive, automatic data recovery reconstructs the data and places it on the replaced drive. This allows a rapid recovery to full operating performance without interrupting normal system operations.

In general, the time required for a rebuild is approximately 15 minutes per gigabyte. However, the actual rebuild time depends on the rebuild priority set for the amount of I/O activity occurring during the rebuild operation, disk drive speed, and the number of drives in the array (RAID 5). In RAID 5 configuration, the rebuild time varies from 10 minutes/GB for three drives to 20 minutes/GB for 14 drives (using 9-GB Wide-Ultra hard drives).

> **NOTE:** You must specify RAID 5 or RAID 1 during array configuration to make the recovery feature available. The drive failure alert system and automatic data recovery are functions of the array controller; they function independently of the operating system.

Hot-Pluggable Drives

The array controller supports hot-plug drives used with a Compaq Storage Enclosure, a Rack-Mountable Compaq Storage Enclosure, a Compaq ProLiant Server, or a Rack-Mountable Compaq ProLiant Server. You can install or remove these drives without turning off the system power. This feature is a

function of the Compaq Storage Enclosure and the Compaq ProLiant Server and operates independently of the operating system.

> **CAUTION: :** Do not turn off the Compaq Storage Enclosure or the Compaq server when removing or installing the hot-plug replacement drives. If you turn off the Storage Enclosure while the server power is on, the array controller marks all the drives as "failed." This could result in permanent data loss when the Storage Enclosure is turned back on.

If a drive fails, the Service Required LED on the front panel of the server lights, indicating that a problem has occurred. See Appendix G, Hot-Plug Drive Replacement and Recovering from Drive Failure, for more details on how to safely replace a drive. Also, refer to your server documentation.

Controller Duplexing

Some operating systems and array controllers support controller duplexing, a fault tolerance feature that requires two array controllers. With duplexing, the two controllers each have their own drives that contain identical data. In the unlikely event of an array controller failure, the remaining drives and array controller service all requests.

Controller duplexing is not the same as duplexing the SCSI buses on a single array controller. Controller duplexing is a function of the operating system and takes the place of other fault tolerance methods. Refer to the documentation included with your operating system for implementation.

Compaq recommends using hardware-based fault tolerance instead of controller duplexing. Hardware-based fault tolerance provides a much more robust and controlled environment for fault-tolerance protection.

If you choose controller duplexing, configure each array controller with RAID 0 to achieve maximum storage capacity. In addition, the following fault-tolerant features will not be available: online spare, auto-reliability monitoring, interim data recovery, and automatic data recovery.

Software-Based Drive Mirroring

Some operating systems support software-based drive mirroring as a fault-tolerance feature. Software drive mirroring resembles hardware-based drive mirroring (RAID 1), except that the operating system mirrors logical drives instead of physical drives.

A pitfall of software-based drive mirroring is that the operating system believes each logical drive is a separate physical drive. If you mirror logical

drives in the same array and a physical drive fails, both logical drives in the mirrored pair will fail. You will not be able to retrieve your data.

Because software-based drive mirroring is a function of the operating system, refer to the documentation included with your operating system for implementation.

Compaq recommends using hardware-based fault tolerance instead of software-based drive mirroring. Hardware-based fault tolerance provides a much more robust and controlled environment for fault-tolerance protection.

If you choose software-based drive mirroring, create the two arrays with RAID 0 to achieve maximum storage capacity. Then, when configuring the drive mirroring through the operating system, mirror logical drives residing in different arrays. In addition, the following fault-tolerant features will not be available: online spare, auto-reliability monitoring, interim data recovery, and automatic data recovery. See Chapter 6 for information on your drive array(s) and fault tolerance.

Appendix **E**

Upgrading to Smart Array Controllers

Replacing an existing array controller with a new Compaq array controller is easy, and all configuration information and data is migrated automatically. Data stored on drives previously connected to an earlier model array controller will automatically be recognized by a Smart Array Controller when upgraded. There are several simple steps that need to be taken to ensure the operating system keeps drives and controllers in sync, but the data is always intact.

All user data and configuration information will be retained after the upgrade process.

This migration will require you to shut the system down to replace the controller and then reconfigure your system (see Chapter 5, "Configuring your System"). A minimum amount of scheduled down time is required.

The following table indicates what action, if any, should be taken immediately before replacing a RAID LC2 Controller with some other Compaq array controller.

Table E-1
Migrating to Other Compaq Controllers

New controller	Action required
221, 431, 3200, 4200, 5300	Backup and restore of data is recommended to prevent data loss. The new driver **must** be loaded **before** replacing the controller.

Appendix **F**

Hot-plug Drive Replacement and Recovering from Drive Failure

The purpose of fault-tolerant configurations on the RAID LC2 Controller is to protect against data loss due to drive failure. Although the array controller firmware is designed to protect against normal drive failure, it is imperative that the correct actions are performed to recover from a drive failure without inadvertently inducing any additional drive failures. Multiple drive failures in the same array generally result in data loss (exceptions include failures following activation of a spare drive and failure of drives in a mirrored configuration that are not mirrored to one another).

Recognizing a Drive Failure

A drive failure can be recognized in one of several ways:

■   Amber LED illuminates on failed drives in a hot-pluggable tray. This, however, assumes the storage system is powered-on and the SCSI cable is working. Note that the amber LED may illuminate briefly when a hot-pluggable drive is inserted; this is normal.

■   A Power-On Self-Test (POST) message lists failed drives whenever the system is restarted (assumes that the controller detects one or more "good" drives. See Appendix H for explanation of POST messages).

■   Array Diagnostic Utility (ADU) lists all failed drives.

■   Compaq Insight Manager can detect failed drives remotely across a network.

Hard Drive LED Indicators

The hard drive LEDs, located on each physical drive, are visible on the front of the server or external storage unit. They provide activity, online and fault status for each corresponding drive when configured as a part of an array, and attached to a powered-on controller. Their behavior may vary, depending on the status of other drives in the array.

This section provides the following information about hard drive LEDs:

■ An illustration detailing the location of each LED

■ A matrix of the possible LED configurations and what each combination means

■ Details about hot-plug drive rapid error recovery and guidelines for utilizing Compaq Insight Manager's predictive failure alert

■ Guidelines for hot-plug drive replacement

For additional information on troubleshooting hard drive problems, refer to "Hard Drive Problems" and "SCSI Device Problems" in Chapter 2 of the *Compaq Servers Troubleshooting Guide*.

Use the following illustration in conjunction with Table F-1 to analyze the current status of hot-plug hard drives that are attached to a Compaq array controller.
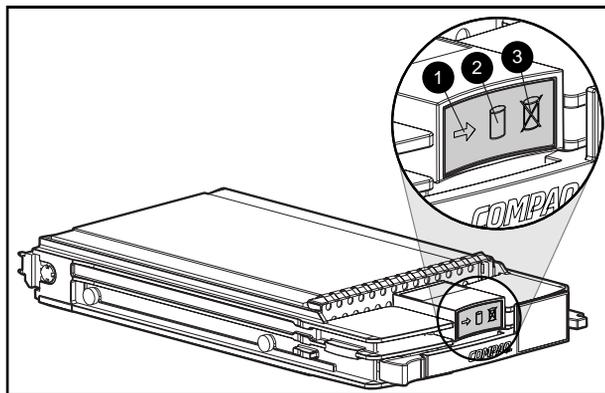
Figure F-1. Hot-plug hard drive LED indicators

IMPORTANT: It is recommended that you familiarize yourself with the guidelines following this table before replacing a drive.

Table F-1
Hot-Plug Hard Drive LED Indicator Status Combinations

❶ Activity	❷ Online	❸ Fault	Meaning
On	Off	Off	**Do not remove the drive. Removing a drive during this process may cause data loss.** The drive is being accessed, but it is: 1. Not configured as part of an array, *or* 2. A replacement drive and rebuild has not yet started, *or* 3. Spinning up during POST
On	Flashing	Off	**Do not remove the drive. Removing a drive during this process may terminate the current operation and cause data loss.** The drive is rebuilding or undergoing capacity expansion.
Flashing	Flashing	Flashing	**Do not remove the drive. Removing a drive during this process can cause data loss in non-fault-tolerant configurations.** Options ROMPaq is upgrading the drive.
Off	Off	Off	OK to replace the drive online if a predictive failure alert is received (see the Predictive Failure Alert section later in this chapter for details) and the drive is attached to an array controller. The drive is not configured as part of an array. -or- If this drive is configured as part of an array, then a powered-on controller is not accessing the drive. -or- The drive is configured as an online spare.

continued

Table F-1
Hot-Plug Hard Drive LED Indicator Status Combinations _{continued}

❶ Activity	❷ Online	❸ Fault	Meaning
Off	Off	On	OK to replace the drive online.
			The drive has failed, and has been placed off-line.
Off, on or flashing	On	Off	OK to replace the drive online if a predictive failure alert is received (see the Predictive Failure Alert section later in this chapter for details), provided that the array is configured for fault tolerance and all other drives in the array are online.
			The drive is online and configured as part of an array.

Hot-Plug Drive Replacement Guidelines

You should be able to hot-plug a drive during normal activity. Be aware, however, that system performance and fault tolerance will be affected.

> **NOTE:** Depending upon the configuration of your system, both a drive failure and the subsequent rebuild process will cause storage subsystem performance degradation. For example, the replacement of a single physical drive in a RAID 1 configuration will have less of an impact than in a RAID 5 configuration.

When a disk drive is hot-plugged, although the system is functionally operational, the disk subsystem may no longer be fault tolerant. Fault tolerance will be lost until the removed drive is subsequently replaced **and** the rebuild operation is completed (this will take several hours even if the system is not busy while the rebuild is in progress). If another drive in the array should incur an error during the period when fault tolerance is unavailable, it is possible to cause a fatal system error due to a data error. If another drive fails during this period, the entire contents of the array will be lost.

> **IMPORTANT:** It is recommended that disk drive replacement be performed during low activity periods whenever possible. In addition, a current valid backup should be available of the logical drives in the array of the drive being replaced, even if drive replacement is being made during server downtime.

Hot-Plug Drive Replacement Precautions

Be aware of the following Compaq guidelines cautioning against unsafe hot-plug replacement procedures.

■ Do not remove a degraded drive if any other member of the array is off-line (the online LED is off). No other drive in the array can be hot-plugged without data loss.

There are some possible exceptions to this:

❑ When RAID 0+1 is used as a fault tolerance option, drives are essentially mirrored in pairs; more than one drive can fail and be replaced as long as the drive(s) they are mirrored to are online.

❑ If an online spare has an unlit online LED (it is offline), the degraded drive can still be replaced.

See Appendix D and later sections of this Appendix for further information on fault tolerance options.

■ Do not remove a degraded drive if any member of an array is missing (previously removed and not yet replaced).

■ Do not remove a degraded drive if any member of an array is being rebuilt unless the drive being rebuilt has been configured as an online spare. The drive's online LED will be flashing, indicating that a replaced drive is being rebuilt from data stored on the other drives.

NOTE: An online spare will not activate and start rebuilding after a predictive failure alert, as the degraded drive is still online. The online spare only activates after a drive in the array has failed.

■ Do not replace multiple degraded drives at the same time (for example, when the system is off), since the fault-tolerance may be compromised. When a drive is replaced, the controller uses data from the other drives in the array to reconstruct data on the replacement drive. If more than one drive is removed, a complete data set is not available to reconstruct data on the replacement drive(s) and permanent data loss could occur. (The only exception is with RAID 0+1, in which, theoretically, up to half of the drives can be replaced while offline without loss of data.)

> **CAUTION:** Do not turn off an attached disk drive enclosure when the server containing the array controller is powered on. Also, do not turn on the server before turning on the disk enclosure. If these ordering rules are not followed, the array controller may mark the drives in this enclosure as "failed," which could result in permanent data loss.

Predictive Failure Alert

The predictive failure alert is a powerful problem-prevention tool that warns you when the system has determined that a drive failure is imminent. This alert

allows you to proactively schedule downtime for maintenance and not interrupt critical business operations that rely on your servers. In addition, with hot-pluggable drives attached to Compaq array controllers, you can remove and replace one or several drives within a server while the system is online, which minimizes the interruption of the network, server downtime and data loss. Refer to your Compaq Insight Manager and Compaq Management Agents documentation (found on the Compaq Management CD) for instructions on implementing this function.

> **CAUTION:** Not following these guidelines could result in data loss.

> **CAUTION:** It is recommended that some level of fault tolerance be utilized in your RAID configuration. See Appendix D and later sections of this Appendix for information on fault tolerance options.

IMPORTANT: You must use Compaq Insight Manager and a Compaq array controller to manage the drive array on your server if you wish to implement Predictive Failure Alert.

Tests carried out by POST or the Array Diagnostics Utility will also note imminent drive failure.

Predictive Failure Replacement Guidelines

To minimize server downtime and data loss, use these guidelines when Compaq Insight Manager implements a predictive failure alert. The alert indicates that a drive is degraded and should be replaced:

■ Make sure all physical drives in the affected array are present and have their online LEDs illuminated before removing the degraded hot-plug drive.

  ❑ If any drive has a flashing online LED (indicating a rebuild), the degraded drive should not be removed.

  ❑ If any drive other than an online spare has an online LED that is not illuminated, the degraded drive should not be removed.

■ If you are upgrading to larger drives in the array, follow the previously stated rules and ensure that each drive has completed its rebuild before adding the next new drive to the array.

■ You must follow the Compaq cabling guidelines when configuring your array to implement the best possible cabling solution for your server.

■ Check for cabling configurations that are not supported. Signal integrity errors may be injected into the SCSI bus when an active drive is hot-plugged.

■ Make sure fault tolerance is not currently being used to recover from errors to other drives in the array, such as media errors or signal integrity errors. Loss of fault tolerance following a drive replacement may result in problems.

> △ **CAUTION:** In extreme cases, when the number of errors is greater than the error recovery firmware is able to sustain, hot-plugging an online drive may cause some unrecoverable errors to be reported to the operating system or may cause a complete failure of the array. Refer to your operating system documentation for more information on implications, as well as possible recovery options.

> **IMPORTANT:** Before replacing a degraded drive, use Compaq Insight Manager to examine the error counters recorded for each physical drive in the array to verify that such errors are not presently occurring. Refer to the Compaq Insight Manager documentation on the Compaq Management CD.

Fault Tolerance and Drive Failure

In the event of a drive failure, the condition of the logical drive varies depending upon the fault-tolerance method used. Since a single array of physical drives can contain multiple logical drives with different fault-tolerance methods, conditions of each logical drive on the same array are not necessarily the same. At any one time, if more drives are failed than the fault-tolerance method allows, fault tolerance is "compromised" and the condition of the logical drive can be referred to as "failed." If a logical volume is "failed," all requests from the operating system will be rejected with "unrecoverable" errors.

A Non-Fault-Tolerant (RAID 0) Logical Drive:

■ Can sustain no drive failures. If any physical drive in the array is failed, the condition of all non-fault-tolerant logical drives in the same array will also be "failed." This is because data is striped across all drives in the array.

A Mirroring (RAID 1) Logical Drive:

■ Can sustain multiple drive failures as long as failed drives are not mirrored to one another.

■ Will be in a "failed" condition if any two failed drives are mirrored to one another.

■ Will be in a "regenerating" condition if at least one drive is failed and no failed drives are mirrored to one another.

■ Will be in a "rebuilding" condition if a previously failed drive has been replaced and the replacement drive is rebuilding. The volume may also be in a "rebuilding" condition following a drive failure if a spare drive was previously assigned and is rebuilding.

In any RAID 1 logical drive on the array controller having N physical drives in the array (not including spare drives), the first N/2 physical drives are normally mirrored in consecutive order to the second N/2 physical drives. When determining the order, number each drive in the array by increasing IDs on the first SCSI bus, followed by drives on the second SCSI bus.

Spare Drives

In the event of a drive failure, if a spare drive is assigned and available, the spare drive acts as an immediate replacement for the failed drive. Data is reconstructed automatically from the remaining drive(s) in the volume and written to the spare drive via the Automatic Data Recovery process (discussed in the following section). Once the spare drive is completely built, the logical drive again runs at full fault tolerance and is then able to sustain another subsequent drive failure. Note, however, that if another drive fails before the spare drive is completely built, the spare drive cannot prevent failure of the entire logical drive. Also note that it is possible for non-correctable disk errors to prevent completion of the Automatic Data Recovery process.

Replacing a Failed Drive

Failed drives in hot-pluggable trays can be removed and replaced while host system and storage system powers are both ON. Hot-pluggable drives can also be replaced when the power is OFF. Remember, however, to NEVER TURN OFF an external storage system while the host system power is on. This would result in the failure of all drives in the storage system, and would likely compromise your fault tolerance. When a hot-pluggable drive is inserted, all disk activity on the controller is temporarily paused while the drive is spinning up (usually 20 seconds or so). If the drive is inserted while power is ON, in fault-tolerant configurations, recovery of data on the replacement drive begins automatically (indicated by the blinking online LED).

Non-hot-pluggable drives should only be replaced while the system power is OFF. On all non-hot-pluggable drives, be sure to check the SCSI ID jumpers to make sure that the correct drive is being replaced. **To prevent compromising the fault tolerance, it is imperative that the correct physical**

drive be replaced. Also, be sure that the SCSI ID jumpers are set to the same SCSI ID on the replacement drive. The SCSI ID jumpers may be located at different places on different drive models, but it is necessary that the SCSI ID on the replacement drive **always** be set to the same value as the original failed drive to prevent SCSI ID conflicts which could compromise the fault tolerance.

The capacity of replacement drives must be at least as large as the capacity of the other drives in the array. Drives of insufficient capacity will be failed immediately by the controller without starting Automatic Data Recovery.

> △ **CAUTION:** If the array controller has a failed drive, replace this drive with one that is new or known to be good. In some cases, a drive that has previously failed by the controller may appear to be operational after the system is power-cycled, or after removal and reinsertion of a hot-pluggable drive. However, this practice is highly discouraged as the use of such "marginal" drives may eventually result in data loss

Automatic Data Recovery

If a drive in a fault-tolerant configuration is replaced while the system power is OFF, the controller displays a Power-On Self-Test (POST) message during the subsequent system startup. This indicates that the replacement drive has been detected and that Automatic Data Recovery may need to be started. Press **F1** to initiate the background Automatic Data Recovery process. If Automatic Data Recovery is not enabled, the logical drive remains in a "ready-to-recover" condition and the same query displays at the next system restart.

Replacement drives are not considered to be "online" until Automatic Data Recovery is completed, at which time the online LED stops blinking and is glowing steadily. Any drives that are not yet "online" are treated as if they are "failed" when trying to determine whether fault tolerance will be compromised. For example, in a RAID 5 logical drive with no spare and one drive rebuilding, another drive failure at this time would result in a "failure" condition for the entire logical drive.

In general, the time required for a rebuild is approximately 15 minutes per gigabyte. The actual rebuild time depends upon the rebuild priority set for the amount of I/O activity occurring during the rebuild operation and the disk drive speed. In a RAID 5 configuration, the rebuild time also depends upon the number of drives in the array; it varies from 10 minutes/GB for three drives to 20 minutes/GB for 14 drives (using 9-GB Wide-Ultra hard drives).

Automatic Data Recovery Failure

If the online LED of the replacement drive stops blinking during Automatic Data Recovery, one of the following scenarios may be the cause:

If all other drives in the array are still online, abnormal termination of the Automatic Data Recovery process may have occurred, due to an non-correctable read error from another physical drive during the recovery process. The background Auto Reliability Monitoring process helps prevent this problem, but it cannot do anything about certain issues, such as SCSI bus signal integrity problems. Reboot the system and a POST message should confirm the diagnosis. Retrying Automatic Data Recovery may help. If not, backup of all data on the system, surface analysis (using User Diagnostics), and restore is recommended.

In the second possible case, if the replacement drive is failed (amber failure LED illuminated or other LEDs go out), the replacement drive is producing unrecoverable disk errors. In this case, the replacement drive should be removed and replaced.

Compromised Fault Tolerance

If fault tolerance is compromised due to failure of multiple drives, the condition of the logical drive will be "failed," and "unrecoverable" errors will be returned to the host. Data loss is probable. Inserting replacement drives at this time will not improve the condition of the logical drive. If this occurs, first try turning the entire system off and on. In some cases, an intermittent drive will appear to work again (perhaps long enough to make copies of important files) after cycling power. If a 1779 POST message is displayed, press **F2** to re-enable the logical drive(s). Remember that data loss has likely occurred and any data on the logical drive is suspect.

Fault tolerance may be compromised due to non-drive problems such as a faulty cable, faulty storage system power supply, or a user accidentally turning off an external storage system while the host system power was on. In such cases, the physical drives do not need to be replaced. However, data loss can occur, especially if the system was busy at the time the problem happened.

In cases of "legitimate" drive failure, once copies of important data have been made (if possible), prevent further drive problems by replacing any drives that have failed. After these (multiple) drives are replaced, the fault tolerance may again be compromised, power may need to be cycled, and the 1779 POST message may again be displayed. Press **F2** to re-enable the logical drive(s), recreate your partitions, and restore all data from backup.

Because of the risk that fault tolerance may be compromised at some point in the future, make regular backups of all logical drives.

Appendix **G**

POST Error Messages

The RAID LC2 Controller produces diagnostic error messages at reboot. Many of these Power-On Self-Test (POST) messages are self-explanatory and suggest corrective actions for troubleshooting. Details of these messages and corrective actions are provided in the following table. Not all the messages in the table will apply to your system or controller.

Table G-1
POST Error Messages

	Meaning	Recommended Action
1702	SCSI cable error detected. System halted.	This message indicates a termination or cabling problem with the system board integrated SCSI controller. See cabling information in the Installation Guide.
1720	Slot x Drive Array – S.M.A.R.T. Hard Drive Detects Imminent Failure: SCSI Port x: SCSI ID x	The indicated drive has reported a S.M.A.R.T. predictive-failure condition, and may fail soon. **Do not replace the drive unless all other drives on the array are on-line!** Back up data before replacing drive(s).
1721	Slot x Drive Array – Drive Parameter Tracking Predicts Imminent Failure The following device(s) should be replaced when conditions permit:	**Do not replace drive unless all other drives on the array are on-line**! Back up data before replacing drive(s). M&P predictive failure threshold exceeded condition. The indicated drive may fail at some time in the near future.

Table G-1
POST Error Messages *continued*

	Meaning	Recommended Action
1723	Slot x Drive Array – to improve signal integrity, internal SCSI connector should be removed if external drives are attached to the same SCSI port (followed by further details).	Follow the remaining instructions in the POST message.
1724	Slot x Drive Array – Physical Drive Position Change(s) Detected – Logical drive configuration has automatically been updated. (RESUME = F1 KEY)	This message indicates that logical drive configuration has been updated automatically following physical drive position changes. Select **F1** key to resume.
1725	Slot x Drive Array – Optimal SIMM (Memory Module) problem detected (followed by one of the following): ■ SIMM has automatically been disabled due to memory errors ■ Unsupported SIMM type installed. Use 4MB Fast-Page 60-70ns Tin-Lead.	Remove or replace the problem SIMM. This message is specific to SMART-2SL controllers.
1726	Slot x Drive Array - Array Accelerator Memory Size Change Detected – Array Accelerator configuration has automatically been updated (RESUME = F1 KEY)	This message appears if the controller is replaced with a model that has a different amount of cache memory.
1727	Slot x Drive Array - New Logical Drive(s) Attachment Detected (if >32 logical drives, this will be followed by Auto-configuration failed: Too many logical drives) (RESUME = F1 KEY)	This message indicates the controller has detected an additional array of drives that was attached when the power was off. The logical drive configuration information has been updated to add the new logical drives. The maximum number of logical drives supported is 32 – additional drives will not be added to the configuration if this number is exceeded. Press the **F1** key to resume.
1728	Slot x drive array – abnormal shutdown detected with write cache enabled. No Array Accelerator battery backup on this model array controller. Any data that may have been in Array Accelerator memory has been lost.	This POST message should never occur unless the write cache is somehow enabled on a controller that does not have batteries.

Table G-1
POST Error Messages *continued*

	Meaning	Recommended Action
1729	Slot 1 Drive Array - disk performance optimization scan in progress – RAID 4/5 performance may be higher after completion.	This message is normal following the initial configuration of RAID 4 or RAID 5 logical drives. This POST message will go away and performance of the controller will improve after the parity data has been initialized by ARM (an automatic process that runs in the background on the controller).
1753	Slot x drive array – array controller maximum operating temperature exceeded during previous power up.	This message appears at the next power-up if the controller locks due to excessive temperature. Check for proper operation of the server cooling fan.
1756	Slot x redundant controllers are not the same model.	The redundant controllers are not of the same model. Use two like model controllers for redundancy.
1757	Slot x Array Accelerator daughterboard incompatible. Please replace 4MB array accelerator card with a 16MB or 64MB card.	The controller does not support the attached Array Accelerator card. Attach the correct Array Accelerator daughterboard.
1758	Slot x drive array – Array Accelerator size mismatch between controllers. 64MB array accelerator should be attached to both controllers.	The size of Array Accelerator cards is different between two controllers in a redundant controller configuration. Use Array Accelerator cards of the same size on both controllers.
1759	Slot x drive array – redundant controller error	Replace controller or server motherboard.
1762	Redundant controller operation is not supported in this firmware version. Please remove redundant controller or upgrade controller firmware. (Controller is disabled until this problem is resolved.)	Remove the redundant controller or visit the Compaq website and get the latest upgrade for the controller firmware.
1763	Array accelerator daughtercard is detached; please reattach. (Controller is disabled until this problem is resolved.)	This controller model cannot operate if the Array Accelerator card is detached. Reattach the card.
1764	Slot x drive array – capacity expansion process is temporarily disabled (followed by a cause).	The capacity expansion process has been temporarily disabled for the reason indicated, and will automatically resume. If the array accelerator has been removed, you must reinstall it for capacity expansion to continue.

continued

Table G-1
POST Error Messages *continued*

	Meaning	Recommended Action
1765	Slot x drive array Option ROM appears to conflict with an ISA card – ISA cards with 16-bit memory cannot be configured in memory range C0000 to DFFFF along with SMART-2/E 8-bit Option ROM due to EISA buffer limitations. Please remove or reconfigure your ISA card.	Remove or reconfigure the conflicting ISA card, referring to the directions provided with the ISA card. Alternatively, the Option ROM can be disabled on the SMART-2/E controller via the System Configuration Utility if a SMART-2/E is not the primary (boot) controller.
1766	Slot x drive array requires System ROM upgrade. Run System ROMPaq Utility.	Run the latest version of System ROMPaq. See Chapter 4 for details.
1767	Slot x drive array option ROM is not programmed correctly or may conflict with the memory address range of an ISA card. Check the memory address configuration of installed ISA card(s) *or* Run Option ROMPaq Utility to attempt SMART-2/E Option ROM reprogramming.	Check the memory address range of any ISA cards that may be installed, and verify that they do not conflict with the address of the SMART-2/E Option ROM as shown via the System Configuration Utility. If there is no conflict, run Option ROMPaq and attempt to reprogram the SMART-2/E Option ROM as described in Chapter 4.
1768	Slot x drive array – resuming logical drive expansion process.	No action required. This message appears whenever a controller reset or power cycle occurs while array expansion is in progress.
1769	Slot x drive array – drive(s) disabled due to failure during expansion (possibly followed by additional details).	Data has been lost while expanding the array; therefore, the drives have been temporarily disabled. Press **F2** to acknowledge the data loss and re-enable the logical drives. Restore data from backup. If the Array Accelerator has failed, replace the Array Accelerator board after the capacity expansion process has terminated. NEVER turn off the system and replace the Array Accelerator board if capacity expansion is in progress.
1770	Slot x Drive Array – Critical Drive Firmware Problem Detected – Please upgrade firmware on the following drive(s) using Options ROMPaq (available from www.compaq.com): SCSI Port (y) SCSI ID (*x*) (RESUME = **F1** OR **F2** KEY)	The indicated drives are running firmware that may cause intermittent problems. Please use the Compaq "Options ROMPaq" utility to upgrade firmware on all drives to the latest revision.

Table G-1
POST Error Messages *continued*

	Meaning	Recommended Action
1774	Slot x drive array – obsolete data found in Array Accelerator. Data found in accelerator was older than data found in drives. Obsolete data has been discarded.	Data found in Accelerator is older than data found on drives due to drives having been disconnected, used on another controller, then reconnected. Press **F1** to discard older data.
1775	Slot x Drive Array – ProLiant Storage System Not Responding SCSI Port (y): Check storage system power switch and cables. Turn the system power off while checking the ProLiant power and cable connections, then turn the system power back ON to retry. (RESUME = **F1** KEY)	Turn off power to system. Check external ProLiant power switch – external drives must all be powered up before or at the same time as the main system. Check cables. If retry does not help, try updating the ProLiant System firmware, or try replacing the cable, ProLiant storage backplane, or the array controller.
1776	Slot x Drive Array – SCSI Bus Termination Error – Internal and external drives cannot both be attached to the same SCSI port. SCSI port (y): Check cables(RESUME = **F1** KEY) (RESUME = F1 KEY)	The internal and external connectors of the specified SCSI port(s) are both attached to drives. The SCSI bus is not properly terminated when internal and external drives are attached concurrently to the same SCSI bus. The indicated SCSI bus is disabled until this problem is resolved. Turn off the server power and check the cabling to the specified SCSI port
1777	Slot x Drive Array – ProLiant Drive Storage Enclosure Problem Detected (followed by one or more of the following): ■ SCSI Port (y): Cooling Fan Malfunction Detected ■ SCSI Port (y): Overheated Condition Detected ■ SCSI Port (y): Side-Panel must be Closed to Prevent Overheating ■ SCSI Port (y): Redundant Power Supply Malfunction Detected ■ SCSI Port (y): Wide SCSI Transfer Failed ■ SCSI Port (y): Interrupt Signal Inoperative (RESUME = F1 KEY)	Check cooling fan operation by placing hand over fan. Check internal plenum cooling fan in tower servers or storage systems. If fan is not operating, check for obstructions and check all internal connectors. Replace unit side panel if removed. If the ProLiant Storage System power LED is amber instead of green, this can indicate a fan failure, redundant power supply failure, or thermal problem. Check SCSI cables. If the message indicates to check SCSI cables, please verify your cabling against the diagrams in the *User Guide*. If the routing is correct, replace cables on the specified port until the POST message is eliminated.

continued

Table G-1
POST Error Messages *continued*

	Meaning	Recommended Action
1778	Slot x Drive Array resuming Automatic Data Recovery process.	No action required. This message appears whenever a controller reset or power cycle occurs while Automatic Data Recovery is in progress.
1779	Slot x Drive Array - Replacement drive(s) detected OR previously failed drive(s) now appear to be operational: Port (*y*): SCSI ID (*x*): Restore data from backup if replacement drive *x* has been installed.	If this message appears and drive *x* (identified by its SCSI ID) has not been replaced, this indicates an intermittent drive failure. This message also appears once immediately following drive replacement before data is restored from backup.
1783	Slot x Drive Array Controller Failure.	If this message appears immediately following a ROM installation, the ROM is defective or not installed properly. Check that the controller is firmly inserted in its slot. Check for improper cabling or SCSI ID conflicts. Try upgrading the System ROMs. Otherwise, replace the array controller.
1784	Slot x Drive Array Drive Failure. The following SCSI drive(s) should be replaced: SCSI port (*y*) SCSI ID (*x*)	Check for loose cables. Replace defective drive *x* and/or cable(s).
1785	Slot 1 Drive Array not Configured (may be followed by one of the following): (1) No drives detected (2) Drive positions appear to have changed – Run Drive Array Advanced Diagnostics if previous positions are unknown. Then turn system power OFF and move drives to their original positions. (3) Configuration information indicates drive positions beyond the capability of this controller. This may be due to drive movement from a controller that supports more drives than the current controller. (4) Configuration information indicates drives were configured on a controller with a newer firmware version. (RESUME = F1 KEY)	(1) Turn off system and check SCSI cable connections to make sure drives are attached properly. (2) Run Drive Array Advanced Diagnostics if previous positions are unknown. Then turn system power OFF and move drives to their original positions. (3) To avoid data loss, turn system power OFF and reattach drives to the original controller. (4) To avoid data loss, reattach drives to the original controller or upgrade the controller firmware to the version on the original controller using Option ROMPaq. Select F1 key to resume.

Table G-1
POST Error Messages *continued*

	Meaning	Recommended Action
1786	Slot 1 Drive Array Recovery Needed. The following SCSI drive(s) need Automatic Data Recovery: SCSI Port (y): SCSI ID (x) Select F1 to continue with recovery of data to drive(s). Select F2 to continue without recovery of data to drive(s). *Or*	The message normally appears when a drive was replaced in a fault-tolerant configuration when system power was OFF. In this case, press **F1** to start the automatic data recovery process.
	Slot 1 Drive Array Recovery Needed. Automatic Data Recovery Previously Aborted! The following SCSI drive(s) need Automatic Data Recovery (Rebuild): SCSI Port (y): SCSI ID (x) Select **F1** to retry Automatic Data Recovery to drive. Select **F2** to continue without starting Automatic Data Recovery data to drive. Data to drive.	The "previously aborted" version of the 1786 POST message will appear if the previous rebuild attempt was aborted for any reason. Run the Array Diagnostics Utility (ADU) for more information. If the replacement drive was failed, try using another replacement drive. If rebuild was aborted due to a read error from another physical drive in the array, you'll need to back up all readable data on the array, run Diagnostics Surface Analysis, and then restore your data.
1787	Slot x Drive Array Operating in Interim Recovery Mode. The following SCSI drive(s) should be replaced: SCSI Port (y): SCSI ID (x)	Following a system restart, this message reminds you that drive x is defective and fault tolerance is being used. Drive x needs replacement as soon as possible. A loose or defective cable may also cause this error.

Table G-1
POST Error Messages *continued*

	Meaning	Recommended Action
1788	Slot x Drive Array Reports Incorrect Drive Replacement. The following SCSI drive(s) should have been replaced: SCSI Port (y): SCSI ID (x).	The drives indicated were installed in the wrong place, so they have been disabled. Reinstall the drives correctly.
	The following SCSI drive(s) were incorrectly replaced: SCSI Port (y): SCSI ID (z).	Press **F1** to restart the computer with the drive array disabled.
	Select **F1** to continue - drive array will remain disabled.	*-Or-*
	Select **F2** to reset configuration - all data will be lost.	Press **F2** to use the drives as configured and lose all the data on them.
	-Or-	
	Faulty power cable connection to the drive.	Repair the connection and press **F2**. If this message is not eliminated by pressing **F2**, run the Drive Array Advanced Diagnostics Utility.
	-Or-	
	Defective SCSI cable.	Contact your Authorized Compaq Service Provider.
1789	Slot x Drive Array SCSI Drive(s) Not Responding. Check cables or replace the following SCSI drives: SCSI Port (y): SCSI ID (x)	This message indicates that previously operating drives are missing or inoperative following a cold or warm reset. Turn off system and check cable connections. If cables are connected, replace the drive. Press **F1** to restart the computer with the drive array disabled.
	Select **F1** to continue - drive array will remain disabled.	*-Or-*
	Select **F2** to failed drives that are not responding - Interim Recovery Mode will be enabled if configured for fault tolerance.	If you do not want to replace the drives now, press **F2**.
1792	Slot x valid data found in Array Accelerator. Data automatically written to drive array.	Power was interrupted while the system was in use, or the system was restarted while data was in the Array Accelerator memory. Power was restored within four days.
1793	Slot x drive array – Array Accelerator battery depleted. Data in Array Accelerator has been lost. (Error message 1794 also displays.)	While the system was in use, power was interrupted while data was in the Array Accelerator memory. Power was not restored within four days, so the batteries were depleted and data in the Array Accelerator was lost. Check all files for potential data corruption.
		-Or-
		The Array Accelerator batteries have failed.

Table G-1
POST Error Messages *continued*

	Meaning	Recommended Action
1794	Slot x drive array – Array Accelerator battery charge low. Array Accelerator is temporarily disabled. Array Accelerator will be re-enabled when battery reaches full charge.	The battery charge is below 90%. Posted writes are disabled. When the batteries are fully charged, the Array Accelerator will automatically be re-enabled and this POST message will no longer display. Replace the Array Accelerator or the Smart Array Controller if batteries do not recharge within 36 power-on hours.
1795	Slot x drive array – SMART-2 Controller configuration error. Data does not correspond to this drive array. Array Accelerator is temporarily disabled.	The data stored in the Array Accelerator does not correspond to this drive array. Match the Array Accelerator to the correct drive array. *-Or-* Run the Compaq System Configuration Utility to clear data in the Array Accelerator.
1796	Slot x drive array – Array Accelerator is not responding. Array Accelerator is temporarily disabled.	Replace the Array Accelerator or the Smart Array Controller.
1797	Slot x drive array – Array Accelerator read error occurred. Data in Array Accelerator has been lost. Array Accelerator is disabled.	Replace the Array Accelerator or the Smart Array Controller. Restore data from backup.
1798	Slot x drive array – Array Accelerator write error occurred. Array Accelerator is disabled.	Replace the Array Accelerator or the Smart Array Controller. Restore data from backup.
1799	Slot x drive array – drive(s) disabled due to Array Accelerator data loss. Select **F1** to continue with logical drives disabled. Select **F2** to accept data loss and re-enable logical drives.	Data stored in the Array Accelerator has been lost; therefore, the drives have been temporarily disabled. Press **F2** to acknowledge the data loss and re-enable the logical drives. Restore data from backup.

Appendix H

Questions and Answers

This Appendix includes common questions about the RAID LC2 Controller.

Q: How many RAID LC2 Controllers can I install in my system, and how many internal drives?

A: Since the RAID LC2 Controller only supports internal drives, only one RAID LC2 Controller can be installed in your system.

The maximum number of internal drives that you can install in your system depends upon your server and your choice of hard drive heights. The RAID LC2 Controller can support up to 15 drives.

Q: Which Compaq ProLiant servers are compatible with the RAID LC2 Controller?

A: The only supported Compaq ProLiant servers are the ProLiant ML330 and ML350.

Q: Does the RAID LC2 Controller support SCSI tape drives and CD-ROM drives?

A: No. The RAID LC2 Controller **only** supports Wide Ultra3 (at 80 MB/s), Wide Ultra2, and Wide-Ultra hard drives.

Q: I installed the hard drives in my server. Must I now terminate each drive?

A: No. If you installed hard drives in a server with a RAID LC2 Controller, all termination requirements are met by the I/O board and the hot-plug

backplane in the server. Individual hot-plug drives should already have termination removed.

Q: What is LVD? Is this the same as Ultra3 SCSI?

A: No. Low-Voltage Differential (LVD) SCSI is a new electrical platform for SCSI protocols. Ultra2 is the first protocol to take up residence on a LVD platform. Therefore, Ultra3 and LVD are not the same. Previous generations of SCSI protocols resided on a Single-Ended (SE) electrical platform.

Q: Are Single-Ended SCSI and Low-Voltage Differential SCSI compatible?

A: Yes. SE and LVD are compatible in as much as when mixing SE drives and LVD drives on a single SCSI channel, all drives will switch down to SE SCSI and operate under SE SCSI rules. According to the rules of SCSI, to maintain a true LVD SCSI bus and its associated performance, only LVD SCSI drives can be on the same LVD SCSI channel.

Q: Should SCSI IDs in my system be consecutive?

A: No. It is no longer required that the IDs of devices on each SCSI bus be consecutive. However, IDs must still be unique for each device on a single SCSI bus.

Q: What must I do with System ROMPaq?

A: Run System ROMPaq to upgrade the firmware in your server to the latest revisions prior to installing a RAID LC2 Controller in an existing system. Otherwise, the system may not reboot if the RAID LC2 Controller is the primary controller.

Q: How do I interpret a POST error message referring to the RAID LC2 Controller?

A: First, copy down the POST error message for later reference. See Appendix G, "POST Error Messages," for information on each POST error message. If you still do not know what to do, run the Array Diagnostics Utility.

Q: Can I use third party (non-Compaq) drives on the RAID LC2 Controller?

A: Yes. However, Compaq offers a unique Pre-Failure Warranty for all drives—valid only when using Compaq Drives, Compaq array controllers,

and Compaq Insight Manager. Contact your dealer for more information on Compaq Pre-failure Warranty.

Although you *can* use third party drives, experience in Compaq testing laboratories reveals that you might have problems such as time-outs, and/or data corruption. The RAID LC2 Controller takes full advantage of tagged-command queuing, something that can be a problem in the firmware of many third party drives.

Q: Why do the drive activity lights light up on some drives when my system is idle?

A: The RAID LC2 Controller performs several different background activities on the drives when the controller is otherwise idle. For example, the Auto Reliability Monitoring task scans fault-tolerant volumes for defects and verifies the consistency of parity data: The Drive Parameter Tracking task periodically checks the performance of all drives on the controller, normally on an hourly basis.

Appendix **I**

Glossary and Acronyms

ADU (Array Diagnostic Utility)

A diagnostic tool that collects comprehensive information about the array controllers in a system and lists any problems detected.

ARM (Auto-Reliability Monitoring)

Also known as surface analysis. A fault management feature whereby hard drives are scanned for bad sectors, and parity data consistency is verified for drives in RAID 5 configuration. Operates as a background process, in RAID 1 or RAID 5 configurations.

Array

A set of physical drives configured into one or more logical drives. Arrayed drives have significant performance and data protection advantages over non-arrayed drives.

Automatic Data Recovery

Also known as rebuild. A process that automatically reconstructs data from a failed drive and puts it onto a replacement drive. Rebuild time depends on several factors, but at least 15 minutes should be allowed per gigabyte.

Cache

A high-speed memory component, used to store data temporarily for rapid access.

Capacity expansion

An increase in storage capacity of a drive array by adding physical drives and creating more logical drives.

Capacity extension

An increase in storage capacity of a drive array by adding physical drives and enlarging existing logical drives (without creating more logical drives). Same as logical drive extension.

Controller duplexing

A type of fault tolerance that requires two array controllers. Each controller has its own drive, and the drives have identical data. When one controller fails, the other automatically takes over the servicing of requests. Controller duplexing is only available for some operating systems with some controllers.

Compaq Insight Manager

An easy-to-use and powerful server management utility, capable of collecting, analyzing and transmitting data about the condition of a server. It is also useful for managing server fault conditions, monitoring server performance, and remotely controlling, reconfiguring or restarting your system.

Compaq Management Agents

Server-based software that transmits data about the server to SNMP-based management tools, such as Compaq Insight Manager.

Data guarding

See **RAID**

Data striping

Data written to logical drives in interleaved chunks to improve system performance.

Drive mirroring

See **RAID**

ECC (Error Correction and Checking) memory

A type of memory that checks and corrects single-bit or multi-bit memory errors (depending on configuration) without causing the server to halt or corrupt data.

Fault tolerance

The ability of a server to recover from hardware problems without interrupting server performance or corrupting data. RAID is most commonly used, but other types of fault tolerance also exist; for example, controller duplexing. Software-based drive mirroring is another type of fault tolerance.

Flashing

Flash memory updating on a system. Flash memory is non-volatile memory used to hold control code such as BIOS information. It is also very fast, because it can be rewritten block by block, rather than byte by byte.

Hot spare

See online spare

Logical drive (or logical volume)

A part of a set of physical drives that is allocated, and behaves, as one unit. Each constituent physical drive contributes the same storage volume to the total volume of the logical drive.

Logical drive extension

An increase in the size of a logical drive without disruption of the data on the drive. There must be free space on the array; if required, physical drives can be added to the array to create free space and allow the logical drive to be extended. Logical drive extension is only available with some operating systems.

LVD (Low Voltage Differential)

A type of SCSI signaling that allows a maximum transfer rate of either 80 MB/s or 160 MB/s, conforming to either the Wide Ultra2 or Wide Ultra3 SCSI standards respectively.

Online spare

Also known as a hot spare. In fault tolerant systems, an extra drive present in the system used by the controller to automatically rebuild data from a failed drive.

ORCA (Option ROM Configuration for Arrays)

A ROM-based configuration utility for experienced RAID users who have simple configuration requirements.

POST (Power-On Self-Test)

A series of diagnostic tests that run automatically each time the server is booted or reset.

RAID (Redundant Array of Independent Disks)

A commonly-used form of fault tolerance that exists in several types. **RAID 0** (no fault tolerance) uses data striping to distribute data evenly across all physical disks in the array, but has no redundant data. **RAID 1** (drive mirroring) duplicates data from one drive onto a second drive; if more than one pair of drives is involved, this is termed **RAID 0+1** (or RAID 10). **RAID 5** (distributed data guarding) stores parity data across all drives in the array, and uses the parity data and data on remaining drives to reconstruct data from a failed drive.

Rebuild

See Automatic Data Recovery

ROMPaq

A utility for updating the system or option firmware, available on the SmartStart and Support Software CD or from the web. Flashing must be supported to take advantage of ROMPaq.

SCSI ID

A unique ID number assigned to each SCSI device connected to a SCSI channel. The ID number determines the device priority on the SCSI bus; ID 7 is the highest priority, and is always assigned to the SCSI controller.

SE (Single-Ended)

A type of SCSI signaling that allows a maximum transfer rate of 40MB/s. Conforms to the Wide-Ultra SCSI standard.

S.M.A.R.T. (Self-Monitoring And Reporting Technology)

Firmware on hard drives that provides advance warning of mechanical drive failure by monitoring critical drive attributes and providing system alerts when an attribute moves out of tolerance.

SmartStart

An abbreviation for the Compaq SmartStart and Support Software CD. A collection of software for updating system drivers, configuring arrays or a system, diagnosing problems with arrays or a system, and updating firmware for the system or options. (The latest version of any of these software packages can be obtained by downloading a SoftPaq from the Compaq website.) SmartStart can also create or update the system partition on your hard drive.

SNMP (Simple Network Management Protocol)

Governs network management and the monitoring of network devices and functions.

SoftPaq

A compressed, self-extracting executable file containing the latest version of a particular support software package. Can be downloaded to diskettes or directly to a hard drive.

Spare

See online spare

Surface analysis

See ARM

VHDCI (Very High Density Cable Interconnect)

A type of external SCSI connector used by SCSI controllers.

Wide-Ultra; Wide Ultra2; Wide Ultra3

A set of SCSI standards that support maximum signal transfer rates of up to 40 MB/s, 80 MB/s, and 160 MB/s respectively. See also LVD and SE.

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